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TECHNICAL MANUAL EDITOR ANALYSIS PROFILE: TEST CONSTRUCTION
AND PRELIMINARY STANDARDIZATION
FOR PERSONNEL SELECTION

by

Aurelius Anthony Abbatiello

A Dissertation Submitted to the Faculty of the Graduate School
of Loyola University in Partial Fulfillment of
the Requirements for the Degree of
Doctor of Philosophy

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1958

LIFE

Aurelius Anthony Abbatiello was born in Chicago, Illinois, February 15, 1924.

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CHAPTER I

INTRODUCTION

Test Purpose

Technical writing is a literary form used exclusively in industry today to explain the use of a manufacturer's product. This semi-technical literature takes the form of booklets, bulletins and brochures illustrating the operation, service and repair of specific products. Although the job area of technical writing is found throughout the manufacturing industry, few technical writers are employed by any single firm. For this reason little systematic attention has been given to the selection of these employees. In view of recent emphasis on specialization in engineering, attention may well turn to the production of a psychological instrument that will aid in the selection process. This study concerns itself with the design of such an instrument.

Those employed in this capacity have rather heterogeneous backgrounds.¹ They serve as ghost writers for the engineering staff, preparing product - use literature for serviceman and consumer alike. Qualifications for this

¹James B. Stone, "Engineer or Writer?", Technical Writing Review, Boston, Massachusetts, II, 2, March, 1955, 1.

job have been gleaned from six years of systematic observation of the field, including discussions with supervisors, technical writers and personnel men² in several industries. A listing of these qualifications would read as follows:

Sex - Male preferred.

Age - 20 to 60 years.

Stature - Incidental.

Physical condition - Ambulatory.

Marital status - None.

Dependents - Incidental.

Intelligence - Above average.

Personality - Introversive, adequately adjusted, analytically oriented.

Interests - Mechanical, scientific, literary, clerical.

Values - Theoretical, economic, aesthetic.

Education - 12 years with supplementary experience in the field of specialization; or, a degree in a science.

Recreation - Passive preferred.

Experience - Related to job area but not required.

The purpose of this paper, then, is to construct and set up preliminary norms for a psychological test devised for the selection of technical writing personnel. The Technical Manual Editor Analysis Profile designed

²Richard S. Schultz, "What Personality Traits and Aptitudes Should Technical Writers and Editors Have?," TWE Journal, New York, I, 1, 1956, 37-38.

in this study attempts to measure the aptitudes of technical writers.

These aptitudes are recognized by industry as clerical ability, writing facility, and specialized knowledge in engineering and the graphic arts.³

This proposed instrument seeks to determine the existence and degree to which each of the aptitudes has been developed as a measure of potential success or failure in technical writing. The series of tests proposed will seek to tap the skills, facility and knowledge necessary for successful performance on the job. Each aptitude represents an element basic to job performance.

Preliminary norms will be set up based on the administration of this test to currently employed technical writers. These norms will take the form of percentiles for ready comparison.⁴ By comparing the test results of an applicant with these tentative norms, the instrument may be used for personnel selection purposes. Further, to facilitate comparison of ability, performance results in each category may be graphically presented in profile form.

Test Design

The Technical Manual Editor Analysis Profile is a selection test of a power nature which has been designed to tap the key aspects of the work

³ Floyd Hickok, "The Informal Technical Writing Curriculum", Technical Writing Review, Boston, Massachusetts, II, 2, March, 1955, 7.

⁴ See Appendix I, 111-114.

involved in technical writing. The TMEAP, as the test shall be designated, is divided into three distinct sections, each constructed as a progressively specialized test of a subject's ability. Each section samples a different level of work within the job area, i.e., clerical, writing and specialized knowledge. The first section is designed to be predominantly clerical in nature. It may in effect be administered separately to determine the fitness of an applicant for a clerical position. The second section has been constructed for the selection of technical writers generally. The last section has been devised to assess the achievement level of an applicant in a particular phase of engineering. Alternate forms of the last section have been prepared, one dealing with the field of electronics and the other, with the field of refrigeration. Additional alternate forms of the subtest in this section may be prepared and inserted to test a particular phase of the engineering field.

To test ability for detailed operations, four subtests have been designated as the first section of the TMEAP, the Clerical Test. Subtest A₁, Proofreading Errors, has been designed to sample the facility for proofreading printed materials. Subtest B₁, Directions Test, has been prepared to determine the ability to perform the manipulations usually required in a filing arrangement. Subtest C₁, Comparisons and Analogies, has been specifically introduced here to serve as a mental adaptability indicator for all types of positions. Subtest D₁, Word Meanings, has been devised to measure the word facility needed by the technical writer. Because vocabulary correlates highly with executive ability, this subtest also measures

the capacity for administrative communication.⁵

The second section of the TMEAP, the Manual Writing Test, deals specifically with technical writing. This section contains three subtests.

Subtest A₂, Writing Instructional Material, deals with the core of the job area, the writing aspect. Subtest B₂, Identification of Assembly Parts, concerns itself with blueprint reading and parts identification. Subtest C₂, Determination of Logical Progression, has been formulated in an attempt to determine the subject's facility for the logical analysis of procedures. This subtest measures the application of the factors found in Subtest C₁ to the job area.

The last section of the TMEAP, the Specialized Aptitude Test, deals with a particular phase of engineering. Two alternate subtests have been completed. Subtest Q_{1A}, Electronics, is an achievement test for those applicants who have specialized in the area of electronics. Subtest Q_{1B}, Refrigeration, is an achievement test for those who have specialized in the area of refrigeration. Both Subtests Q_{1A} and Q_{1B} are pointed toward the measurement of the knowledge and theory required for the servicing of appliances developed within these phases of engineering.

Group Studied

The members of the parent population referred to in this study are usually employees of a manufacturing concern. These employees generally are

⁵F. H. Achard and F. H. Clarke, "You Can Measure the Probability of Success As a Supervisor", Personnel, XXI, 1944-1945, 353-373.

attached to departments handling the service of the appliance manufactured. They are responsible for the preparation of "technical mammals, bulletins, and other publications dealing with subjects, such as improvements in electrical and mechanical equipment and services, and the assembly, use, maintenance, and repair of materials."⁶

In the process of compiling this information the technical writer must consult workers engaged "in developing new equipment and in making improvements, and other sources, such as blueprints, trade and engineering journals, and manufacturers' catalogs, to acquire or verify technical knowledge of the subject."⁷ He may also select, organize, edit and rewrite "articles, bulletins, mammals, or other materials dealing with general and particular phases of the subject."⁸ It is his further responsibility to direct the "preparation of illustrative materials, such as photographs, drawings, and sketches."⁹ Specialization may occur in any phase of technical writing, such as the use, repair and maintenance of firearms or the application, theory, installation and operation of telephone and telegraph equipment.

⁶ U. S. Department of Commerce, Division of Occupational Analysis, "Technical Publications Writer", Dictionary of Occupational Titles Supplement, Edition III, Compiled under the supervision of Carl A. Heinz, Washington, D.C., 1945, 518.

⁷ Ibid.

⁸ Ibid.

⁹ Ibid.

The population sample that has been used consists of 60 subjects. Forty subjects comprise the original validation group and 20 subjects, the cross-validation group. Each of the subjects was employed as a technical writer by a manufacturer or private agency. Those manufacturing firms contacted were selected on the basis of fabricating facilities and type of appliance manufactured. Four electronics appliance manufacturers cooperated in the study along with a communications appliance manufacturer, two household appliance manufacturers, and three private agencies engaged exclusively in technical writing. All are located in or near the Chicago area. Each organization allowed the members of the technical writing staff to participate at his own discretion in the project. Since Subtests Q_{1A} and Q_{1B} apply specifically to electronics and refrigeration, only those firms dealing with these types of products were included. Because of this limiting factor the statistics applicable to purposive sampling have been used in the study.

CHAPTER II

REVIEW OF RELATED LITERATURE

Related Tests and Studies

At the present time no psychological instrument exists for the express purpose of selecting technical writing personnel. Nor has any study been found in a survey of the literature treating the specific problem of personnel selection in this area. Instruments and associated studies have appeared which attempt to measure elements assumed by their authors to be common to all forms of writing. However, none has attempted to measure those elements peculiar to the job area of technical writing.

This void in the literature probably reflects a lack of understanding of the peculiar combination of aptitudes and abilities required for job success in this area.¹⁰ As a result, several authors have attempted to extend a more generalized instrument to include this specific job category. Such an extension is neither warranted nor feasible in the light of the peculiarities of the specific job area of technical writing. The analysis of the job area previously discussed¹¹ indicates that the factors of prime importance to job success are a combination of:

¹⁰ Cf. *supra*, 1-2, 6-7.

¹¹ *Ibid*, 6-7.

- a. specific clerical aptitudes;
- b. technical writing ability; and,
- c. specialized engineering knowledge.

More specifically, those tests and batteries of tests presumed to tap areas related to and important for technical writing are: 1) the Flanagan Aptitude Classification Tests; 2) the Aptitude Tests of Occupations; 3) the Factored Aptitude Series of Business and Industrial Tests; and, 4) the General Aptitude Test Battery. The nature and contents of these tests and batteries of tests will now be discussed and evaluated.

- 1) The Flanagan Aptitude Classification Tests (FACT) provide test scores for 14 critical job elements, presumed to be common to many occupations.¹² The FACT battery is intended to avoid rigid pre-design and ideal conceptualization of job content. The battery of Tests breaks down into components the generalized aptitudes required for a given occupation. Extensive analysis has indicated several specific skills that make up the key components of each job area. Tests of these components are considered the best estimate of probable success in that occupation. Application of this battery is based on the fact that different occupations require different combinations of skills. The choice of the appropriate combination of tests lies with the vocational counselor. It is assumed that the counselor will draw on his own experience to select a test battery best suited to the purpose at hand.

¹² John C. Flanagan, Flanagan Aptitude Classification Tests, Science Research Associates, Chicago, Illinois, 1947.

The FACT battery identifies three aptitudes as requisites to writing success. These "critical" components of success in writing are "memory", "judgment and comprehension", and "expression."

Flanagan's elements neglect, however, to account for more essential aptitudes required for success in the area of technical writing, namely:

- a. specific clerical aptitudes;
- b. technical writing ability; and,
- c. specialized engineering knowledge.

- 2) The Aptitude Tests of Occupations "were constructed for the purpose of obtaining a quick but valid general vocational profile or picture of an individual."¹³ Although these Tests were devised for vocational purposes, the manual does not report test scores obtained by persons actively engaged in any occupation. A listing of coefficients of correlation between subtests and criterion is the only attempt to identify vocational areas. The manual also lacks specific reference to the sources for the occupational patterns listed. These occupational patterns "include not only a list of occupations related to each of the six major fields of aptitude measured by the tests but also include occupations which are related to more than one field."¹⁴

¹³ Wesley Roeder and Herbert Graham, The Aptitude Tests of Occupations, Manual, Form A, Grades 9-13, California Test Bureau, Los Angeles, California, 1951, 2.

¹⁴ Ibid, 6.

Here, emphasis is placed on the general rather than the specific. The most closely related job area to that being considered is that of "Editor". The specific area of technical writing is not considered. Furthermore, the purpose of the tests is not personnel selection but vocational guidance.

- 3) The Factored Aptitude Series of Business and Industrial Tests is a collection of tests based on the findings of factor analysis and designed for use in business and industry.¹⁵ Eight major factors of intelligence were selected as the basic framework for the battery. The factors are comprehension, reasoning, systems, perception, fluency, memory, space relations and coordination. These factors are sampled by means of 14 separate tests. The complete series of tests are intended for use in various combinations to predict success in given "job-test areas." The proportions of job areas represented and the composition of the total employed population on which norms were established seem rather arbitrary.

This Series represents the closest existing approximation to an adequate test battery in the job area under consideration. Six "aptitude factors" are deemed necessary to success in the "Writer job area" of the "Technical job family". These are "fluency in expression, language comprehension, logical thinking,

¹⁵ Joseph E. King, The Factored Aptitude Series of Business and Industrial Tests, Industrial Psychology, Incorporated, Tucson, Arizona, 1947.

memory for details, part-whole organization, and perception of details." Nevertheless, this proposed battery lacks specificity. It fails to measure two very essential components of technical manual writing, namely:

- a. technical writing ability; and,
- b. specialized engineering knowledge.

- 4) The General Aptitude Test Battery "is designed to measure several aptitudes which have been found important to success in many occupations."¹⁶ This Battery is intended to serve as an aid in placing applicants who have insufficient job experience. The Battery consists of 15 tests, 11 paper and pencil tests and four apparatus tests. The greater number of these tests are not original and resemble tests usually found in group intelligence batteries.

The range of difficulty of the paper and pencil tests limits these tests to adults capable of reading and understanding English. The manipulative type tests were designed not as work samples, but as measures of the aptitudes likely to be required in successful job performance. Since this Battery was intended as an advanced vocational guidance tool, it is not suitable for purposes of the present study.

¹⁶ United States Employment Service, General Aptitude Test Battery, Guide to the Use of the GATE, B1001, Bureau of Employment Security of the Labor Department, Washington, D.C., 1946, Part I, 5.

None of the tests analyzed in this section differentiate the technical writer. Although several treat some of the areas of technical writing, they measure only general aptitudes related to this area. With one exception, they serve as little more than vocational guidance aids. This exception, the Factored Aptitude Series, falls down by failing to deal with the more essential components requisite to success in technical writing. As a result of this survey, the need for a test of this particular job area becomes more apparent.

Studies of Test Construction

Research studies concerned with the construction of psychological tests have been fully described in several contemporary texts, and are now so numerous that no attempt will be made to survey the literature entirely. Reference may be made to the works of Florence Goodenough,¹⁷ of Lee Cronbach,¹⁸ of Herbert Moore,¹⁹ of Charles Lawshe, Jr.,²⁰ and of Anne Anastasi²¹ for adequate summaries of the principles of test construction. The nature and contents of only those studies which bear directly on the problem at

¹⁷Florence Goodenough, Mental Testing, New York, 1949, 134-138.

¹⁸Lee J. Cronbach, Essentials of Psychological Testing, New York, 1949, 43-83.

¹⁹Herbert Moore, Psychology for Business and Industry, New York, 1942, 106-121.

²⁰Charles H. Lawshe, Jr., Principles of Personnel Testing, New York, 1948, 177-191.

²¹Anne Anastasi, Psychological Testing, New York, 1955, 72-172.

hand will be considered in the following paragraphs.

- 1) Probably the work that has contributed most to the construction of the Technical Manual Editor Analysis Profile (TMEAP) is that of Dorothy Adkins.²² This volume contains a step-by-step procedure for the development of an aptitude test. Provisions are made for an understanding of the structure of a test battery, of the most acceptable ways of arriving at test content, of the manner in which items behave in combination, of the means by which one may arrive at a job success criterion and of the ways to determine the contribution of each item to the desired end. The particular value of this manual for the present study lies in its orientation. The use of examples drawn from real situations indicates a concern for the practical problems in personnel selection.
- 2) Another work pertinent to test construction and test acceptance is worth noting. It has relevance to the problem at hand by way of implication rather than by inference. This discourse prepared by a joint committee of the American Psychological Association, American Educational Research Association, and National Council on Measurements Used in Education has been offered to the profession as an aid to test selection.²³ Tenets are set down for both test

²² Dorothy C. Adkins, Construction and Analysis of Achievement Tests, Washington, D. C., 1947.

²³ Lee J. Cronbach, et al., "Technical Recommendations for Psychological Tests and Diagnostic Techniques," Psychological Bulletin, Washington, D.C., LI, 1954, 201-238.

constructors and test users.

Adkins' procedure has been adopted for use in constructing the TMEAP. The wealth of experience that it represents makes it an invaluable guide for test construction. The "Technical Recommendations for Psychological Tests and Diagnostic Techniques" represent a crystallisation of current thought on psychological tests. It is considered valuable because it itemizes the type of information needed by test consumers.

Studies of Item Analysis, Selection and Construction

For a historical summary of the principles of item analysis, the reader is referred to those sources mentioned in the preceding section²⁴ and also to the work of J. P. Guilford.²⁵ Over and above the works cited, there are several studies that merit more detailed attention. Each touches on a phase of item analysis, selection and construction as it applies to this present study.

- 1) P. M. Symonds' discussion of the choice of test items offers six propositions that have been of assistance in the present study.²⁶ His proposed selection process was based on item difficulty with equal validity assumed. He contended that the items measuring the ability of an individual most adequately are those that can be done with 50% accuracy. The most appropriate item for determining

²⁴Cf. supra, 13-14.

²⁵J. P. Guilford, Fundamental Statistics in Psychology and Education, 2nd, New York, 1950, 473-543.

²⁶P. M. Symonds, "Choice of Items for a Test on the Basis of Difficulty," Journal of Educational Psychology, Baltimore, Maryland, XX, 1929, 491-493.

variance between individuals is one which lies midway in difficulty between two items resembling the one previously constructed.

Although the study antedates present statistical methods, it is noteworthy from a historical standpoint. It stands in the literature as one of the earlier studies treating the selection of items from a statistical approach. The six propositions are still being considered by test constructors in the selection of discriminating test items.

- 2) The types of information supplied by the technique of item analysis have been discussed by H. Conrad.²⁷ He suggests that the use of item analysis data yields more detailed, objective and quantitative information for each item than could be otherwise obtained. Such data provide a convenient, practical basis for selecting items for subsequent forms of a test as well as for revisions and improvement of test items. The judicious selection of these items on the basis of these data may improve the reliability of a test.

The monograph has been utilized as a guide for improving the test items of the TMEAP. The use of item analysis data in the present study has improved the reliability of the instrument.

- 3) Because methods of item analysis became important on consideration of Conrad's monograph, further investigation of the literature was necessary. Four methods of item analysis were compared by

²⁷ Herbert S. Conrad, "Characteristics and Uses of Item-Analysis Data," Psychological Monograph, Washington, D. C., LXIII, 8, 1948, vi, 1-48.

Jerome Ely using a multiple-choice vocabulary test.²⁸ Three of the methods, phi coefficient, D-values and Davis' r, were found to be practically identical. The method of percent, however, was found to be disparate. The implication is that any of the three methods found identical may be used in analysis with equally efficient results.

- 4) For the development of multiple choice test items, Mosier, Myers and Price maintain that "planning, rather than the inspiration technique," should be used.²⁹ Helpful suggestions are given for:
- 1) defining and sampling the subject matter;
 - 2) forming the question for a satisfactory multiple choice item; and,
 - 3) forming the criterion for those items constructed.

The studies cited in this section are primarily concerned with the problems of item analysis, selection and construction. Since such problems arise anew with each attempt to measure an aptitude, they must be considered in detail by test constructors. The work of H. Conrad, in particular, stands as a classic in its own right, offering a point of departure on this problem for the present study.

Studies of Reliability

A good discussion of the concept of reliability may be found in the

²⁸Jerome H. Ely, "Studies in Item Analysis. 2. Effects of Various Methods upon Test Reliability," Journal of Applied Psychology, Washington, D. C., XXXV, 1951, 194-203.

²⁹C. I. Mosier, M. C. Myers and H. G. Price, "Suggestions for the Construction of Multiple-Choice Items," Educational and Psychological Measurement, Durham, North Carolina, V, 1945, 261-271.

work of A. Anastasi.³⁰ The reader is referred to this source for the most recent historical summary of the studies on the subject. Each of the statistical methods cited by J. P. Guilford³¹ and Henry Garrett³² for determining reliability has been considered here. However, only those studies immediately pertinent to the construction of the TNEAP will be discussed in detail.

- 1) Alexander Wesman and John Kernan found that empirical data did not agree consistently with theoretical expectations about speed and power in subtests of the General Classification Test.³³ This experiment showed that internal consistency measures of reliability can be spuriously high when test scoring depends more on speed than on power. In an effort to check theory by specific fact, test-retest correlative, split-half, the Kuder-Richardson formulae 20 and 21 were used to calculate reliability measures for each of

³⁰Anastasi, Psychological Testing, 94-119.

³¹Guilford, Fundamental Statistics, 473-511.

³²Henry E. Garrett, Statistics in Psychology and Education, 3rd, New York, 1950, 380-403.

³³Alexander G. Wesman and John P. Kernan, "An Experimental Comparison of Test-Retest and Internal Consistency Estimates of Reliability with Speeded Tests," Journal of Educational Psychology, Baltimore, Maryland, XLIII, 1952, 292-298.

the GCT scores. The split-half and Kuder-Richardson formula 20 coefficients resembled each other closely. Both tended to be higher than the test-retest coefficients. Kuder-Richardson formula 21 gave measures appreciably lower than the others.

This experiment confirms the fact that items steeply graded in difficulty control the spuriousness of the internal consistency measures. This relation of item difficulty to internal consistency holds only when test scoring depends more on speed than on power. These findings dictate caution in selecting appropriate consistency measures for determining reliability.

- 2) The use of Kuder-Richardson formulae 20 and 21 were considered by Ledyard Tucker for quick estimates of test reliability.³⁴ Tucker found that formula 20 yields a much better estimate, as did Wesman and Kernan, but is more time consuming. Formula 21, on the other hand, underestimates reliability. As a result, formula 20 was rewritten to be identical to 21 except for the addition of the standard deviation of that portion of the sample population passing an item. In the present study formula 21 is being used to determine the internal consistency of some of the subtests of the TMEAP.
- 3) Exploring a somewhat different facet of test reliability, Edward Clark found that split-half correlations showed a negligible

³⁴Ledyard R. Tucker, "A Note on the Estimation of Test Reliability by the Kuder-Richardson Formula," Psychometrika, Colorado Springs, Colorado, XIV, 1949, 117-119.

variance due to methods as compared with the variance due to samples.³⁵ He concluded that the subjects used were the primary cause for the instability of the coefficients of consistency -- provided that the method used in splitting the test was longitudinal. These conclusions were applied to the selection of the sample population in the present study.

- 4) N. Gage and D. Damrin compared the concepts of reliability represented by the Spearman-Brown corrected split-half coefficient, Guttman's L and Kuder-Richardson Cases III and IV.³⁶ The differences between these single trial estimates of reliability were in the directions expected from an analysis of the formulae. The formulae were used on data obtained from the Ohio State Psychological Test but the differences between them were too small to be of practical significance. Of even more importance to the present study was the finding that variations in the number of answer choices per item increased the reliability as the offered choices increased. This conclusion aided greatly in deciding upon the most appropriate measure for determining reliability in the TMEAP.
- 5) Frederic Lord undertook a study of curvilinear correlation as it

³⁵ Edward L. Clark, "Methods of Splitting versus Samples as Sources of Instability in Test-Retest Coefficients," Harvard Educational Review, Boston, Massachusetts, XIX, 1949, 178-182.

³⁶ N. L. Gage and Dora E. Damrin, "Reliability, Homogeneity, and Number of Classes," Journal of Educational Psychology, Baltimore, Maryland, XII, 1950, 385-404.

relates to test reliability.³⁷ An expression in terms of item difficulties and intercorrelations is derived for the curvilinear correlation of test scores on the "ability underlying the test." This particular ability has been previously defined as the common factor of item tetrachoric intercorrelations corrected for guessing. The curvilinear correlation is shown to be equal to the square root of test reliability. Thus, numerical results, if defined in terms of their item parameters, indicate that reliability and correlation will be maximized under two conditions. The variability of item difficulty must be minimized and the level of item difficulty must lie halfway between chance and a correct answer.

Lord's study on curvilinear correlation and test reliability is an important contribution to determining the reliability of multiple-choice items. The article is of particular interest because several subtests of the TMEAP are of a multiple-choice nature. Lord's conclusion that the curvilinear correlation is equal to the square root of the test's reliability has immediate application.

These articles represent the material on test reliability that is most pertinent to the present study. Each covers some aspect of reliability. The mechanics of standardization that have

³⁷Frederic M. Lord, "The Relation of the Reliability of Multiple-Choice Tests to the Distribution of Item Difficulties," Psychometrika, Colorado Springs, Colorado, XVII, 1952, 181-194.

been considered are applicable in determining the consistency of the TMEAP.

Studies of Validity

A comprehensive review of the principles of validity may be found in Anastasi's latest work, Psychological Testing.³⁸ This volume contains the most recent developments in the area of validity. The statistical methods recommended by Anastasi have been secured in detail from J. P. Guilford.³⁹ These general works form the basis for the development of the concept of validity in the present study along with the following articles.

- 1) Franklin Henry as well as H. Taylor and J. Russell have studied extensively the problem of the practical utility of tests in the selection process. Taylor and Russell have rationalized the problem in a clear and lucid manner. It is their contention that test utility depends upon other factors than the validity of the test battery.⁴⁰ It depends upon the percentage of employees who would have succeeded if testing had not been applied in selection. It also depends upon the percentage of applicants who are selected by means of tests.

Henry has developed a broader basis than Taylor and Russell

³⁸Anastasi, Psychological Testing, 120-172.

³⁹Guilford, Fundamental Statistics, 512-543.

⁴⁰H. C. Taylor and J. T. Russell, "The Relationship of Validity Coefficients to the Practical Effectiveness of Tests in Selection," Journal of Applied Psychology, Washington, D. C., XXII, 1939, 565-578.

for delineating "the relationship between degree of selection and the degree of criterion success for specified validity coefficients, leading to a rational basis for determining the best placement of 'cutting-scores' for selection or rejection of tested individuals, and for deciding whether it is worthwhile to use a certain test in some particular situation."⁴¹ Emphasis throughout his study is placed on the importance of recognizing the variance in efficiency of tests while the validity coefficient remains constant.

Henry's technique has greater significance for this study than has Taylor's and Russell's technique because it permits "the determination of the effectiveness of a test in eliminating potentially successful individuals from the rejected groups."⁴² This procedure is important in preventing a Type II error, where exclusion from a position is based on test scores.

- 2) In view of the need for greater accuracy in validating procedures, Hubert Brogden and Erwin Taylor have stressed the elimination of faulty criteria as a means of increasing predictive efficiency of

⁴¹ Franklin Henry, "The Theoretical Efficiency of a Test," Research Quarterly of the American Association for Health, Physical Education and Recreation, Washington, D. C., XVIII, 1947, 91.

⁴² Ibid.

a test.⁴³ Faulty or biased criteria are grouped into four categories:

- a. Criterion deficiency,
- b. Criterion contamination,
- c. Criterion scale unit bias, and,
- d. Criterion distortion.

Particular stress is laid on the concept of test-free or test correlated bias as a supplementary factor affecting the final results.

This proposal for criterion construction is of value to the present study. There is little doubt, as indicated, that faulty criterion construction detracts from the efficiency of the predictive instrument. The article serves its purpose by pointing out the pitfalls of criterion construction.

- 3) Asa Knowles rephrased and regrouped the job requirements of the usual supervisory type task. He translated these requirements into terms "that will cause the rater to think of the factors involved in terms of the capacity of an individual to meet them."⁴⁴ His basic assumption was that rating scales "attempt to measure the presence or absence in individuals of the characteristics which are

⁴³Harbert E. Brogden and Erwin K. Taylor, "The Theory and Classification of Criterion Bias," Educational and Psychological Measurement, Durham, North Carolina, X, 1950, 159-186.

⁴⁴Asa Knowles, Merit Rating of Supervisors, Foremen and Department Heads, Bulletin 4, Northeastern University, Boston, Massachusetts, November, 1940, 8.

essential to meet the job requirements set forth in the job specifications."⁴⁵ He summarized the results of several job studies by graphing the responsibilities of the individual into a scale composed of factor constellations. In using this scale, the rater is asked to judge the performance of the worker on the job. Ratings are given in terms of these factor constellations, as well as "the relative significance of each trait therein as applied to that particular job."⁴⁶

The contribution of Knowles to the present study is probably the greatest of all those cited. The rating scale outlined in a series offered by Northeastern University to industry seemed most adaptable as a criterion measure for the current study. The most important feature of the scale is its overall versatility.

- 4) An attempt to develop a battery of aptitude tests to aid in personnel selection led E. Rundquist and R. Bittner to a study of ratings obtained for criterion purposes.⁴⁷ Evidence is presented that foremen do not readily distinguish between ability and personality. Additional findings showed that personality ratings were not

⁴⁵Ibid, 7.

⁴⁶Ibid, 12.

⁴⁷Edward A. Rundquist and Reign H. Bittner, "Using Ratings to Validate Personnel Instruments," Personnel Psychology, Baltimore, Maryland, I, 1948, 163-183.

appreciably influenced by length of service and that overall ratings were not superior to the sum of the second-part ratings.

A question concerning the validity of the criterion measure proposed by Asa Knowles⁴⁸ was brought to light by the study of ratings. Here we find that a high relationship between test and rating will result, if the proper precautions are taken, in the rating process. On the basis of such findings, it seemed plausible to proceed with the use of the rating scale proposed.

- 5) According to L. Cronbach and P. Meehl the validation of psychological tests has not yet been adequately conceptualized.⁴⁹ To do this, it is necessary to distinguish four types of validity: Predictive, concurrent, content and construct. The last of these, construct validity, was introduced into test construction in order to specify types of research required in developing tests for which conventional views on validation are not appropriate. This discussion indicates how evidence of attributes can be substantiated and interpreted in the absence of an adequate criterion.

Cronbach's and Meehl's elaboration of construct validity, has recently appeared in the literature to extend the discussion on

⁴⁸Cf. supra, 25-26.

⁴⁹Paul E. Meehl and Lee J. Cronbach, "Construct Validity in Psychological Tests," Psychological Bulletin, Washington, D. C., III, 4, 1955, 281-302.

validity of the previous year.⁵⁰ Since construct validity concerns subjective type tests, it is not immediately applicable to objective type tests such as the TMEAP.

Each of the studies cited has been of value in the determination of the validity of the TMEAP. Each study or discussion has a particular contribution to make. Most important has been that of Knowles in contributing the criterion measure for the TMEAP. Of lesser importance have been the contributions of the others.

Summary

The bulk of the material cited has to do with the mechanics of test construction and standardization. The studies dealing with mechanics have been divided into several areas in order to systematize the phases of construction and standardization. For the most part, those works that concern methodology cut across these arbitrary divisions. They serve in varying degrees of usefulness throughout the construction and the standardization of the instrument. The sequence of topics in this chapter parallels the order of concern with them. A consideration of test construction appears first, followed by the construction, selection and analysis of items, and finally the determination of reliability and validity.

Those tests that have relevance to the job area under consideration have been discussed. Each has been evaluated for validity with respect to

⁵⁰ Cronbach, et al., "Technical Recommendations," Psychological Bulletin, LI, 227-228.

the job area of technical writing. None has completely satisfied the demands of personnel selection. The survey of the literature has revealed the need for an instrument in this job area. The construction of the TMEAP attempts to fill that need.

CHAPTER III

METHODOLOGY AND APPROACH

Test Construction

A review of the literature has shown that there exists a need for a suitable psychological instrument to measure the aptitudes required in the job of technical manual writing. It was also shown that to be effective such an instrument must identify at least the grosser aspects of each aptitude. To be of practical value in the industrial setting the test must be simple to administer, easy to score and specific in its application. In the light of each of these criteria the demands of the job area were carefully analyzed.⁵¹ Eight specific facets were selected for measurement. A pilot study has shown that a measure of each of these facets can provide adequate reliability within reasonable testing limits. In addition, these measures intercorrelate low enough to indicate measurement of different aspects and furnish valid predictors of success in the job area.

In constructing subtests to measure the eight key facets, a set of practical criteria has been applied. By meeting these criteria, the Technical Manual Editor Analysis Profile (TMEAP) has taken on practical significance. The application of each of these governing principles or criteria

⁵¹Cf. supra, 1-2, 6-7.

to the instrument will be discussed in detail. These criteria are:

- a. Each subtest must be independent.
 - b. Each subtest must be a measure of power as well as speed.
 - c. Each subtest must contain practical materials.
 - d. Each subtest must be easy to administer.
 - e. Each subtest must have separate norms.
 - f. The battery of subtests must yield a profile.
- a. Because of the varied situations in which selection takes place, each facet of the aptitude should be measured separately. While it is important to administer the complete battery of subtests in the selection process, situations will arise in which only part of the TMEAP is required. For this reason, the subtests were constructed to permit easy division of the battery into sections for clerical, technical writing, or specialized technical writing positions.
- b. Aptitude test scores must reflect power in performance as well as speed in performance.⁵² Although earlier aptitude tests had been based essentially on speed, the current trend is to reduce emphasis on speed alone. Only Subtests B₁ and C₂ of the TMEAP have been constructed with speed as the critical factor although time limits have been set for all the subtests. The remaining subtests are of a power nature with time limits set to allow most subjects time to consider all items.

⁵²Wegman and Kernan, "An Experimental Comparison of Test-Retest and Internal Consistency Estimates of Reliability," Journal of Educational Psychology, XLIII, 292-298.

- c. The TMEAP is constructed to meet the practical demands of an industrial situation. The eight subtests can be administered in whole or in part to tap different sets of skills. Subtests A₁ through D₁ are intended to assess clerical skills. Subtests A₂ through C₂ are proposed to assess technical writing skills. Subtest Q_{1A} or Q_{1B} is designed to assess specialized engineering-service knowledge.
- d. Directions for administration appear at the beginning of each subtest. These directions are read by both administrator and subject alike. Illustrations have been included where it has been found necessary to clarify the task to the subject. The governing principle here is to simplify the administration of the test as much as possible. Detailed information on test administration and general test conditions appear in the test manual.⁵³
- e. The norms published in the test manual are based on a sample of forty technical writers.⁵⁴ These writers are currently employed by industrial firms or technical writing agencies in and around the Chicago area. Firms located elsewhere which will use the test may wish to develop their own norms, especially if their work population differs from the sample used in this study.
- f. The score on each subtest of the TMEAP may be plotted on the chart

⁵³See Appendix I, 97-99.

⁵⁴See Appendix I, 113.

appearing on the face of the test booklet. The resulting profile can be used to facilitate interpretation of the results. Since the weighted subtest score is a multiple of 100, the intervals on the profile chart for each subtest are comparable. All weighted scores may be converted to percentile ranks for ready comparison.⁵⁵

The eight subtests of the TMEAP⁵⁶ shall now be described briefly in the light of the criteria developed in the previous paragraphs. Each subtest regardless of its form has been constructed by the author with one end in view -- to appraise a particular aspect of the technical writing job area. While no clear demarcation between aptitude and achievement is possible, the intent was to produce an aptitude test. The varied sources of origin for each subtest shall be noted. Some subtests have rather new item types or novel versions of older forms. Others have item types that have been used before. The aim in each instance has been to present materials that possess face validity for the subject.

Proofreading Errors

Subtest A₁ is intended to measure the subject's ability to proofread printed materials for typographical, grammatical, and punctuation errors. The item form is original and has the unusual advantage of providing fifty items distributed evenly throughout the passage. Herein the subject must consider each word, phrase and sentence for possible error both in and out

⁵⁵See Appendix I, 111-114.

⁵⁶Cf. *supra*, 3-6.

of context. Since any number of errors may occur in any grouping of words, the subject cannot follow a set response pattern. He must react singly and separately to each error.

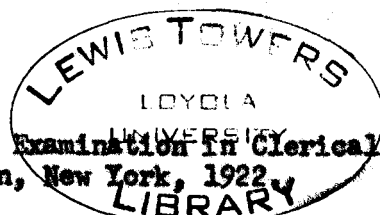
In originally constructing this type item, the length of the passage became a matter of concern. It was suspected that a considerable amount of material may have to be included to act as "filling" for the errors in which there was special interest. From a measurement standpoint, this "filling" would prove ineffective. However, in the course of construction it was found that much of the "filling" material contributed very effectively to the measurement of proofreading ability.

Directions

Subtest B₁ is intended to measure speed of response in a simple perceptual task. Two different types of items were used. The first is a cancellation form item which draws heavily on immediate recall and perceptual acuity. Herein the subject is required to cross out letters, A, Z, C, and U, found among several rows of letters. The second is a substitution form item which calls for retention and greater hand-eye coordination. Herein the subject is required to code several rows of figures by substituting a letter for a number. These types of items were adapted from the Thurstone Employment Tests.⁵⁷

The item type provides situations which approximate those found in many clerical tasks. It involves a simple task of a routine nature. Little if

⁵⁷ L. L. Thurstone, Thurstone Employment Tests, Examination in Clerical Work: Form A, World Book Company, Yonkers-on-Hudson, New York, 1922.



any intellectual difficulty is introduced since other components of intelligence are adequately measured by the remaining subtests in the battery. The objective of this test is to measure memory as well as perceptual speed and acuity.

Comparisons and Analogies

Subtest C₁ is intended as a measure of ability to understand verbal concepts. Its aim is to evaluate the subject's ability to abstract, to generalize and to structure ideas. This ability for comprehension is tapped by analogies and comparisons particularly suited to multiple-choice construction. Both types of items have proven useful for the ease with which they may be constructed into highly reliable items. Such a measure of comprehension is relatively complex without being esoteric.

The simple analogy has been used extensively in group tests of intelligence. It requires the expenditure of a good deal of mental energy for its solution. At the same time, its content may be as varied as test construction demands. The widespread use of the analogy demonstrates its value in measuring one facet of intelligence. The type of item appearing in this subtest follows the form of several of the more widely used group intelligence tests, such as, the Otis Employment Tests⁵⁸ and the Hermon-Nelson Tests of Mental Ability.⁵⁹

⁵⁸ Arthur S. Otis, Otis Employment Tests, Higher Examination Form A, World Book Company, Yonkers-on-Hudson, New York, 1922.

⁵⁹ V. A. C. Hermon and M. J. Nelson, The Hermon-Nelson Tests of Mental Ability, Form A, Houghton Mifflin Company, New York, 1931.

Word Meanings

Although the items in Subtest D_1 are original, this type of item is used widely in intelligence tests. Each word chosen for use was selected according to item difficulty. The complete list of words is steeply graded in difficulty in an effort to cover the range of intellectual capacity possessed by subjects in the job area.

The selection of a word list of appropriate difficulty proved to be a problem. Many of the words selected in the first few attempts at construction were found to be familiar to subjects specializing in some field of study. These words proved to be poor predictors. A more extensive study of words and word difficulty provided a list of 25 items which proved to be more effective. An item analysis has shown that every item contained in this present form of the subtest contributes its share to the accuracy of measurement, thus insuring greater reliability.⁶⁰

Writing Instructional Material

Subtest A_2 is an original form prepared exclusively for the TMEAP. It consists of only one item accompanied by an illustration. This item is a work sample. The problem requires the subject to prove his ability to write an instructional procedure for operating a familiar instrument. Extensive research indicated that a simple apparatus common to the experience of the greatest number of subjects would prove most reliable in measurement.⁶¹

⁶⁰The item-test correlational method was used for purposes of item analysis. For details see Adkins, Construction and Analysis of Achievement Tests, 182-184.

⁶¹Ibid., 56-64.

The model apparatus used is a dial telephone hand set, Model 202C3F, manufactured for the Bell System by Western Electric Company.

Identification of Assembly Parts

The type of item devised for Subtest B₂ represents a unique approach to the measurement of another facet of technical writing - blueprint reading. The ability to visualize a constructed object of three dimensions from a two-dimensional drawing and to identify those parts of the constructed object is essential to technical writing. The technical writer is often required to write directions for operating a mechanism not yet fabricated. Here his spatial ability to convert from two to three dimensions comes into play.

A simple mechanism has been found appropriate for this subtest. The task requires the subject to identify the various parts of the mechanism and to relate each part to the whole. Since the drawing of the mechanism is large and clear, no premium is placed on visual acuity. It is typical of engineering assembly blueprints produced by draftsmen. The correctness of the response does not depend upon specialized knowledge but upon the subject's ability to recognize the structural components of a mechanism presented in two dimensions.

Determination of Logical Progression

Subtest C₂ is intended as a measure of the subject's ability to reason logically. The task is also closely allied to the practice of technical writing. It demands that the subject determine the operating principle of a procedure. By rearranging a set of statements into their proper sequence,

the subject gives evidence of understanding that underlying principle.

A series of statements is presented for each of two individual problems. The first series involves a simple household chore; the second series, the servicing of a simple device. The task is to number the statements consecutively in the step-by-step progression required for successful completion of operation. Complexity is achieved by increasing conceptual difficulty. Each step in each problem has been constructed as a separate statement. Care has been taken to eliminate cues to the proper sequential arrangement. The arrangement of these steps into a meaningful whole is the exercise.

Electronics

Refrigeration

Subtests Q_{1A} and Q_{1B} are designed to measure the subject's understanding of electronics and refrigeration principles respectively. The items are framed in a multiple-choice item form. This form was used to determine the accuracy and extent of the subject's working knowledge in each respective field of engineering. The advantages of this item form are objectivity and ease of scoring.

The subtest items have been constructed to tap both the subject's knowledge of working principles and of theory. Each item calls for a thorough understanding of a particular engineering-service field. The results of an item analysis executed by the author have shown that measurement of such factual knowledge is not impaired by framing the questions into multiple-choice items. These items are sufficiently complex in nature to challenge

subjects regardless of the extent of their knowledge.

Criterion Construction

Efforts to set up a criterion on the bases of output and speed proved impossible because of differing demands made on the technical writer in each job setting. No single unit of output beyond the finished product was found to be common to technical writers. For this reason, it was found expedient to use a subjective impression measure as a criterion for the TMEAP. With such a measure those characteristics related to job success could be assessed most efficiently.

The appraisal of a subject's effectiveness on the job can become meaningful only by defining the scope of the job, the limitations and the demands imposed on the successful employee. Such an appraisal is most easily achieved by means of a rating scale. An adaptation of a rating scale⁶² devised by A. Knowles⁶³ has proven best as a criterion measure. This scale attempts to measure a subject's performance in terms of the proper fulfillment of the job demands. It also proposes to assess characteristics deemed essential to meet the requirements determined by job analysis.⁶⁴ These requirements have been formulated as factors for the rater to consider in his evaluation. These factors have been grouped into three constellations: Personality, Performance and Executive Capacities.

⁶² See Appendix IV, 147.

⁶³ Knowles, Merit Rating of Supervisors, Foremen and Department Heads, 9.

⁶⁴ Cf. supra, 1-2, 6-7.

The Personality factors deal with the capacities for working cooperatively with others: Appearance, Ability to Get Along with Others, Character, Intelligence. The factors that bear directly on job performance, Performance factors, are: Personal Productivity, Productivity of Unit for Which Responsible, Personal Efficiency, Efficiency of Unit for Which Responsible. The factors that indicate potential growth, Executive Capacities, are: Initiative, Organizing Ability, Leadership, Cooperation.

This rating scale has the advantages of the structural components to be found in the "Graphic", "Grouping", and "Specific Item" scales. The rating is accomplished simply by checking the position of the ratee on the linear categorical scale. This procedure is completed in turn for each of the factors listed in the three constellations. When these ratings have been completed, the rater is asked to determine the "essentialness", "desirableness" or "unimportance" of each factor in job performance. Thus, the rater fulfills two distinct functions. He assesses the subject's performance in terms of job analysis and determines the relative significance of those factors isolated by the job analysis. No other rating scale has been found which accomplished these ends quite as simply and as directly.

Test Validation

Validation Study

The purpose of psychological testing is to provide information to aid the user in making predictions about the subjects. The problem of providing this information for personnel selection is extremely complex. Primary evidence that employees can be selected for a given job by means of a test

can only be secured by a longitudinal study. Such a study would begin with the date of employment and continue over a considerable period of time. This procedure would prove too time consuming and costly to be used here. However, secondary evidence of the usefulness of the TMEAP can be obtained by comparing an employee's test results with a rating of his job proficiency.

The latter method of validation has been used in this study in lieu of direct longitudinal evidence of the TMEAP's usefulness. The TMEAP was administered to forty subjects in group form.⁶⁵ Each group contained not less than five men. Ratings obtained for each subject were related to test results. Sampling statistics appear in Table I.

The intercorrelations of eight subtests of the TMEAP are presented in Table II. Inspection of the Table shows that the intercorrelation coefficients range from a high of plus 0.67 to a low of minus 0.05. As might logically be expected, the independent variables measured by some of the subtests are more closely related than others. Since these variables are not mutually exclusive, the subtests must overlap also, duplicating one another to some extent. This clustering may be explained by the similarity of intellectual function demanded on certain subtests which "...is partly a consequence of the fact that good human qualities tend to go together and partly that our predictive indices tend to remain in the same area of abilities..."⁶⁶ The ability to identify proofreading errors, Subtest A₁,

⁶⁵Cf. *supra*, 6-7.

⁶⁶Guilford, Fundamental Statistics, 427.

for example, seems to be positively related to the ability to make comparisons, Subtest C₁, and to a knowledge of electronics, Subtest Q_{1A}. The ability to make comparisons, Subtest C₁, seems to be related to a knowledge of word meanings, Subtest D₁. The ability to follow directions as specified in the first portion of Subtest B₁ is closely related, as would be expected, to the same ability as specified in the second section of the same subtest.

TABLE I

VALIDATION SAMPLING STATISTICS
FOR TMEAP SUBTESTS A₁ THROUGH Q_{1A}

Subtest	A ₁	B ₁₁	B ₁₂	C ₁	D ₁	A ₂	B ₂	C ₂	Q _{1A}
Mean	71.5	73.1	71.1	65.1	33.7	66.6	44.9	62.8	64.4
Standard Deviation	10.9	14.7	11.6	10.2	21.3	16.7	12.9	21.8	16.7
Standard Error of Mean	1.7	2.4	1.9	1.6	3.4	2.7	2.1	3.5	3.0

VALIDATION SAMPLING STATISTICS
FOR RATING SCALE

Factor	RS*	Pers*	Perf*	ExCap*
Mean	205.0	67.8	76.4	59.8
Standard Deviation	39.2	13.7	17.1	13.8
Standard Error of Mean	6.3	2.2	2.7	2.2

* RS equals Rating Scale raw score; Pers equals Personality score; Perf equals Performance score; and, ExCap equals Executive Capabilities score.

TABLE II

VALIDATION CORRELATION MATRIX

FOR TMEAP SUBTESTS A_1 THROUGH Q_{1A} *[©]

Variable	A_1	B_{11}	B_{12}	C_1	D_1	A_2	B_2	C_2	Q_{1A}
A_1		.391	.380	.492	.582	.322	.199	.297	.570
B_{11}			.530	.219	.129	.225	.163	.036	.206
B_{12}				.280	.166	.250	.184	.228	.300
C_1					.673	.379	.325	.144	.273
D_1						.377	.161	.286	.424
A_2							.294	.246	.261
B_2								.383	-.048
C_2									.125

* N equals 40.

© The correlation coefficients were computed by the product-moment method.

While positive relationships indicate the extent of agreement between variables, no relationship indicates a complete independence of variables. Thus, in spite of the fact that blueprint reading and a knowledge of electronics seem to be the best predictors of success in technical writing, these subtests are not related to each other. The relationships indicated in the matrix seem to demonstrate that the abilities measured by each of the subtests are distinct enough to warrant inclusion in the TMEAP. A statistical evaluation confirms the premise that each subtest taps a different aspect of technical writing.

The correlation indices establishing the relationship between the TMEAP, its subtests and the criterion are found in Table III. The beta coefficients, regression weights and regression equations that have been determined appear in Tables IV, V, VI, and VII. To the extent that the eight subtests are related to success in technical writing, the correlation indices offer evidence of validity. These indices are particularly high in view of the many additional variables responsible for success in carrying out any job. Despite the small sample used in the study, statistically significant results have been obtained.⁶⁷

Table III lists coefficients of correlation relating each subtest to the whole criterion, as well as each subtest to each of its parts. Each column identifies a subtest, except the last column which contains the multiple coefficient of correlation. The rows identify the criterion and

⁶⁷Guilford, Fundamental Statistics, 164-167.

its factor constellations. Under each of these headings appear three rows of coefficients. The first coefficient listed is the Pearson product-moment coefficient of correlation; the second, the correlation ratio of x over y ; and, the third, the correlation ratio of y over x . The last column shows that the index of multiple correlation is highest between the criterion and the TMEAP as a whole.

TABLE III

VALIDATION CORRELATION INDICES
BETWEEN TMEAP SUBTESTS A₁ THROUGH Q_{1A} AND CRITERION[®]

Criterion		Subtests									
		A ₁	B ₁₁	B ₁₂	C ₁	D ₁	A ₂	B ₂	C ₂	Q _{1A}	
zRS*	r	.472	.333	.392	.332	.324	.490	.425	.302	.478	R.72
	eta _{xy}	.529	.419	.532	.451	.509	.747	.658	.365	.661	
	eta _{yx}	.648	.551	.593	.679	.653	.787	.695	.617	.690	
Pers*	r	.529	.308	.340	.257	.225	.366	.393	.278	.433	R.68
	eta _{xy}	.645	.478	.482	.336	.428	.742	.586	.408	.717	
	eta _{yx}	.852	.407	.462	.510	.498	.564	.788	.563	.719	
Perf*	r	.306	.234	.310	.306	.304	.347	.376	.271	.332	R.56
	eta _{xy}	.487	.362	.570	.416	.584	.649	.596	.416	.502	
	eta _{yx}	.493	.467	.505	.671	.452	.474	.712	.439	.646	
ExCap*	r	.439	.267	.320	.307	.278	.381	.377	.366	.359	R.61
	eta _{xy}	.484	.508	.572	.489	.556	.600	.640	.361	.656	
	eta _{yx}	.580	.452	.434	.582	.465	.538	.605	.596	.564	

®N equals 40.

* zRS equals Rating Scale raw score; Pers equals Personality score; Perf equals Performance score; and, ExCap equals Executive Capabilities score.

Tables IV, V, VI, and VII, give more explicit data on the computation of the multiple correlation indices listed in Table III. Multiple correlation coefficients and the standard error of each appear in the Tables along with regression equations and the standard error of estimate. Indices of forecasting efficiency are also included in these Tables.

A number of interesting conclusions can be drawn from the Tables. While each subtest correlation is significant at or beyond the 5% level of confidence, those subtests dealing with operations peculiar to technical writing relate best to the criterion. This phenomenon would seem to indicate that general intellectual capacity is less important to success on the job than more specific abilities. The Tables also show that each subtest relates better to the criterion as a sum than to any of its parts.

Further investigation of the statistical data shows that job success is predicted mainly by Subtests A_2 , B_2 and Q_{1A} in Table IV. These Subtests account for 12%, 14% and 17% of the variance respectively. This is not to infer that the other subtests are to be discounted. Each accounts for some variance. This conclusion is, of course, relative to the sample, although the influences of overlapping variables have also been taken into account. Slight variations of this predictor combination occur in each of the other Tables containing data relevant to each factor constellation of the rating scale. In presenting these variables, it seems preferable for selection purposes to allow each to fall in the same order as the Br products listed in the third column of Tables IV, V, VI, and VII.

TABLE IV

REGRESSION COEFFICIENTS FOR RATING SCALE-
MULTIPLE REGRESSION EQUATION
OF VALIDATION STUDY

Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
A_1	.067	.472	.031563	3.594	.240	71.525	-17.195
B_{11}	.081	.333	.027057	2.669	.217	73.05	-15.852
B_{12}	.097	.392	.037976	3.373	.327	71.075	-23.249
C_1	-.025	.332	-.008310	3.844	-.096	65.05	6.251
D_1	-.035	.324	-.011430	1.845	-.065	33.725	2.196
A_2	.250	.490	.122328	2.350	.587	66.6	-39.081
B_2	.323	.425	.137137	3.038	.980	44.875	-43.973
C_2	.041	.302	.012459	1.801	.074	62.75	-4.656
Q_{1A}	.360	.478	.171733	2.137	.761	64.375	-49.002
R^2 equals \sum			.520513				-184.561
σR^2			.376667				
R \sum RS- $A_1 B_{11} C_{11} D_{11} A_2 B_2 C_2 Q_{1A}$			.722			$M_{\sum RS}$	205.
σR \sum RS			.614				
σ_R			.088			a	20.439

\sum RS Regression Equation

\sum RS equals 20.439 plus .240 A_1 plus .217 B_{11} plus .327 B_{12} plus (-.096) C_1
plus (-.065) D_1 plus .587 A_2 plus .980 B_2 plus .074 C_2 plus
.761 Q_{1A} .

(Cont'd.)

TABLE IV (Cont'd.)

Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
$\sigma_{\xi RS}$			27.17				
$c\sigma_{\xi RS}$			29.89				
E			21.05%				

TABLE V

REGRESSION COEFFICIENTS FOR PERSONALITY FACTOR-
MULTIPLE REGRESSION EQUATION
OF VALIDATION STUDY

Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
A_1	.349	.529	.184394	1.250	.436	71.525	-31.199
B_{11}	.040	.308	.012185	.928	.037	73.05	- 2.688
B_{12}	.047	.340	.015869	1.173	.055	71.075	- 3.895
C_1	-.042	.257	-.010790	1.337	-.056	65.05	3.656
D_1	-.195	.225	-.043797	.642	-.125	33.725	4.222
A_2	.153	.366	.055986	.818	.125	66.6	- 8.318
B_2	.309	.393	.121530	1.057	.327	44.875	-14.652
C_2	.035	.278	.009633	.626	.022	62.75	- 1.362
Q_{1A}	.270	.433	.117061	.829	.224	64.375	-14.414
R^2 equals \leq			.462070				-68.649
cR^2			.300691				
R^2 Pers-A ₁ B ₁ C ₁ D ₁ A ₂ B ₂ C ₂ Q _{1A}			.680			M_{Pers}	67.75
cR^2 Pers.			.548				
σ_R			.098			a	- 0.899

Pers Regression Equation

X^1 Pers equals (-.899) plus .436 A_1 plus .037 B_{11} plus .055 B_{12} plus
 (-.056) C_1 plus (-.125) D_1 plus .125 A_2 plus .327 B_2
 plus .022 C_2 plus .224 Q_{1A} .

σ Pers 10.01
 $c\sigma$ Pers 11.01
 E 16.38%

TABLE VI

REGRESSION COEFFICIENTS FOR PERFORMANCE FACTOR-
MULTIPLE REGRESSION EQUATION
OF VALIDATION STUDY

Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
A_1	-.113	.306	-.034452	1.567	-.177	71.525	12.631
B_{11}	.066	.234	.015518	1.164	.077	73.05	- 5.647
B_{12}	.111	.310	.034450	1.471	.164	71.075	-11.621
C_1	.025	.306	.007566	1.676	.041	65.05	- 2.693
D_1	.096	.304	.029123	.805	.077	33.725	- 2.600
A_2	.118	.347	.040748	1.025	.121	66.6	- 8.025
B_2	.296	.376	.111274	1.325	.392	44.875	-17.600
C_2	.069	.271	.018693	.785	.054	62.75	- 3.395
Q_{1A}	.279	.332	.092873	.905	.253	64.375	-16.268
R^2 equals Σ			.315792				-55.217
cR^2			.110529				
$R_{\text{Perf}} - A_1B_1C_1D_1A_2B_2C_2Q_{1A}$			.562			M_{Perf}	76.375
cR_{Perf}			.333				
σ_R			.125			a	21.158
Perf Regression Equation							
X^1_{Perf} equals 21.158 plus $(-.177)A_1$ plus $.077B_{11}$ plus $.164B_{12}$ plus $.041C_1$ plus $.077D_1$ plus $.121A_2$ plus $.392B_2$ plus $.054C_2$ plus $.253Q_{1A}$.							
σ_{Perf}			14.15				
$c\sigma_{\text{Perf}}$			15.57				
E			5.69%				

TABLE VII

REGRESSION COEFFICIENTS FOR EXECUTIVE CAPACITIES FACTOR-
MULTIPLE REGRESSION EQUATION
OF VALIDATION STUDY

Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
A_1	.154	.439	.067415	1.264	.194	71.525	-13.883
B_{11}	.061	.267	.016236	.939	.057	73.05	-4.179
B_{12}	.044	.320	.013988	1.186	.052	71.075	-3.682
C_1	.061	.307	.018702	1.352	.082	65.05	-5.354
D_1	-.107	.278	-.029776	.649	-.070	33.725	2.347
A_2	.158	.381	.060036	.827	.130	66.6	-8.678
B_2	.222	.377	.083685	1.068	.237	44.875	-10.631
C_2	.179	.366	.065514	.633	.113	62.75	-7.110
Q_{1A}	.219	.359	.078687	.786	.172	64.375	-11.085
R^2 equals Σ			.374488				-62.253
cR^2			.186835				
$R_{\text{ExCap}-A_1B_1C_1D_1A_2B_2C_2Q_{1A}}$			.612			M_{exCap}	59.75
cR_{ExCap}			.432				
σ_R			.114			a	-2.503

ExCap Regression Equation

$$X_{\text{ExCap}}^1 \text{ equals } (-2.503) \text{ plus } .194A_1 \text{ plus } .057B_{11} \text{ plus } .052B_{12} \text{ plus } .082C_1 \text{ plus } (-.070)D_1 \text{ plus } .130A_2 \text{ plus } .237B_2 \text{ plus } .113C_2 \text{ plus } .172Q_{1A}.$$

σ_{ExCap}	10.91
$c\sigma_{\text{ExCap}}$	12.00
E	9.82%

A general conclusion may be drawn from these data. The correlation indices obtained for the sample tested demonstrate the utility of the TMEAP for selecting technical writing personnel. When further data have been gathered, the value of the TMEAP may be better defined. The present data, however, seem to demonstrate the potential usefulness of each of the subtests. As expected, some of these subtests have proven more useful than the others. Since certain abilities are called upon more frequently, the subtests that sample such abilities take on greater significance.

Cross-Validation Study

The notion of cross-validation ties in rather intimately with the general question of test validity. Its specific purpose is to confirm the findings of the initial validation study. If the validity coefficients of a test are similar from one sample to another, more confidence can be placed in the use of that instrument. For validation purposes, these samples must be independent--although selected from the same population.

Mosier has recently summed up the problems and designs of cross-validation.⁶⁸ He considers the kind of a study outlined above as a "distinct experimental design" called "validity generalization." In such a design, an attempt is made to demonstrate that a decision derived from the data in one sample can be applied to another independent sample from the same population.

The design he proposes has been attempted here, using a small independent sample. The TMEAP was administered for a second time to twenty

⁶⁸ Charles I. Mosier, "Symposium: The Need and Means of Cross-Validation. I. Problems and Designs of Cross-Validation," Educational and Psychological Measurement, Durham, North Carolina, XI, 1, 1951, 5-11.

technical writers who are actively employed by several agencies.⁶⁹ Each group contained ten men. Ratings obtained for each subject were related to test results. Sampling statistics on this group appear in Table VIII.

The intercorrelations of seven subtests of the TMEAP are presented in Table IX. Inspection of the Table shows that the intercorrelation coefficients range from a high of plus 0.60 to a low of minus 0.48. As noted previously,⁷⁰ the independent variables measured by some of the subtests were expected to be more closely related than others. This hypothesis has been verified statistically and confirmed by cross-validation. The ability to identify proofreading errors, Subtest A₁, for example, seems to be related to the ability to make comparisons, Subtest C₁, and to a knowledge of word meanings, Subtest D₁. The ability to make comparisons, Subtest C₁, in turn, seems to be related to a knowledge of word meanings, Subtest D₁.

⁶⁹Cf. supra, 6-7.

⁷⁰Cf. supra, 41.

TABLE VIII

CROSS-VALIDATION SAMPLING STATISTICS

FOR TMEAP SUBTESTS A₁ THROUGH C₂

Subtest	A ₁	B ₁₁	B ₁₂	C ₁	D ₁	A ₂	B ₂	C ₂
Mean	68.0	75.9	69.7	64.6	32.4	66.8	32.8	55.0
Standard Deviation	15.3	10.7	11.9	18.1	21.6	14.9	16.1	27.6
Standard Error of Mean	3.5	2.5	2.7	4.2	4.9	3.4	3.7	6.3

CROSS-VALIDATION SAMPLING STATISTICS

FOR RATING SCALE

Factor	ΣRS*	Pers*	Perf*	ExCap*
Mean	200.7	72.0	66.8	60.4
Standard Deviation	36.4	16.6	16.6	16.2
Standard Error of Mean	8.4	3.8	3.8	3.7

*ΣRS equals Rating Scale raw score; Pers equals Personality score; Perf equals Performance score; and, ExCap equals Executive Capabilities score.

TABLE IX

CROSS-VALIDATION CORRELATION MATRIX

FOR TMEAP SUBTESTS A_1 THROUGH C_2 *@

Variable	A_1	B_{11}	B_{12}	C_1	D_1	A_2	B_2	C_2
A_1		-.394	.125	.555	.424	-.092	-.139	.100
B_{11}			.196	-.483	-.223	.297	.036	-.119
B_{12}				.100	.280	.175	.280	.222
C_1					.604	.394	.103	.150
D_1						.223	.262	.177
A_2							.077	-.228
B_2								.293
C_2								

* N equals 20.

@ The correlation coefficients were computed by the product-moment method.

While positive relationships indicate the extent of agreement between variables, negative relationships indicate the extent of disagreement. The ability to follow directions as measured by the first portion of Subtest B_1 , for example, is negatively related to the ability to make comparisons, Subtest C_1 . These relationships shown in the following matrix seem to confirm rather substantially those found in the matrix of the validation

study.

The correlation indices establishing the relationship between the TMEAP, its subtests and the criterion are found in Table X. The beta coefficients, regression weights and regression equations that have been determined appear in Tables XI, XII, XIII, and XIV. To the extent that the cross-validation sample duplicates the original one, the correlation indices confirm the findings of the validation study despite its comparatively small size.⁷¹ The multiple correlation indices are significant beyond the 5%

level of confidence while the simple correlation indices may or may not be. When corrected for bias, the multiple correlation index for the rating scale is significant at the 15% level of confidence.⁷² The multiple correlation indices for the rating scale factors fall below this level of confidence.

Table X lists the Pearson product-moment coefficient of correlation relating each subtest to the rating scale, as well as to each of its parts. Each column identifies a subtest, except the last column which contains the multiple coefficient of correlation. The rows identify the criterion and its factor constellations. Tables XI, XII, XIII, and XIV give more explicit

⁷¹N equals 20.

⁷²The size of the sample coupled with the number of independent variables is responsible for the apparent discrepancy between the level of significance achieved and that required for greater acceptance of the results. If a larger sample of technical writing personnel had been available for study, the results would probably have attained the level of significance found in the validation study.

data on the computation of the multiple correlation indices listed in Table X. Multiple correlation coefficients and the standard error of each appear in the Tables along with regression equations and the standard error of estimate. Indices of forecasting efficiency are also included in these Tables.

TABLE X

CROSS-VALIDATION CORRELATION INDICES
BETWEEN TMEAP SUBTESTS A_1 THROUGH C_2
AND CRITERIONS

Criterion		Subtests								
		A_1	B_{11}	B_{12}	C_1	D_1	A_2	B_2	C_2	R
$\pm RS^*$	r	.265	.100	.451	.219	.587	.172	.608	.281	.841
Pers*	r	-.049	.222	.408	-.168	.389	.079	.493	.142	.786
Perf*	r	.561	.030	.178	.424	.363	.041	.196	.317	.756
ExCap*	r	.070	-.034	.411	.226	.554	.261	.661	.160	.826

@ N equals 20.

* $\pm RS$ equals Rating Scale raw score; Pers equals Personality score; Perf equals Performance score; and, ExCap equals Executive Capabilities score.

Investigation of the statistical data shows that job success is predicted mainly by Subtests A_1 , D_1 and B_2 in Table XI. These Subtests account for 10%, 26% and 31% of the variance respectively, while the remaining ones account for only a small part of the variance. This conclusion is, of

course, relative to the sample although the influences of overlapping variables have also been taken into account. Slight variations of this predictor combination occur in each of the other Tables containing data relevant to each factor constellation of the rating scale. In presenting these variables, it seems preferable for selection purposes to allow each to fall in the same order as the Br products listed in the third column of Tables XI, XII, XIII, and XIV.

A general conclusion may be drawn from this attempt at cross-validation. The correlation indices obtained from this second sampling confirm the utility of the TMEAP for selecting technical writing personnel. The discrepancies that seemingly appear between the original results and the cross-validation data are to be explained on the basis of sampling variance between the manufacturing firm and agency settings. The manner in which chance factors influence prediction within and between these two settings will be discussed in terms of the simple correlation indices relating each independent variable to the dependent variable and its component factors.⁷³

⁷³Cf. *infra*, 68-69.

TABLE XI

REGRESSION COEFFICIENTS FOR RATING SCALE-
MULTIPLE REGRESSION EQUATION
OF CROSS-VALIDATION STUDY

Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
A_1	.387	.265	.102584	2.379	.922	68.0	-62.676
B_{11}	.081	.100	.008066	3.402	.274	75.9	-20.789
B_{12}	.098	.451	.044323	3.059	.301	69.7	-20.959
C_1	-.388	.219	-.084822	2.011	-.781	64.6	50.433
D_1	.451	.587	.264931	1.685	.760	32.4	-24.631
A_2	.204	.172	.035003	2.443	.499	66.8	-33.307
B_2	.506	.608	.307628	2.261	1.145	32.8	-37.546
C_2	.106	.281	.029782	1.319	.140	55.0	-7.695
R^2 equals \leq			.707496				-157.168
cR^2			.493968			$M_{\epsilon RS}$	200.7
$R_{\epsilon RS} - A B C D A B C$ 1 1 1 1 2 2 2			.841			a	43.532
$cR_{\epsilon RS}$			.703				
σ_R			.088				
ϵRS Regression Equation							
$X^1_{\epsilon RS}$ equals 43.532 plus .922 A_1 plus .274 B_{11} plus .301 B_{12}							
plus (-.781) C_1 plus .760 D_1 plus .499 A_2 plus 1.145 B_2							
plus .145 C_2 .							
$\sigma_{\epsilon RS}$			19.71				
$c\sigma_{\epsilon RS}$			25.90				
E			28.86%				

TABLE XII

REGRESSION COEFFICIENTS FOR PERSONALITY FACTOR-
MULTIPLE REGRESSION EQUATION
OF CROSS-VALIDATION STUDY

Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
A_1	.191	-.049	-.009430	1.085	.207	68.0	-14.083
B_{11}	-.117	.222	-.025896	1.551	-.181	75.9	13.738
B_{12}	.159	.408	.064915	1.395	.222	69.7	-15.487
C_1	-.864	-.168	.145445	.917	-.793	64.6	51.202
D_1	.584	.389	.226806	.769	.449	32.4	-14.538
A_2	.299	.079	.023756	1.114	.333	66.8	-22.264
B_2	.375	.492	.184552	1.031	.387	32.8	-12.677
C_2	.058	.142	.008302	.601	.035	55.0	- 1.931
R^2 equals ϵ			.618450				-16.040
cR^2			.339918			M_{Pers}	72.0
$R_{Pers} - A_1B_1C_1D_1A_2B_2C_2$			.786			a	55.960
cR_{Pers}			.583				
σ_R			.115				

Pers Regression Equation

X^1_{Pers} equals 55.960 plus .207 A_1 plus (-.181) B_{11} plus
.222 B_{12} plus (-.793) C_1 plus .449 D_1 plus .333 A_2
plus .387 B_2 plus .035 C_2 .

σ_{Pers}	10.25
$c\sigma_{Pers}$	13.47
E	18.75%

TABLE XIII

REGRESSION COEFFICIENTS FOR PERFORMANCE FACTOR-
MULTIPLE REGRESSION EQUATION
OF CROSS-VALIDATION STUDY

Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
A_1	.551	.561	.308942	1.085	.597	68.0	-40.623
B_{11}	.539	.030	.016275	1.551	.836	75.9	-63.452
B_{12}	-.097	.178	-.017259	1.395	-.135	69.7	9.410
C_1	.431	.424	.182789	.917	.395	64.6	-25.517
D_1	-.027	.363	-.009949	.769	-.021	32.4	.684
A_2	-.189	.041	-.007785	1.114	-.210	66.8	14.028
B_2	.204	.196	.039906	1.031	.210	32.8	- 6.885
C_2	.186	.317	.058941	.601	.112	55.0	- 6.144
R^2 equals ϵ			.571859				-118.500
cR^2			.259316				
$R_{\text{Perf}} - A_1B_1C_1D_1A_2B_2C_2$			.756			M_{Perf}	66.8
cR_{Perf}			.509				
σ_R			.129			a	-51.700

Perf Regression Equation

X^1_{Perf} equals (- 51.700) plus .597 A_1 plus .836 B_{11} plus

(-.135) B_{12} plus .395 C_1 plus (-.021) D_1 plus

(-.210) A_2 plus .210 B_2 plus .112 C_2 .

σ_{Perf}	10.88
$c\sigma_{\text{Perf}}$	14.30
E	13.94%

TABLE XIV

REGRESSION COEFFICIENTS FOR EXECUTIVE CAPACITIES FACTOR-
MULTIPLE REGRESSION EQUATION
OF CROSS-VALIDATION STUDY

Variable	B_{1k}	r_{1k}	$B_k r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
A_1	.111	.070	.007831	1.059	.118	68.0	- 8.024
B_{11}	-.256	-.034	.008743	1.514	-.388	75.9	-29.464
B_{12}	.153	.411	.062970	1.361	.208	69.7	-14.526
C_1	-.442	.226	-.099891	.895	-.395	64.6	25.543
D_1	.456	.554	.252585	.750	.342	32.4	-11.071
A_2	.349	.261	.090837	1.087	.379	66.8	-25.324
B_2	.545	.661	.360323	1.006	.549	32.8	-17.994
C_2	-.010	.160	-.001652	.587	-.006	55.0	.330
R^2 equals Σ			.681745				-21.601
cR^2			.449419				
$R_{\text{ExCap}} - A_1 B_1 C_1 D_1 A_2 B_2 C_2$			.826			M_{ExCap}	60.4
cR_{ExCap}			.670				
σ_R			.096			a	38.799

ExCap Regression Equation

X^1_{ExCap} equals 38.800 plus .118 A_1 plus (-.388) B_{11} plus
.208 B_{12} plus (-.395) C_1 plus .342 D_1 plus .379 A_2
plus .549 B_2 plus (-.006) C_2 .

σ_{ExCap} 9.12
 $c\sigma_{\text{ExCap}}$ 11.98
E 25.80%

Test Reliability

Beyond the evidence for its usefulness, a test must show consistency of measurement. Reliability is of prime importance in tests designed for personnel selection. A series of checks has been built into the TMEAP to insure stability of measurement.⁷⁴ Coefficients of reliability for each of the subtests are shown in Table XV. These indices of internal consistency would seem to argue for reliability of measurement.

Every correlation coefficient that appears in Table XV lies well beyond the 1% level of confidence. The method used to determine the internal consistency of all the subtests except Subtest B₁ was that of rational equivalence.⁷⁵ This method was used because it estimates the reliability of a test free from the objections raised against the test-retest, the alternate forms and the split-half methods. Since this method was not applicable to Subtest B₁, a speed test, the test-retest method of determining reliability was employed.

⁷⁴Cf. *supra*, 29-32.

⁷⁵M. W. Richardson and G. F. Kuder, "The Calculation of Test Reliability Coefficients Based Upon the Method of Rational Equivalence," Journal of Educational Psychology, Baltimore, Maryland, XXX, 1939, 681-687.

TABLE XV

INTER-ITEM CONSISTENCY INDICES

FOR TMEAP SUBTESTS A₁ THROUGH Q_{1A}*@

Subtest	A ₁	B ₁₁	B ₁₂	C ₁	D ₁	A ₂	B ₂	C ₂	Q _{1A}
r ₁₁	.839	.902	.638	.787	.960	.930	.860	.960	.927

* N equals 40.

@ Sampling statistics appear in Table I, 42.

CHAPTER IV

INTERPRETATION OF RESULTS AND NORMATIVE DATA

Interpretation of Study Results

The primary objective of this investigation was to ascertain the validity of the Technical Manual Editor Analysis Profile (TMEAP) for predicting job performance. The correlation indices relating the TMEAP and each of its subtests to a criterion rating of job effectiveness have been computed for this purpose. The relationship among these factors has been determined on two independent samples from the same population. In the first instance the work was attempted as a validation study; in the second, as a cross-validation study.

Inspection of the multiple correlation coefficients in Tables III and X reveals that the test standard of validity has been satisfied.⁷⁶ Each multiple coefficient shows a marked relationship between the TMEAP and the criterion. In each instance the multiple coefficient is significant. The TMEAP is related to the sum of the three rating scale factors at the 1% level of confidence. The factors of Personality and Executive Capacities are also related to the TMEAP at the 1% level of confidence. The Performance factor is related to the TMEAP at the 5% level of confidence. Even when

⁷⁶Cf. *supra*, 46 and 58.

corrected for chance deviations, the full scale remains significant, while the individual factors fall below the 5% level of confidence.

These results seem reasonable in view of the nature of the criterion. Inasmuch as the primary purpose of the study centered about job effectiveness, the relationship between the TMEAP and the overall subjective assessment of that effectiveness will be maximized. A somewhat more elaborate explanation will need to be given in the case of the criterion factor constellations. The variation that occurs does not seem wholly consistent with a logical arrangement that would place the relationship between the TMEAP and the Performance factor above the other two factors.

One plausible interpretation might suggest that the criterion selected tends to emphasize rater bias in those areas involving inter-individual relationships. The subjectivity of the unsophisticated rater will undoubtedly be reflected in his ratings. This bias could easily account for the results obtained in this study. However, in view of the size of each full scale multiple index,⁷⁷ the standard of validity has been satisfied.

Further examination of Table III reveals both the linear and non-linear indices of relationship for each subtest. Both types of correlation statistics were undertaken to support a contention of linearity. Using the X^2 test for linearity on each of the coefficients yielded by the critical ratio of x and y ,⁷⁸ the divergence was found to be so little as to leave no doubt

⁷⁷Ibid.

⁷⁸Guilford, Fundamental Statistics, 320-321.

about linearity. See Table XVI. The deviation in each instance suggests that only chance factors are at work.

When interpreting test validity it should be borne in mind that the sample is highly preselected. First, because of the demands of the job, subjects would require above-average ability and personality adjustment specific to these requisites. Many have had years of experience in this job area, and natural selection has had its effect. Further, the selection process carefully prescreens all applicants so that only the promising ones are employed.

In spite of this sharp curtailment of range, the magnitude of the coefficients in Tables III and X indicates that the TMEAP is useful. In addition, the matrices appearing in Tables II and IX show that the relationships follow closely the pattern that would be logically predicted for the various traits tested. Since these relationships have already been discussed,⁷⁹ the reader may refer to these Tables to determine which have the validity expected by traditional interpretation. In general, these findings support the interpretations suggested.

In the following Tables, Tables IV through VII and Tables XI through XIV, coefficients of multiple determination may be found which bear directly on interpretation. In Table IV, for example, R^2 is composed of nine comparatively distinct variables. The sum of these test variables predict 52% of the variance in the overall criterion. The same variables predict 46%

⁷⁹Cf. *supra*, 41-44 and 52-55.

TABLE XVI

CHI-SQUARE TEST OF LINEARITY@
FOR TMEAP SUBTESTS A₁ THROUGH Q_{1A}@@

Criterion		Subtests								
		A ₁	B ₁₁	B ₁₂	C ₁	D ₁	A ₂	B ₂	C ₂	Q _{1A}
zRS#	eta _{xy}	1.6	1.6	3.6	2.3	4.2	14.4	8.9	1.0	7.4
	eta _{yx}	6.8	5.5	6.1	13.0	11.2	19.9	11.7	9.3	9.5
Pers#	eta _{xy}	4.7	3.5	3.0	1.1	3.2	18.5	5.8	2.1	13.4
	eta _{yx}	32.5*	1.7	2.5	5.2	5.2	5.4	24.6	7.0	12.8
Perf#	eta _{xy}	3.6	1.7	6.4	1.8	7.2	9.9	6.3	2.3	3.6
	eta _{yx}	3.8	4.0	4.1	12.3	2.7	2.6	14.1	2.8	10.0
ExCap#	eta _{xy}	1.1	5.0	6.7	3.8	6.7	6.7	9.1	-0.1	10.6
	eta _{yx}	4.3	3.3	2.1	7.4	3.5	4.1	7.1	6.9	5.5

@Some question arises as to the appropriateness of the X^2 Test of Linearity in this correlational situation because N does not exceed k considerably.

@@N equals 40.

#zRS equals Rating Scale raw score; Pers equals Personality score; Perf equals Performance score; and, ExCap equals Executive Capabilities score.

*This value is the only one in the Table to exceed a X^2 value of 28.869 which could occur by chance only five in 100 times.

of the Personality factor as shown in Table V; 32% of the Performance factor (Table VI); and 37% of the Executive Capacities factor (Table VII). Thus, in this particular correlational situation, the subtests account for 52% of the total variance responsible for job success and varying amounts of each factor involved in the criterion.

The results in Tables XI through XIV show a change in the predicted variance. This change is the result of the difference in the size and characteristics of the samples tested. While drawn from the same universe, the size of this sample is half of that used in the initial validation study. Further, the second sample was drawn from several of the larger technical writing agencies in and around the Chicago area. These agencies generally demand a more diversified background of experience in their employees than do the technical writing departments of manufacturing firms represented in the initial sample. In spite of the sampling variations, the correlation indices are not significantly different in each instance of validation. For a precise evaluation of the similarities between the validation results, reference may be made to Table XVII.

TABLE XVII

z TEST OF SIGNIFICANT DIFFERENCES
BETWEEN PEARSON PRODUCT-MOMENT COEFFICIENTS OF CORRELATION
FOUND IN VALIDATION AND CROSS-VALIDATION STUDIES

Criterion	Subtests							
	A ₁	B ₁₁	B ₁₂	C ₁	D ₁	A ₂	B ₂	C ₂
zRS@	0.78	0.82	0.24	0.41	1.19	1.26	0.85	0.07
Pers@	2.18*	0.34	0.31	1.50	0.61	1.06	0.44	0.51
Perf@	1.06	0.68	0.48	0.44	0.24	1.13	0.68	0.17
ExCap@	1.37	1.06	0.38	0.34	1.13	0.44	1.33	0.78
σ_{d_z}	0.293							

@zRS equals Rating Scale raw score; Pers equals Personality score; Perf equals Performance score; and, ExCap equals Executive Capabilities score.

*This value is the only one in the Table to exceed a t-ratio of 1.96 which could occur by chance only five in 100 times.

More critical examination of Tables IV through VII and Tables XI through XIV will disclose the fact that multiple-regression equations have also been included in each Table. The use of these equations provides an estimate of the critical value of the TMEAP variables. While the regression equation differs to some degree in the case of each factor constellation of the criterion, a striking similarity exists between the regression equations for the overall criterion in both studies. The variables showing the greatest difference are those that might be expected to be weighted differently in each job situation. Within the technical writing agency, greater emphasis is placed on the ability to proofread printed materials, Subtest A₁, and on the possession of an extensive vocabulary, Subtest D₁. Because of the high degree of specialization required in an agency, a negative emphasis is placed on the ability to make comparisons and analogies, Subtest C₁.

Each of the subtests, Subtests A₂ through Q_{1A}, makes a contribution to the prediction of job performance. The amount of variance accounted for by each subtest would probably not be sufficient to indicate validity. However, when taken in combination, these subtests account for a substantial share of the variance in the criterion. By considering the complementary data which these subtests provide, as demonstrated by the regression equation, the user can place more confidence in the instrument for predicting successful job performance.

The regression equations derived from each validation study are peculiar to the population sample used. The validation study sample

contained subjects employed by manufacturing organizations whereas the cross-validation study sample contained subjects employed by agencies. As a consequence of the difference in situational settings,⁸⁰ it becomes necessary to limit the usefulness of the equations derived.

The suggested usefulness of the regression equations found in the validation study is limited to predicting success in an industrial setting. In contrast, the regression equations of the cross-validation study are useful in predicting success in an agency setting. In the industrial setting, product specialization is necessary while operational specialization is not. In the agency setting, the reverse is true. The range of ability to perform different operations in technical manual writing is more in demand in the fabricating situation than in the agency situation. Product knowledge, on the other hand, is more restricted in the industrial setting.

Predictions of success in either case based upon the regression equations are never perfectly reliable. For subjects with a given score on the TMEAP, the equations only indicate the mean success potential rating. The actual ratings are scattered on either side of the mean, so that the estimate for any particular individual would seldom coincide with his actual rating. The reliability of such estimates would depend upon the standard deviation of the ratings for persons with the same subtest score profiles. Thus it becomes necessary to invoke the standard error of estimate to describe the reliability of prediction, i.e., to consider about how far the prediction of success would deviate from that obtained.

⁸⁰ Cf. supra, 64.

In the case of the validation study, reference to the standard error of estimate in Tables IV, V, VI, and VII will indicate how far two-thirds of the obtained values will lie from the predicted values of the criterion and its factors. In the case of the cross-validation study, reference to the standard error in Tables XI, XII, XIII, and XIV will give similar indications. The margin of error with knowledge of the variables is R^2 (expressed as %) as great as the margin of error would be without that knowledge.⁸¹ These conclusions presuppose that predictions are made on the basis of the regression equation shown as applied to individuals belonging to the same population.

The index of forecasting efficiency for each equation appearing in the Tables may also be used by way of interpretation. Closely related to the standard error of estimate, this index is the percentage reduction in errors of any prediction by reason of correlation between the variables. Using the index that appears in Table IV as an example, E is equal to 21.05%, which means that predictions by means of the equation are 21.05% better than those made merely from a knowledge of the mean of the criterion values.

The foregoing has been offered as an argument for the usefulness of the TMEAP in predicting job success. The results of the validation studies have been invoked as *prima facie* evidence of this usefulness. The variables that were considered unique to the job area of technical writing have been confirmed statistically. Further research, of course, would be necessary to

⁸¹ Guilford, Fundamental Statistics, 432.

establish the general validity of the TMEAP so that specific interpretations can be made with greater confidence.

Interpretation of Normative Data

Preliminary norms have been prepared from the study, for using the TMEAP in personnel selection. These norms appear in a manual for test use included in the Appendix.⁸² The results of each subtest are reported in percentile scores. In this form, they provide a substantial amount of interpretative information. The performance of each individual on all subtests is reported in relation to the sample used in the validation study. Since this group was highly selected for ability, the distributions of scores on the subtests may be expected to be skewed to some degree.

A typical profile plotted from the subtest data appears in the Interpretation of the Analysis Profile section of the manual.⁸³ It portrays the profile of the average technical manual writer. Scores are plotted on a continuum ranging from 0 to 100. The position of the average range of scores offers a clue to the skewness of the sample distribution and the direction of skewness. The mean range of six subtests, Subtests A₁, B₁, C₁, A₂, C₂, and Q_{1A}, falls in the upper half of the continuum. The range of the remaining two subtests, Subtests D₁ and B₂, fall in the lower half of the continuum.

Those subtests whose mean ranges fall in the upper half of the continuum offer further corroborative evidence of the TMEAP's validity. Those subtests whose mean ranges fall in the lower half of the continuum will require

⁸²See Appendix I, 111-114.

⁸³Ibid, 108-111.

further explanation. The statistical data shows that technical writers will tend to score in the upper half of the continuum. With the exception of Subtests D₁ and B₂, the mean range of scores for each of the other subtests form a horizontal line across the face of the profile.

Subtest A₁, Proofreading Errors, shows fairly good discrimination with a distribution of scores slightly negatively skewed. The mean of the distribution is 71.5. Subtest B₁, Directions, follows much the same pattern but lacks the fineness of discrimination. The distribution mean for the first portion of the Subtest is 73.1; for the second portion, 71.1. Subtest C₁, Comparisons and Analogies, is not as markedly skewed as are the preceding subtests. It strikes a more nearly normal curve with a mean of 65.1.

The distributions of scores for Subtest A₂, Writing Instructional Material, Subtest C₂, Determination of Logical Progression, and Subtest Q_{1A}, Electronics, follows the pattern of the first three Subtests. The means are 66.6, 62.8, and 64.4 respectively. The level of difficulty of these Subtests seems to be comparable to that of Subtests A₁, B₁, and C₁. While their contents are dissimilar, a comparable level of difficulty perseveres with respect to the job area of technical writing.

The direction of the distribution of scores for Subtest D₁, Word Meanings, is reversed. Skewness is positive. The relative difficulty of the materials is much greater than that of the other subtests. By way of explanation, it is to be noted that during the construction phase it was found necessary to select items capable of sampling the breadth of knowledge possessed by all subjects in technical writing. Although this

subtest may be considered difficult, it would appear necessary as a means of measuring the wide range of word knowledge possessed by technical manual writers.

The distribution of scores for Subtest B₂, Identification of Assembly Parts, resembles that of Subtest D₁. The mean is 44.9. The symmetry of the distribution is greater than any other subtest. One interpretation would suggest that the increments here are more constant in terms of difficulty than the other subtests. This condition would account for acceleration and deceleration of the curve at similar rates.

In accord with logical expectations, it may be tentatively concluded that technical manual writers will score in the upper portion of the range in tasks that are more closely associated with the job. Those tasks that have been considered pertinent but are not immediately useful, are considered more difficult. They show reverse trends. Aside from a consideration of usefulness, it may be that facility in these areas is not weighed heavily in the selection process nor subsequently emphasized in training.

Summary

The interpretation given to the results of this study appears in the preceding sections. The interrelationship found between the TMEAP and the criterion, and the intrarelationshi ps found between the subtests of the TMEAP are considered each in turn. The interrelationship of TMEAP and criterion is considered for purposes of establishing validity. The intrarelationshi ps of the subtests are considered for purposes of supporting that interpretation. The significance of an interpretation of these relationships, established statistically, becomes apparent on consideration

of the TMEAP's usefulness.

Elaborating further on the interpretation of study results, the normative data are considered. The norms that have been compiled appear in the manual for the use of the TMEAP in personnel selection. The data considered are the distributions of scores. These distributions confirm logical expectation and serve as a means of characterizing the technical manual writer.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary of Study, Purpose and Methods

The objective of this study has been to construct and standardize the Technical Manual Editor Analysis Profile (TMEAP). The proposed instrument attempts to measure the aptitudes that have been found necessary for successful job performance in the area of technical manual writing. In designing this instrument an attempt has been made to determine the existence and measure the strength of those aptitudes. In an industrial setting such a measure of potential success or failure in this job area can become a useful tool for selecting technical writing personnel.

A review of related literature shows that little attention has been given this area of employment. As a consequence, no attempt has been made to study the job area. Several instruments do exist, however, that purport to measure this aptitude but only incidentally. Each taps a general job area wherein the technical manual writer's job is presumably to be included. Of greater assistance have been works on test construction. Articles, volumes and studies by D. C. Adkins,⁸⁴ J. P. Guilford,⁸⁵ A. Anastasi⁸⁶

⁸⁴ Adkins, Construction and Analysis of Achievement Tests.

⁸⁵ Guilford, Fundamental Statistics.

⁸⁶ Anastasi, Psychological Testing.

and A. S. Knowles⁸⁷ have proven of immeasurable value in the construction and standardization phases of the operation. Other works have also been cited but more by way of complementing the review than by way of assisting the author in his study. Each study bears on a particular aspect of the work and thus requires some mention.

The design of the TMEAP is similar to that of contemporary aptitude measuring instruments. It consists of eight subtests which are divided into three sections. Each section taps a different level of performance in the job area. The first section serves as a measure of clerical aptitude and such other basic factors as have been deemed essential to an adequate preliminary assessment of job potential. The second section measures the aptitudes peculiar to technical manual writing. The third section measures achievement in a particular area of service-engineering. Structuring the TMEAP in this manner allows for greater versatility and more effective use of the instrument. Such a structured design enables the tester to use the instrument for personnel selection at each work level, i.e., clerical, technical writing and specialized technical writing.

The method of test and criterion construction has been presented in detail. Each of the TMEAP's eight subtests is the end product of a careful study of some phase of the technical writing job area. Each measures the strength of that phase of the more general aptitude of technical manual writing. The criterion has been as carefully planned. A rating scale for

⁸⁷ Knowles, Merit Rating of Supervisors, Foremen and Department Heads.

lack of more objective evidence of success or failure was devised in an effort to evaluate the validity of the TMEAP.

The population sample tested consisted of 60 subjects. Forty subjects comprised the validation group; twenty subjects, the cross-validation group. The firms or departments of manufacturing firms from which the subjects were drawn are devoted exclusively to the production of technical manuals for various purposes. All the data that have been used in this study were obtained from subjects employed by these organizations as technical manual writers.

Two validation studies were undertaken. The data used were taken from the administration of the TMEAP to the population sample specified. The first was a validation study which yielded significant results. Here a positive relationship appeared between the TMEAP and the criterion beyond the 5% level of confidence. The second was a cross-validation study. This study yielded the same significant results. Better than half of the job variance has been accounted for by the TMEAP. Intercorrelation matrices show that the subtests of the instrument for the most part were not appreciably related. Those subtests, however, that were found to be related were defensible on a logical basis.

The reliability of each of the eight subtests has also been determined. The consistency with which these subtests measure that which they purport to measure was found to be significant. With the exception of Subtest B_{12} and C_1 the data yielded high reliability coefficients. Subtests B_{12} and C_1 showed only a substantial relationship with the criterion. While such a substantial relationship may not be completely satisfactory, it gave

promise of consistency and, as a consequence, the subtests were retained.

The interpretations to be made from the results of the study have been discussed in detail. All the data presented in the preceding study were considered in the light of validity. Confirmation of the judgments to be made was based on the statistical data presented. The multiple indices of relationship, the linearity of measurement, the matrices of intercorrelation, the coefficients of multiple determination and the regression equations were each considered in turn. The interpretation to be accorded the normative data has also been discussed. An attempt was made to analyze the distributions of subtest scores for the sample tested.

A complete manual for the use of the TMEAP as a selection instrument appears in the Appendix.⁸⁸ Scoring keys appear separately for the convenience of the test user.⁸⁹ Contained in the manual is a description of each of the subtests as well as directions for administration and scoring. The interpretation that may be accorded subtest scores is considered in detail. Suggestions are given regarding the significance of clusterings or combinations of scores. The significance of the clusterings has been inferred from the study findings. Norms derived from the sampling data also appear. These have been provided to assist the test user to evaluate test performance more objectively. Armed with the study findings and the manual, the test user may then proceed to use the Technical Manual Editor Analysis

⁸⁸ See Appendix I, 92-114.

⁸⁹ See Appendix III, 135-146.

Profile to full advantage.

Conclusions

The present study while considered preliminary in nature offers evidence of the TMEAP's validity. This evidence appears elsewhere⁹⁰ and will not be reconsidered in detail. However, the conclusions derived will be discussed in the following paragraphs. These conclusions, of course, are relative to the correlational situations outlined and lack finality. But, because similar conclusions can be drawn from the results of each of the studies completed, a certain amount of confidence may be placed in the predictive ability of the TMEAP.

- 1) A substantial relationship exists between the TMEAP and criterion. The strength of the relationship will allow the reader to conclude that the TMEAP measures that which it purports to measure. Better than half of the job variance is accounted for in each instance of validation. The variance that is not accounted for may be due in whole or in part to other factors such as motivation and interest. If it were possible to take into account each of these factors, prediction of success on the job would leave even less to chance.
- 2) The reliability indices of the TMEAP subtests indicate that seven of the eight subtests, Subtests A₁, C₁, D₁, A₂, B₂, C₂ and Q_{1A}, possess marked internal consistency. Each is of a power nature. The internal consistency of the remaining subtest, Subtest B₁,

⁹⁰Cf. supra, 40-62.

has been assumed from the nature of the material and the fact that speed was the main determinant. The consistency of the two portions of this subtest is also marked. An external method, test-retest method, has been used to determine reliability in contrast to the internal method specified above.

- 3) The interrelatedness of each of the subtests is such that each may be considered as tapping a different aspect of the aptitude of technical manual writing. While there is reason to believe that some overlapping exists in the measurement of the aptitude, each aspect is sufficiently distinct to consider its contribution unique.

A case in point is that of Subtests C_1 and D_1 . Subtest C_1 has been constructed as a measure of the subject's ability to make analogies and comparisons. Subtest D_1 has been constructed as a measure of the subject's word knowledge. Thus, each presumably taps a different aspect of the aptitude in question. The matrix of correlation in each validation study shows that each is related to the other. Yet in the computation of the multiple correlation coefficient, Subtest D_1 accounts for more of the job variance than does Subtest C_1 .

In short, it may be concluded that the premise upon which the Technical Manual Editor Analysis Profile was constructed is valid. The consistency of measurement is satisfactory. And, each of the facets of the aptitude measured seems substantially distinct from each and every other facet measured.

Other research projects will be needed, however, to make dependable generalizations about the instrument. One such project would entail the administration of the TMEAP to personnel employed in closely allied job areas. The results will show how well the instrument differentiates individuals in related groups. Another project may consist of administering the TMEAP to a sample of the adult population and to a sample of the technical writing population. A comparison of results here would show how well the instrument differentiates individuals in nonrelated groups.

Research should also be done to determine empirically the similarities and differences of the TMEAP to other available psychological instruments. Once these similarities and differences have been determined, further development of this instrument may be in order. These refinements may then be made in the light of the relationship between the TMEAP and other measuring instruments as well as the technical manual writer and the demands of his job. In this way, the Technical Manual Editor Analysis Profile may realize its end -- a more efficient selection of technical manual writing personnel.

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APPENDIX I

**TECHNICAL MANUAL EDITOR ANALYSIS PROFILE
MANUAL**

TEST DESIGN

Analysis Profile

The Technical Manual Editor Analysis Profile (TMEAP) is a psychological test of a power nature which has been designed to tap the key aspects of the work involved in technical manual writing for purposes of personnel selection or placement. The TMEAP consists of eight subtests which are divided into three distinct sections, each constructed as a progressively more specialized test of a subject's ability. Each section samples a different level of performance within the job area. The first section serves as a measure of clerical skills and such other basic factors as have been deemed essential to an adequate preliminary assessment of job potential. The second section measures the aptitudes peculiar to technical manual writing. The third section measures achievement in a particular area of service-engineering. Alternate forms of the last section have been prepared, one dealing with the field of electronics and the other, with the field of refrigeration. Additional alternate forms of the subtest in this section may be prepared and inserted to test a particular phase of service-engineering. Structuring the TMEAP in this manner allows for greater versatility and more effective use of the instrument. Such a structured design enables the tester to use the instrument for personnel selection at each work level, i.e., clerical, technical manual writing and specialized technical manual writing.

Analysis Profile Subtests

To test ability for detailed operations, four subtests have been designated as the first section of the TMEAP, the clerical test.

Subtest A₁ - Proofreading Errors

Subtest A₁ is intended to measure the subject's ability to proofread printed materials for typographical, grammatical, and punctuation errors. The item form is original and has the unusual advantage of providing fifty items distributed evenly throughout the passage. The subject must consider each word, phrase and sentence for possible error both in and out of context. Since any number of errors may occur in any grouping of words, the subject cannot follow a set response pattern. He must react singly and separately to each error.

Subtest B₁ - Directions

Subtest B₁ is intended to measure speed of response in a simple perceptual task. Two different types of items were used. The first is a cancellation form of item which draws heavily on immediate recall and perceptual acuity. The subject is required to cross out letters, A, Z, C, and U, found among several rows of letters. The second is a substitution form of item which calls for retention and greater hand-eye coordination. The subject is required to code several rows of figures by substituting a letter for a number. The item type provides situations which approximate those found in many clerical tasks. It involves a simple task of a routine nature.

Subtest C₁ - Comparisons and Analogies

Subtest C₁ is intended as a measure of ability to understand verbal concepts. Its aim is to evaluate the subject's ability to abstract, to generalize and to structure ideas. This ability for comprehension is tapped by analogies and comparisons particularly suited to multiple-choice

construction. Both types of items have proven useful for the ease with which they may be constructed into highly reliable items. Such a measure of comprehension is relatively complex without being esoteric.

Subtest D₁ - Word Meanings

Subtest D₁ has been devised to measure the word facility needed by the technical writer. Although the items in this Subtest are original, this type of item is used widely in intelligence tests. Each word chosen for use was selected according to item difficulty. The complete list of words is steeply graded in difficulty in an effort to cover the range of intellectual capacity possessed by subjects in the job area.

The second section of the TMEAP, the technical manual writing test, deals specifically with technical writing. This section contains three subtests.

Subtest A₂ - Writing Instructional Material

Subtest A₂ deals with the core of the job area, the writing aspect. It is an original form prepared exclusively by the author for the TMEAP. It consists of only one item accompanied by an illustration. This item is a work sample. The problem requires the subject to prove his ability to write an instructional procedure for operating a familiar instrument. Extensive research indicated that a simple apparatus common to the experience of the greater number of subjects would prove most reliable in measurement. The model apparatus used is a dial telephone hand set, Model 202C3F, manufactured for the Bell System by Western Electric Company.

Subtest B₂ - Identification of Assembly Parts

Subtest B₂ is concerned with blueprint reading and parts identification. The type of item devised for this subtest represents a unique approach to the measurement of another facet of technical writing, blueprint reading. The ability to visualize a constructed object of three dimensions from a two-dimensional drawing and to identify those parts of the constructed object is essential to technical writing. The technical writer is often required to write directions for operating a mechanism not yet fabricated. Here his spatial ability to convert from two to three dimensions comes into play.

A simple mechanism has been found appropriate for this Subtest. The task requires the subject to identify the various parts of the mechanism and relate each part to the whole. Since the drawing of the mechanism is large and clear, no premium is placed on visual acuity. It is typical of engineering assembly blueprints produced by draftsmen. The correctness of the response does not depend on specialized knowledge but upon the subject's ability to recognize the structural components of a mechanism presented in two dimensions.

Subtest C₂ - Determination of Logical Progression

Subtest C₂ is intended as a measure of the subject's ability to reason logically. The task is also closely allied to the practice of technical writing. It demands that the subject determine the operating principle of a procedure. By rearranging a set of statements into their proper sequence, the subject gives evidence of understanding that underlying principle.

A series of statements is presented for each of two individual problems. The first series involves a simple household chore; the second series, the servicing of a simple device. The task is to number the statements consecutively in the step-by-step progression required for successful completion of operation. Complexity is achieved by increasing conceptual difficulty. The arrangement of these steps into a meaningful whole is the exercise.

The last section of the TMEAP, the specialized aptitude test, deals with a particular phase of service-engineering. Two alternate subtests have been completed.

Subtest Q_{1A} - Electronics

Subtest Q_{1B} - Refrigeration

Subtest Q_{1A} is an achievement test for those applicants who have specialized in the area of electronics. Subtest Q_{1B} is an achievement test for those who have specialized in the area of refrigeration. Both Subtests Q_{1A} and Q_{1B} are pointed toward the measurement of the knowledge and theory required for the servicing of appliances developed within these phases of engineering. These subtests are sufficiently complex in nature to challenge subjects regardless of the extent of their knowledge.

TEST ADMINISTRATION

The complete series of eight subtests of the TMEAP may be considered self-administering. The examiner distributes the test materials and directs the examinees to fill in the blanks on the front of the test booklet. He also instructs them to read the directions carefully. Time limits have been

set for each subtest and should be noted by the examiner. Before each subtest is begun the contents should be explained briefly to the subjects.

Directions for completing each subtest should be read carefully by the subjects. The examiner should read these directions and examples aloud at the same time, to be sure that each subject understands the subtest requirements.

If questions arise regarding the directions, the examiner should reread the appropriate portions of the directions or review the example. By refraining from giving more detailed information about any one subtest, the examiner can keep testing conditions standard. The reading of directions and the inquiry should not be hurried. Every subject must understand what is required.

Each subtest is begun on the order "Begin!" and terminated on the order "Stop!". Timing starts with the first order and ends with the second. The exact time interval of each subtest appears in Table I. On completion of the total testing period, the examiner collects all test materials.

TABLE XVIII
TIME LIMITS
FOR TMEAP SUBTEST ADMINISTRATION

Subtest	Name	Running Time*
A ₁	Proofreading Errors	8
B ₁	Directions	
1		1½
2		4
C ₁	Comparisons and Analogies	10
D ₁	Word Meanings	15
A ₂	Writing Instructional Material	15
B ₂	Identification of Assembly Parts	10
C ₂	Determination of Logical Progression	
1		¾
2		3
Q _{1A}	Electronics	20
Q _{1B}	Refrigeration	15

*Running time is given in minutes.

TEST SCORING

A separate scoring key is provided for each of the eight subtests of the TMEAP.⁹¹ Instructions for their use appear on the key. Scoring is simple and direct. Responses are compared with the answer appearing on the key. Any deviation from the accepted response is scored as an error and the total raw score for the subtest is recorded. This score is posted in the blank provided at the end of the subtest.

The weighted score is computed as directed on the answer key. Formulae for the computation of the weighted score appear on the key. Directions should be carefully followed. Table II summarizes the scoring data described above.

The weighted score can be plotted as a test profile. Once computed, the score may be transferred in the form of an X to the chart appearing on the front of the test booklet. The weighted score for each subtest is to be located on the profile by scoring interval and subtest designation. Columns are coded by the letter and subscript assigned to each subtest. A profile chart of the subject may be formed by drawing connecting lines between the X's.

TEST INTERPRETATION

Subtest Data

The subtests of the TMEAP are intended to provide the examiner with meaningful information about job performance in the area of technical

⁹¹See Appendix III, 135-146.

TABLE XIX
SCORING DATA
FOR TECHNICAL MANUAL EDITOR ANALYSIS PROFILE
SUBTESTS A₁ THROUGH Q_{1B}

Subtest	Maximum Possible Score	Scoring Formula	Key	Remarks
A ₁	100	$2[50 - (W + G/2)]$	Rights only	One mark for each error. One half mark for each guess.
B ₁				
1	100	2(50-W)	Rights only	One mark for each error.
2	100	0.625(160-W)	Rights only	One mark for each error.
C ₁	100	4R	Rights only	One mark for each correct answer.
D ₁	100	4R	Rights only	One mark for each correct answer.
A ₂	100	16.66(6-W)	Rights only	One mark for each error.
B ₂	100	5(20-W)	Rights only	One mark for each error.
C ₂	100	10(10-W)	Rights only	One mark for each error.
Q _{1A}	100	4R	Rights only	One mark for each correct answer.
Q _{1B}	100	5R	Rights only	One mark for each correct answer.

writing. The aptitudes measured are those which judgment and experience have indicated as being important in the selection process.⁹² It is axiomatic, however, that the sophisticated examiner, personnel interviewer or industrial psychologist will always use all available information in interpreting the subtest scores. These scores, taken singly, provide useful information. Taken as an aggregate, the profile of scores assumes greater significance. To be most effective in the selection process, this profile pattern must be considered in a framework of all available data on the individual. It must be interpreted in terms of academic achievement, intellectual prowess, interests, motivation, and cultural background; in short, everything relevant to the purpose of selection.

Although each of the subtests is intended to make a unique contribution to the understanding of the individual in terms of job performance, groupings of two or more subtest scores should also be considered. These groupings provide configurations that become meaningful in terms of a profile pattern. Thus, Subtests C₁, D₁ and C₂ may be considered measures of those functions associated with general intelligence. How closely they parallel the information obtained from various intelligence tests will depend on the contents of the intelligence test chosen. Subtests C₁ and C₂ tap the same general area as those items in general intelligence which require determining relationships. Subtest D₁ taps another aspect of general intelligence, that of conceptualization.

⁹²Cf. *supra*, 1-2, 6-7.

Subtests A₂, B₂ and Q_{1A} relate closely to the subject's ability to analyze a situation in an objective manner. The subject is required to recognize common principles and to determine their application. These abilities are crucial to successful performance in the technical writing job area.

Subtests A₁ and B₁ are tests designed to measure general operating efficiency on the job. They represent a configuration of skills that are necessary but are not essential to satisfactory job performance.

Certain other configurational arrangements will probably suggest themselves to the examiner confronted with immediate application of the TMEAP. The second section of the TMEAP consisting of Subtests A₂, B₂ and C₂, for example, is presumed to be of basic importance to technical manual writing. If technical writing is concerned with a specific service-engineering field, the administration of Subtest Q_{1A} or Q_{1B} is in order. In considering positions of a clerical nature within technical writing, administration of the first section of the TMEAP consisting of Subtests A₁, B₁, C₁ and D₁ may prove helpful. Similarly, many other positions within the technical writing field may be expected to be concerned with various groupings of subtests.

Writing Instructional Material
Electronics
Refrigeration

A considerable amount of confidence can be placed in Subtests A₂, Q_{1A} and Q_{1B} as measures of technical writing ability. They were constructed for this express purpose. Extensive research upon the Subtests has demonstrated the usefulness of this approach in the technical writing field. Subtests Q_{1A} and Q_{1B} have been devised to supplement Subtest A₂. With minor changes

suggested by experience with earlier forms of the Subtests, they complement the data secured from Subtest A₂.

The ability measured by Subtest A₂ may be regarded as one aspect of intelligence, broadly defined. A high score on this Subtest indicates the ability to grasp and understand the principles realized in fabricating a mechanical instrument. In verbal form, this ability is expressed by a concise and logical operational procedure. The score is affected by previous experience but not to a degree that presents serious difficulty in interpretation. Formal training in the area from which the instrument is derived produces no appreciable increase in the score.

Subtest Q_{1A} is a measure of the subject's achievement in the field of electronics; Subtest Q_{1B}, a measure of the subject's achievement in the field of refrigeration. Subjects specializing in one field may be expected to score well on that subtest devoted to his specialty. Specialists in one field are not expected to score well on the subtest in the other field. In each field success on the job requires the kind of information demanded by each subtest.

Identification of Assembly Parts

Subtest B₂ is a measure of the ability to read blueprints and thereby deal with an object in different dimensions. In the execution of his job the technical writer is required to visualize the tangible attributes of a fabricated object. The ability to give substance to a plan is what this subtest is designed to evaluate. It is essential to an area where the need is to visualize in three dimensions an object that has been given in two dimensions.

Comparisons and Analogies

Subtest C_1 may be expected to predict with reasonable accuracy success in an area where complex verbal relationships are important. Success in most job areas would certainly fall under this classification. More specifically, the Subtest indicates something of the occupational level to which the subject may be suited. In technical writing, there seems to be a positive relationship between the level of job responsibility and the complexity of ideas to be comprehended.

Word Meanings

Subtest D_1 is a measure of the breadth of a subject's vocabulary. It complements Subtest C_1 as a measure of general learning ability. An extensive general vocabulary is probably as satisfactory an indicator of intellectual prowess as any other indicator of achievement. A precise knowledge of words and word meanings are required in the job area of technical writing.

Determination of Logical Progression

Subtest C_2 supplements the information secured from Subtests C_1 and D_1 . It measures the ability to perceive relationships and to determine the logical order for performing a task from verbal designs. Although this Subtest cannot substitute for Subtest C_1 , since the ability to reason logically is not the same as the ability to compare and to form analogies, it is valuable as a check on the validity of Subtest C_1 . Under ordinary conditions, the Subtest C_2 score may be considered more relevant to technical writing than the scores on the other two Subtests. In general, the job

draws more heavily on the perception of relationships than on concept comparison or analogy, or word meanings. For this reason, Subtest C_2 may be as properly grouped with Subtests A_2 and B_2 as with Subtests C_1 and D_1 .

Proofreading

Subtest A_1 is a clerical type aptitude test. The reason for its inclusion among the subtests of the TMEAP lies in its work-sample nature. It measures a basic clerical skill that is essential to the clerical phase of technical writing. The nature of this skill is to be able to pinpoint typographical or grammatical errors. Subjects scoring high on Subtests A_2 and C_2 and low on Subtest A_1 probably display a lack of perceptual acuity in addition to a lack of a thorough understanding of grammatical construction, punctuation and spelling.

Directions

Subtest B_1 is designed to measure the subject's speed and accuracy of perception on a simple paper-and-pencil task. Here, a heavy premium is placed on speed. Separate scores are reported for each of two sections of the Subtest. While each task demands a different perceptual pattern, few instances arise when one skill is needed and not the other. The decision to report separate scores is based on empirical evidence.⁹³ The two skills are not so closely related as to make separate scores meaningless.

The ability to perform satisfactorily in work of a routine nature, as exemplified in this Subtest, is important in filing, coding, posting, etc.

⁹³Cf. *supra*, Table II, 43.

Scores on Subtest B₁ should be interpreted in the light of other subtest scores. A low score on Subtest B₁ where other scores are high is to be eyed suspiciously. With otherwise acceptable subtest scores, a low score is just as likely to indicate that undue stress has been placed on accuracy as it is likely to indicate gross inability to work rapidly. Most work situations require accuracy above speed so it is not surprising that a subject continues to follow his normal work habits. If Subtest B₁ is considered essential to a particular work situation, it may be readministered to the subject who scores low only on this particular subtest. The tester on readministration should emphasize speed above accuracy.

In the preceding paragraphs, various situations have been brought to light in which the aptitudes measured by the subtests of the TMEAP are necessary or useful. The sophisticated examiner is not to be misled by such oversimplification. The identification and quantification of an aptitude with a single subtest is used merely for illustration. In the selection process the entire profile pattern will need to be considered together with all relevant data. For technical writing more than one of the aptitudes measured will probably prove significant in a given instance. Ideally, all the aptitudes measured by the TMEAP are required for the job. Practically, only those required for a specific job in the area of technical writing will be measured and the TMEAP utilized accordingly.

Analysis Profile

In evaluating the scores of a subject for selection purposes, concern arises regarding both the general level of ability and the irregularities

of performance from test to test. When scores have been plotted in such a way as to provide a graphic profile, they are presented in a manner permitting this kind of appraisal.

A profile chart which will provide just such a graphic illustration of a subject's performance appears on the front of the test booklet.⁹⁴ Here each subtest score of the TMEAP is plotted. The profile reveals at a glance whether the aptitudes tested are highly differential or are generally comparable. The specific use to which this visual aid may be put depends greatly on the selection situation and the sophistication of the test examiner. Without attempting to require the use of the profile chart, some remarks regarding the basic assumptions involved are in order.

The profile chart discussed above is an example of the most widely used type of profile illustration. The separate subtest scores are located with an X in their respective positions on the chart. The X's are connected with straight lines and the result is a line chart.⁹⁵ The popularity of this method of plotting a profile stems from the ease with which the relative position of each score of a set may be determined and plotted. Also to be considered is the level of sophistication that is required for interpretation. Since wide variations may occur among examiners, it was considered wise to use the simplest method possible.

While these considerations have been offered as distinct advantages,

⁹⁴See Appendix II, 115-134.

⁹⁵Cf. *supra*, 100-.

there are several characteristic limitations of this method. Most important is the erroneous assumption that position and linkage of given positions by lines must indicate relatedness among the subtests. This may or may not be true. The relatedness of subtests is not determined by position and connection necessarily but by the intercorrelatedness of each subtest. While such an assumption is not illogical, the order of subtest appearance has been set quite arbitrarily. An entirely different order of appearance might be supported with equal logic.

Figure 1 gives the average range of scores for the technical manual writer in industry today. Inspection of the Figure shows that the average range of scores for the greater number of the subtests falls in the upper half of the scoring range. The two exceptions are Subtests D₁ and B₂. This phenomenon is cited as evidence of the care with which the TMEAP was constructed. The structure of the instrument has been so controlled during the construction phase that even the scoring range for technical writers possesses face validity. The attribute of face validity was considered of the greatest importance for acceptance by examinee and examiner alike.⁹⁶

The scores achieved on each subtest that comprise any one shaded block run from the fourth to the sixth decile. This particular range of scores was selected for illustration because in practice the two deciles represented are considered the upper and lower limits of an average range of scores. Contained in this range is the mean, median and mode of the distribution of the sample population scores. As a consequence, Figure 1 may be

⁹⁶Cf. supra, 29-38.

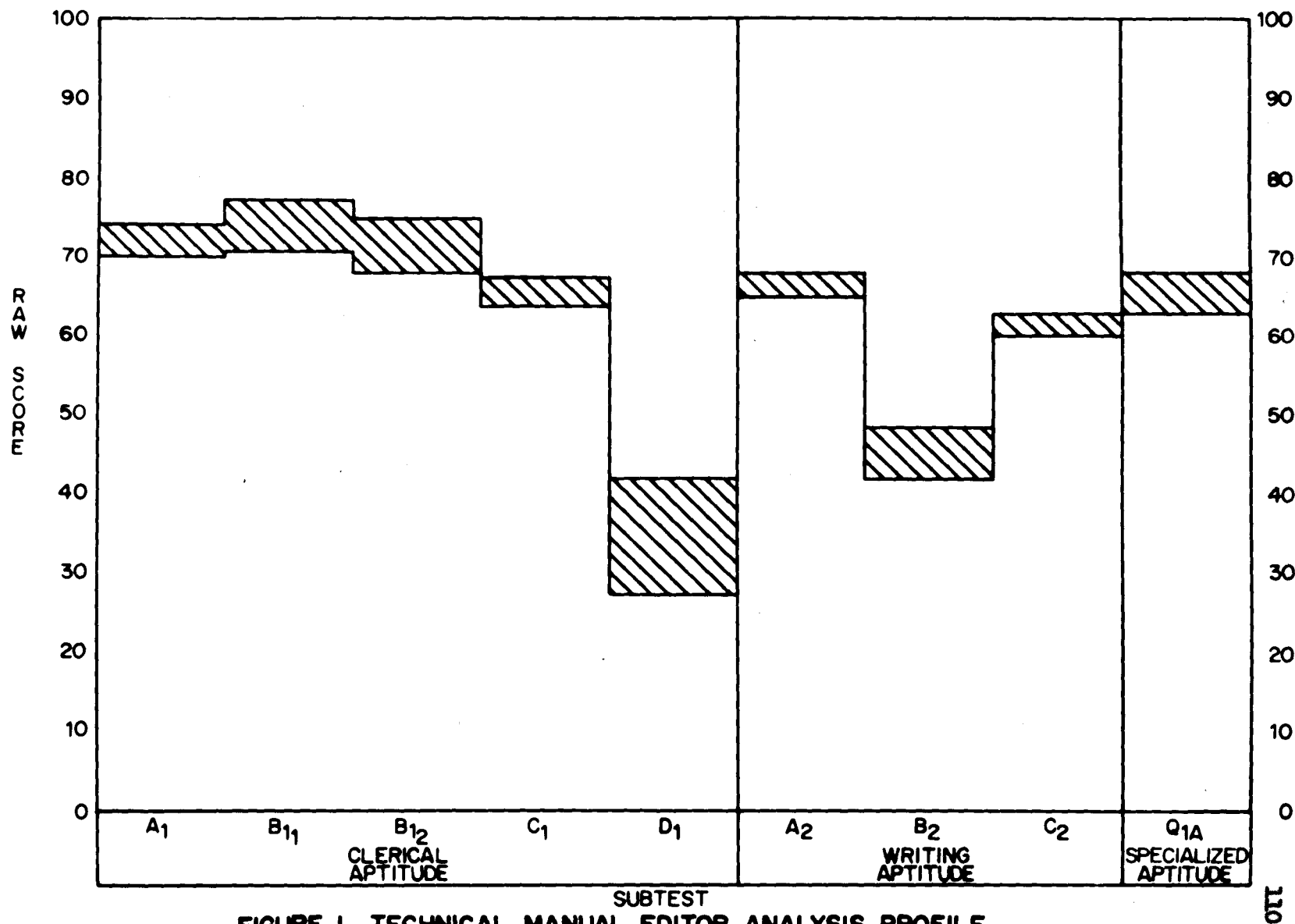


FIGURE 1. TECHNICAL MANUAL EDITOR ANALYSIS PROFILE

considered the typical profile of the technical manual writer in an industrial setting. This profile may be used as a master key in identifying technical manual writers.

TEST NORMS

The most appropriate manner of expressing norms is a very controversial subject.⁹⁷ A good deal of study has recently produced a number of variations in the presentation of norms. Among the commonly derived scales that had been considered for use in this study were the percentile rank equivalent scale, the standard scale, the T scale and the C scale. The use of percentile rank equivalents is considered most common which, in turn, would find easy acceptance and popularity among test users. According to Guilford, "They serve their best purpose when measurements must be interpreted to the layman."⁹⁸

In accord with this concept, the norms for the TMEAP have been expressed in percentile rank equivalents. See Table III. Rank equivalents are provided for the score points corresponding to deciles 1 to 9, to quartiles 1 to 3 and also to centiles 95 and 99 at the upper end and to centiles 5 and 1 at the lower end of the scale. The reason for including the points at the extremes is that there is actually a great range of ability above the ninth decile and below the first decile. In fact, the range of ability is about as great beyond the ninth decile as it is between the mean and the

⁹⁷ Guilford, Fundamental Statistics, 288-308.

⁹⁸ Ibid, 289.

ninth decile, and as great below the first decile as between that point and the mean.⁹⁹ If greater exactness is required, interpolation is necessary.

At the lower limit of the scale under column D₁, it is to be noted that a score of 0 yields a percentile rank of 1. Within this particular distribution of scores, the lowest 1 percent of the sample tested received a raw score of 0. Scoring 0 on this Subtest, however, is not to be considered evidence of a lack of this ability but rather that the strength of the ability is not great enough to register on this scale. Or better, the strength of this aptitude is negligible in terms of the requirements of the technical manual writing job area.

Five manufacturing firms and three technical manual production agencies contributed to the normative sampling. In several of these firms, the whole technical writing staff was tested; in some, all of the technical writers were tested. In others, the technical writers considered representative of the group, as judged by their immediate supervisor, were tested.

On almost every occasion, the TMEAP was administered to the group at one sitting. Where time did not allow, the various sections of the TMEAP were administered on subsequent occasions. The clerical aptitude section and the technical writing aptitude section were given to all the subjects. The specialized aptitude section, however, was given only to those who felt qualified as specialists - the decision was their own. The Electronics test, Subtest Q_{1A}, was administered to those specializing in electronic

⁹⁹Ibid, 127.

TABLE XX

PERCENTILE NORMS
FOR TECHNICAL MANUAL WRITERS*

Subtest										Percentile
Percentile	A ₁	B ₁₁	B ₁₂	C ₁	D ₁	A ₂	B ₂	C ₂	Q _{1A}	
99	93	98	94	88	74	99	83	100	94	99
95	87	94	90	82	70	96	67	100	91	95
90	84	92	86	79	60	92	62	100	84	90
80	82	86	82	75	51	80	58	83	80	80
75	81	83	80	70	49	77	56	81	77	75
70	80	81	78	69	47	75	55	75	73	70
60	74	77	75	67	42	68	48	63	68	60
50	72	74	72	66	37	66	45	62	65	50
40	70	71	68	64	27	65	42	60	63	40
30	67	68	64	60	20	58	40	53	60	30
25	65	66	63	59	16	56	38	52	57	25
20	63	63	61	57	13	54	36	51	52	20
10	55	55	55	51	6	45	31	42	38	10
5	51	35	50	45	3	40	27	32	33	5
1	47	27	42	41	0	27	17	2	26	1

*N = 40.

devices; the Refrigeration test, Subtest Q_{1B}, was administered to those specializing in refrigeration devices. None of those tested, were pressured in any way to take any or all of the subtests.

APPENDIX II

TECHNICAL MANUAL EDITOR ANALYSIS PROFILE

APPENDIX I II

TECHNICAL MANUAL EDITOR ANALYSIS PROFILE

SUBTEST SCORING KEYS

APPENDIX IV

TECHNICAL WRITING PERSONNEL RATING REPORT

TECHNICAL WRITING PERSONNEL RATING REPORT

Designed after A. S. Knowles

Name	Position
Firm	Department

Instructions to Rater

This rating scale has been designed specifically for purposes of test standardization and is effective only in determining the assayed qualifications of each writer to the degree intended by the rater. Therefore, it will be necessary to objectify the ratings in an effort to substantiate the qualifications.

Instructions for completing the rating scale satisfactorily are as follows:

1. Judge the technical writer for each of the twelve traits listed.
2. Check the appropriate level of performance for the trait in the space provided under Column 1.
3. Qualify your judgment for each trait in the space provided under Column 2.
4. Determine the relative significance of each of the twelve traits as a requisite to the position.
5. Assign a weight to each factor in Column 3.
 - a. Essentialness - 4
 - b. Desirability - 3
 - c. Unimportance - 2

DO NOT FILL IN THIS SPACE

Rating Summary		Overall Rating Scale	
		(Expressed as percentage of total possible score.)	
I. Personality		88 - 100	Superior
II. Performance		63 - 87	Above Average
III. Executive Capacities		38 - 62	Average
Total Point Rating		13 - 37	Below Average
		0 - 12	Unsatisfactory

Rated by	Date
Position	

[illegible]

- a. Appearance
Consider dress, manner, neatness.
- b. Ability to get along with others
Consider courtesy and tact, temperament and self-control.
- c. Character
Consider dependability, sincerity and consideration for others.
- d. Intelligence
Consider ability to learn, mental alertness, judgment, imagination, flexibility in handling new problems, ability to reason logically.

II. Performance

- a. **Personal productivity**
Consider use of working time and amount of work done personally (not by unit for which person rated is responsible); consider also diligence in fulfilling duties.
- b. **Productivity of unit for which responsible**
Consider amount of output or accomplishment of satisfactory quality.
- c. **Personal efficiency**
Consider promptness in completing work for which person rated is personally responsible; care and accuracy in preparing materials.
- d. **Efficiency of unit for which responsible**
Consider economy in operation; prevention of waste of material and time; care and orderliness of personal equipment.

III. Executive Capacities

- a. Initiative
Consider energy, ingenuity, self-starting ability.
- b. Organizing ability
Consider ability to plan and coordinate units systematically.
- c. Leadership
Consider ability to deal with others from whom he must extract information.
- d. Cooperation
Consider capacities for teamwork, willingness to subordinate personal desires.

* Rating X Weight

APPROVAL SHEET

The dissertation submitted by Aurelius Anthony Abbatiello has been read and approved by five members of the Department of Psychology.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the dissertation is now given final approval with reference to content, form, and mechanical accuracy.

The dissertation is therefore accepted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

10/4/58
Date

W. H. Lewis
Signature of Adviser

TECHNICAL MANUAL EDITOR ANALYSIS PROFILE

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Date _____

Name: _____

Age _____

Address: _____

Position: _____

Directions:

1. Read this page carefully. Do not look at another page until you are asked to do so.
2. The following pages contain various tests, each consisting of a number of problems.
3. The examiner will tell you when to begin and stop each test. You are not to begin the next test until you are told to do so. Do not turn back to any test after you have finished.
4. Work as fast as you can. Do not lose time by spending too long on any one problem; if you find the problem too difficult, go on to the next one.
5. If there is anything you do not understand about these instructions, ask now. No questions are allowed after the test begins.

Score:

	Clerical				Manual Writing			Special- ized Applics	
	A ₁	B ₁	C ₁	D ₁	A ₂	B ₂	C ₂	Q ₁	Q ₂
100									
90									
80									
70									
60									
50									
40									
30									
20									
10									

A. Proofreading Errors

Directions: Read the following paragraphs. Assume that this sheet had been received from the typesetter for proofreading. Circle every word or group of words that require correction or alteration. Do not use proofreader's mark. Both speed and accuracy are important.

Example: (I'll) work (til) I have (compleated) the test.

it is customary to hold that punctuation is for the eye rather than for the ear, that it is visual rather than auditory. But this is very largely a false contention, except in the case of writing that is intended specifically for silent reading. As far as spoken language is concerned, it is altogether a false contention. The intelligent speaker has not difficulty whatever in "visualizing" to his audience the "quotes", and the "exclaims" with which he gives notice to deliberate leaps into the various levels of speech. And the good speaker, whatever the style of English he uses, indicates parentheses and commas and semicolons and periods as well as exclamation and interrogation marks, by voice inflexion and phrasing and pausing, and by tonal quality. This power of the human voice to underwrite punctuation by its shading and flexibility constitutes one of the speaker's greatest assets in persuasiveness. There are those, to be sure, who would have it believed that, in the dictation of matter to students for the purpose of practice stenography, the method of dictation must be staccato and stilted and detached, regardless of any natural relationship of words into phrases and clauses and sentences. They accordingly dictate in frozen and monotonous and mechanical tones, monosyllabic morsels of sound that forbid an idea of "contextual" sequence or meaning. For the beginner in stenographic practice it may be that isolated units of sound should be dealt out by the dictator. But in the main, after the student has mastered the elementary sounds, the dictator should dictate parts or phrases or periods thereof. & the dictator who cannot indicate the proper punctuation to his stenographer by means of voice, and who, instead, has to, dictate the words 'comma, period, semicolon', and the rest, begs the whole question of punctuation as well as of dictation. Except perhaps in involved legal dictation, the dictator should be able to indicate by voice not only the proper punctuation of his copy, but the paragraphing as well. Punctuation, which seems little more than partitioning, is a natural part of expression - the part that, nine times out of 10 signals subordination and coordination and modification.

STOP here.

¹ J.B. O'Dyck, The Language of Advertising, Sir Isaac Pitman & Sons, New York, 1925.

Raw Score.....
Weighted Score.....

B. Directions Test

118

1. Directions: Read the following list of letters carefully. Draw a line through the letters A, Z, U and C. Do not draw a line through any other letters. Both speed and accuracy are important.

Example: H L ~~Z~~ D S G M ~~C~~ R F N D O E Q

J I K A X W H L B Y M G Z V C H U F O D P E Q R T S C W E V O A N X M U D L
P Y Z T E Q F R I Z C S H Y D X C O W B Z P N E V A N Q F U R L G S H Z T I
J ~~E~~ T D P S C O B R N Q U A M P V L W G X H Y K I Z J O F M E U Q B N V L A
T G C P K R J W D H S I Z X Y W X J V K I U Y A T P M V C W L U B K N D X T
A O J Y E Z P S F R Q G H I Q I H P A R G J O B K S Z F N T L C X M U E Y W
D V Q E N D M Z P L C Y F X Q K G U R B W H S I T A V J K A U J T L I S B R
Z H M W Q C X G N P D Y F O Z E P M N B O L A K J C Q I Z D Y H X E R V F W
U G S T S H R G Q F A T P E J D O C K B K F G R O C U S G L H T F M P R O D

STOP here.

Raw Score
Weighted Score.....

2. Directions: Look over the following list of figures and the letters directly below each figure. Discover which letter represents which figure. Fill in the proper figure below each letter. Both speed and accuracy are important.

Key: 1 2 3 4 5 6 7 8 9 0
C L J S T U V W Z A

Example: C Z L T J A S V
1 9 2 5 3 0 4 7

C T V L A C W T A V U A S J S B U L Z S Z C L W L T U V U C A J U W L Z C Z U A Z
L A T V J L J A C W U C V T S A J Z T W L W S U C S Z V W J W U J C L S V T A U
L C S J Z A T V L U J A S A C J L Z J Z V L W S T Z W C A Z J T A W A T J U V C
W T W T L S V C U V Z U A S L Z T V S W C U W Z T U S J L V A T S L Z J C U L V

STOP here.

Raw Score
Weighted Score.....

C. Comparisons and Analogies

119

Directions: Read each of the following statements carefully. Fill in the parenthesis with the correct answer. Both speed and accuracy are important.

Example: Conservative is the opposite of:

1. vigilant 2. liberal 3. reserved 4. inherent (2)

1. Dissonant pertains to:

1. smells 2. tastes 3. colors 4. sounds ()

2. shall this explained be carefully.

If the above words were arranged to make a sentence, what would be the last letter of the third word in the sentence?

1. e 2. s 3. y 4. d ()

3. Abject is the opposite of:

1. sordid 2. slavish 3. imperious 4. cowering ()

4. Habit is to custom as defection is to:

1. loyalty 2. reconciliation 3. apostasy 4. abandonment ()

5. Lemur is a kind of:

1. monkey 2. mouse 3. cat 4. donkey ()

6. A person who is coy is:

1. brazen 2. shameless 3. demure 4. decorous ()

7. materials of sections are reading composed.

If the above words were arranged to make a sentence, what would be the last letter of the first word in the sentence?

1. d 2. g 3. e 4. s ()

8. Dilate is the opposite of:

1. constrict 2. condense 3. expand 4. swell ()

9. Charitable is to stingy as mild is to:

1. moderate 2. fierce 3. serene 4. tranquil ()

10. Gargoyle is a kind of:

1. spout 2. handle 3. bucket 4. garter ()

11. To maim is to:

1. mutilate 2. spoil 3. assist 4. collate ()

12. voltages vary will that note these greatly.

120

If the above words were arranged to make a sentence, what would be the last letter of the fourth word in the sentence?

1. e 2. t 3. l 4. s ()

13. Jittery is the opposite of:

1. unnerved 2. nonchalant 3. collected 4. hectic ()

14. Amuse is to recreate as gibe is to:

1. chaff 2. taunt 3. rally 4. flout ()

15. Brochure is a kind of:

1. pamphlet 2. newspaper 3. magazine 4. book ()

16. An hydrometer is used in determining:

1. density 2. depth 3. angles 4. curves ()

17. necessary it replace to each not unit is.

If the above words were arranged to make a sentence, what would be the last letter of the fourth word in the sentence?

1. h 2. t 3. e 4. y ()

18. Liberal is the opposite of:

1. covetous 2. munificent 3. scanty 4. profuse ()

19. Mind is to neglect as proffer is to:

1. design 2. reject 3. intend 4. prefer ()

20. Shoal is a kind of:

1. shore 2. bank 3. bed 4. reef ()

21. Rive pertains to:

1. cutting 2. sewing 3. breeding 4. dividing ()

22. meaning device to written is lingual a punctuation clarify.

If the above words were arranged to make a sentence, what would be the last letter of the eighth word in the sentence?

1. g 2. a 3. s 4. l ()

23. Prolong is the opposite of:

1. shorten 2. curtail 3. persist 4. last ()

24. Meager is to rich as depleted is to:

1. full 2. sparse 3. teeming 4. abound ()

25. Decanter is a kind of:

1. glass 2. mug 3. bottle 4. jug ()

STOP here.

Raw Score.....
Weighted Score.....

CLERICAL TEST

122

D. Word Meanings

Directions: Give an adequate definition to each of the words in the following list. Both speed and accuracy are important.

1. abridgment -

2. batten -

3. citable -

4. decalog -

5. engraft -

6. finical -

7. gambol -

8. handsel -

9. instill -

10. jounce -

11. knar -

12. libelant -

13. molt -

14. niche -

10

15. obsequious -

16. pommel -

17. qualm -

18. refractory -

19. sylvan -

20. trammel -

21. usurp -

22. victual -

23. waive -

24. yodel -

25. zany -

STOP here.

Raw Score
Weighted Score

ARTICLE 11111111 11111

111

A. Writing Instructional Material

Directions: The illustration accompanying this section of the Profile is that of a dial telephone. Study it carefully and list the steps necessary to describe fully how to operate this phone. Bear in mind that the instructional procedure is to be used by persons absolutely unfamiliar with the instrument.

Present your procedure as you would for publication. Refer to the illustration as part of the presentation.

Raw Score
Weighted Score

MANUAL WRITING TEST

B. Identification of Assembly Parts

125

Directions: The accompanying illustration is that of a refrigerator door. Study it carefully and identify each part by placing the correct description number after each call-out.

- | | |
|----------------------------------|---------------------------------|
| 1. Door Weld Assembly | 10. Door Handle Escutcheon Stud |
| 2. Lock Mechanism Sealer | 11. Speed Nut |
| 3. Lock Mechanism Assembly | 12. Strip Insulation |
| 4. Door Handle | 13. Strip Insulation |
| 5. Door Handle Escutcheon | 14. Door Liner Assembly |
| 6. Lock Mechanism Screw | 15. Door Gasket |
| 7. Handle Support Screw | 16. Sealer |
| 8. Bead Sealer | 17. Insulation |
| 9. Door Handle Escutcheon Emblem | 18. Batt Type Insulation |

Raw Score
Weighted Score

MANUAL WRITING TEST

C. Determination of Logical Progression

127

Directions: Read the following instructions carefully. Determine the order of sequence in each listing. Number each step in the order in which it falls. Both speed and accuracy are important.

1. Fresh vegetables are best when cooked either in very little water or, as with leafy vegetables, no water at all. The perfectly controlled heat of a Flex-O-Heat switch surface unit makes it possible to cook in this manner. Thus the following method of cooking for these items is suggested.
 - a. Turn the control knob to the SIMMER heat position for the cooking period. ()
 - b. Place the vegetables to be steamed into the pan. ()
 - c. Cover the pan. ()
 - d. Add enough water to cover the bottom of the pan, or just enough to create steam ($\frac{1}{2}$ to $\frac{3}{4}$ cup). ()
 - e. Turn the control knob to the HIGH heat position until the liquid begins to steam. ()

STOP here.

2. Conventional 1951 refrigerators use new, all-plastic type shelf studs for supporting all shelves except the hydrator shelves in 11 cubic foot models. Drop shelves are also supported with all-plastic studs of different shapes which are to be removed and installed as described below. Refer to accompanying illustration.
 - a. Place the stud on a solid surface and drive the pin in enough to break the pin loose. ()
 - b. Pull the stud from the hole in the liner. ()
 - c. Carefully drive the center pin into the stud until the stud is flush with the flat surface of the body. ()
 - d. Carefully drive the center pin through the damaged stud into the insulation. ()
 - e. Press the stud into the hole in the liner. ()

STOP here.

Raw Score
Weighted Score

SPECIALIZED APTITUDE TEST

Q1A Electronics

128

Directions: Read each of the following statements carefully. Fill in the parenthesis with the correct answer. Both speed and accuracy are important.

Example: Ohm's law is best described by the formula:

1. $I = RE$ 2. $E = IR$ 3. $X_L = 2\pi fL$ 4. $X_C = \frac{1}{2\pi fC}$ (2)

1. The conversion of 100,000 ohms to megohms is:

1. 0.1 megohm 2. 0.01 megohm 3. 1.0 megohm 4. 0.001 megohm ()

2. The RF response curve of a television receiver indicates that the 55.25 MC video marker (Channel 2) is approximately at the top center of the curve. The 59.25 MC marker has moved to one side, but remains at the top of the curve. The 59.75 MC marker has moved down the curve approximately 80%. If the local oscillator is above the signal frequency, such a condition will cause:

1. a loss of low frequency response.
2. a decrease in the FM sound level.
3. ghosts in the television picture.
4. a loss of high frequency response. ()

3. The repetition rate produced in the output of a full wave rectifier on 60 cycles without a filter is:

1. 60 cycles 2. 50 cycles 3. 120 cycles 4. 25 cycles ()

4. FM interference in a television picture will result in:

1. snow in the television picture.
2. vertical lines in the television picture.
3. white horizontal lines in the television picture.
4. an herringbone pattern in the television picture. ()

5. The usual potential on a screen grid with respect to the cathode is:

1. positive 2. negative 3. same 4. zero ()

6. The 25.75 MC marker stands at a point 50% down one side of the IF response curve. The 22.25 MC marker stands at a point 85% down the side of the curve instead of standing at a point 30% down the side of that same curve as recommended by the manufacturer. If the local oscillator is above the signal frequency, such a condition will result in:

1. a loss of high frequency video response.
2. a loss of low frequency video response.
3. a loss of horizontal and vertical synchronization.
4. a loss of picture brightness. ()

1. rises 2. drops 3. does not fluctuate 4. does not perform as described here

8. A loss of horizontal and vertical synchronization may be the result of:

1. an open condenser in the differentiator circuit.
2. a defect in the synchronization amplifier stage.
3. improper ratio detector alignment.
4. a defective horizontal output tube.

()

9. Fundamentally, the purpose of a vibrator in an automobile radio is:

1. to convert AC to DC.
2. to convert DC to AC.
3. to change pulsating DC to AC.
4. to change DC to pulsating DC.

()

10. "Wrinkles" across the television picture from left to right may be the result of:

1. an incorrect horizontal sweep voltage waveform.
2. a weak vertical oscillator tube.
3. a dead horizontal tube.
4. an open vertical damping resistor.

()

11. If the reactance of a condenser is 25000 ohms at 60 cycles, its reactance at 6 megacycles is:

1. 2500 ohms 2. 250 ohms 3. 25 ohms 4. 0.25 ohms

()

12. In common practice the sound IF channel in an intercarrier receiver is being fed from:

1. the RF tuner.
2. the video amplifier.
3. the first video IF plate.
4. the integrator circuit.

()

13. Capacitance is best expressed by the formula:

1. $Q = CE$ 2. $\frac{E}{Q} = C$ 3. $EC = L$ 4. $\frac{E}{L} = C$

()

14. A 23.75 MC marker appears at the top to one side of the IF response curve. A 23.0 MC marker appears at the base line on the same side of the response curve. The 25.75 MC marker appears at a normal point 50% down the opposite side of the curve. If the local oscillator is above the signal frequency, this condition will result in:

1. a lack of brightness in the television picture.

15. If the voltage of a given heating coil is reduced to one half of its original value, the wattage is:
1. doubled
 2. halved
 3. quartered
 4. quadrupled
- ()
16. If the current is constant, the best type of antenna listed below for fringe area reception on one channel is:
1. a straight dipole antenna.
 2. a folded dipole antenna.
 3. stacked folded dipole antennas with reflectors.
 4. a folded dipole antenna, reflector and high band adaptor.
- ()
17. Doubling the current through a resistor:
1. doubles the heat produced.
 2. triples the heat produced.
 3. quadruples the heat produced.
 4. halves the heat produced.
- ()
18. Retrace lines in an otherwise normal television picture may be the result of:
1. a lack of DC restoration.
 2. a defective coupling condenser in the video IF amplifier.
 3. a defect in the horizontal sweep circuit.
 4. synchronization pulse clipping in the video amplifier.
- ()
19. The frequency in megacycles of the fifth harmonic of 20 meters is:
1. 750 megacycles
 2. 75 megacycles
 3. 7.5 megacycles
 4. 0.75 megacycles
- ()
20. In order to determine whether or not the receiver oscillator is operating on the DC scale of a VTVM, measure:
1. the bias on the RF amplifier.
 2. the bias on the oscillator grid.
 3. the oscillator plate voltage.
 4. the oscillator screen voltage.
- ()
21. Faraday's law is best described by the formula:
1. $e = -L \frac{di}{dt}$
 2. $e = -L \frac{di}{dt} M^2$
 3. $i = -L \frac{de}{dt}$
 4. $e = -L \frac{dt}{di}$
- ()
22. Matching impedances in power or communication circuits is desirable because it results in:
1. gaining voltage from one circuit to another circuit.
 2. transferring a maximum of current.
 3. transferring a maximum of impedance.
 4. transferring a maximum of power.
- ()
23. Each picture presented on TV per second is composed of:
1. 20 fields
 2. 30 fields
 3. 60 fields
 4. 120 fields
- ()
24. In order to make a dipole antenna more directive,

25. The impedance at the resonance of a series dipole is

1. 200 ohms 2. 300 ohms 3. 400 ohms 4. 500 ohms

STOP here.

Q18 Refrigeration

Directions: Read each of the following statements carefully. Fill in the parenthesis with the correct answer. Both speed and accuracy are important.

Example: The boiling point of Freon-12 is:

1. -10.66°F. 2. -21.7°F. 3. 14°F. 4. 48°F. (2)

1. Heat may be considered:

1. a substance, not a form of energy.
2. a form of energy, not a substance.
3. neither a form of energy nor a substance.
4. none of these alternatives.

()

2. Reducing the pressure on a liquid:

1. has no effect.
2. raises the boiling point.
3. lowers the boiling point.
4. raises the temperature of the liquid.

()

3. When changing from a solid to a liquid state, water:

1. absorbs heat.
2. gives off heat.
3. neither absorbs nor gives off heat.
4. changes in temperature.

4. Gases expand as the volume as expressed in the formula:

1. $V_o \times T_n$ equals $V_n \times T_o$.
2. $V_o \times T_o$ equals $V_n \times T_n$.
3. $P_o \times T_n$ equals $T_n \times T$.
4. $P_o \times P_n$ equals $T_n \times T$.

()

5. Convection may be defined as :

1. the flow of heat from warm to cold within a confined space.
2. the flow of heat from warm to cold mediums in direct contact.
3. the flow of heat from warm to cold through a medium.
4. none of these alternatives.

()

6. The term used to express the ratio between the quantity of heat required to change the temperature of a given substance 1°F and the

1. changes the cut-in or cut-out temperatures.
 2. changes neither the cut-in nor cut-out temperatures.
 3. none of these alternatives.
15. The operating pressure of sulfur dioxide is:
1. higher than Freon-12.
 2. lower than Freon-12.
 3. neither higher nor lower than Freon-12.
 4. none of these alternatives. ()
16. The selection of metals to be used in the manufacture of cooling and condensing units depends:
1. on high heat conductivity.
 2. on low heat conductivity.
 3. on average heat conductivity.
 4. none of these alternatives. ()
17. The operating pressure of methyl chloride is:
1. higher than sulfur dioxide.
 2. lower than sulfur dioxide.
 3. neither higher nor lower than sulfur dioxide.
 4. none of these alternatives. ()
18. The term "hermetic system" implies that:
1. the system is partially sealed.
 2. the system is completely sealed.
 3. the system is not sealed.
 4. none of these alternatives. ()
19. A customer reports a water leak from the float valve of the refrigerator. The refrigerator is operating satisfactorily but the source of the water leakage cannot be located. This condition may be caused by:
1. an evaporator that is not level.
 2. a defective needle and/or seat.
 3. too much refrigerant in the unit.
 4. an improperly adjusted temperature control. ()
20. A customer reports evidence of moisture condensation on the outside front of the cabinet. The refrigerator seems to be operating satisfactorily but the source of the trouble is not apparent. This condition may be caused by:
1. an inoperative temperature control.
 2. a void in the cabinet insulation.
 3. a lack of refrigerant gas.
 4. improper gasket seal. ()

Raw Score.....
Weighted Score.....

CLERICAL TEST A

Scoring Directions: One point for each omitted correction.
1/2 point for each misplaced correction.
50 - Raw Score x 2 equals Weighted Score.

It punctuation eye
except. visual auditory this reading
spoken specifically
speaker no difficulty
good leaps
parentheses English
exclamation inflection pausing
human indicate
constitutes speaker's
stenography
method clauses
morsels sound "frozen" For
forbid practice isolated
main
elementary thoughts
And indicate
means instead
whole
Except
proper
modification

Scoring Directions: One point for each misplaced or omitted cancellation.

50- Raw Score x 2= Weighted Score

A Z C U C A U
Z C C Z A Z U Z A
C C U A Z U C A
A Z C Z U A Z C U
Z C Z U A C Z A U
U C A C C U

CLERICAL TEST B-2

Scoring Directions: One point for each figure not exactly reproduced.

160- Raw Score x 0.625= Weighted Score

1 5 7 2 0 1 8 5 0 7 6 0 4 3 4 6 2 9 4 9 1 2 8 2 5 6 7 6 1 0 3 6 8 2 9 1 9 6 0 9

2 0 5 7 3 2 3 0 1 8 6 1 7 5 4 0 3 9 5 8 2 8 4 6 1 4 9 7 8 3 8 6 3 1 2 4 7 5 0 6

2 1 4 3 9 0 5 7 2 6 3 0 4 0 1 3 2 9 3 9 7 2 8 4 5 9 8 1 0 9 3 5 0 8 0 5 3 6 7 1

CLERICAL TEST C

Scoring Directions:

One point for each correct answer.
Raw Score x 4 equals Weighted Score.

1. 4. sounds
2. This shall be explained carefully. 1. e
3. 3. imperious
4. 3. apostasy
5. 1. monkey
6. 3. demure
7. Reading materials are composed of sections. 2. g
8. 1. constrict
9. 2. fierce
10. 1. spout
11. 1. mutilate
12. Note that these voltages will vary greatly. 4. s
13. 3. collected
15. 1. pamphlet
16. 1. density
17. It is not necessary to replace each unit. 4. cy
18. 1. covetous
19. 2. reject
20. 2. bank
21. 1. cutting
22. Punctuation is a device to clarify written lingual meaning. 4. 1
23. 2. curtail
24. 1. full
25. 3. bottle

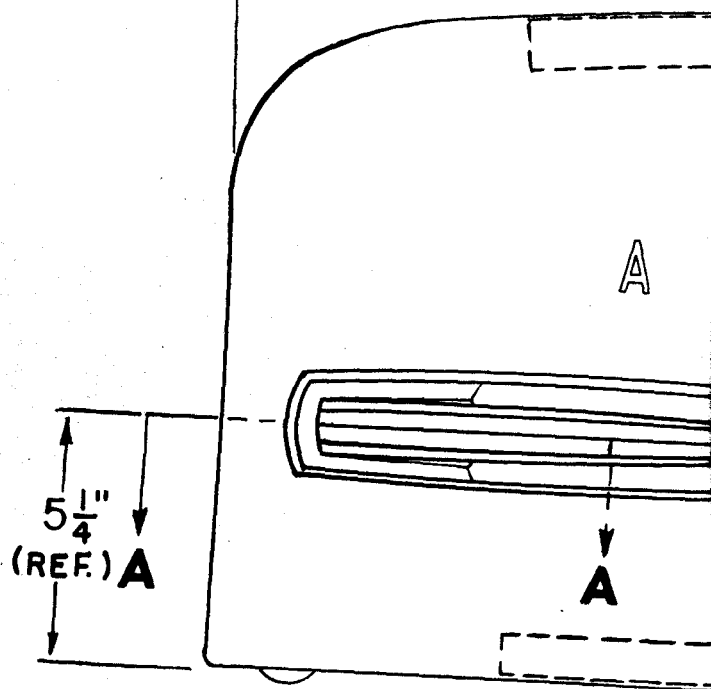
CLERICAL TEST D

Scoring Directions: One point for each correct definition given. Only one definition is to be scored for each word.
Raw Score x 4 equals Weighted Score.

1. abridgment - 1. Act of abridging, or state of being abridged.
2. A reduced form of a work, retaining the general sense and unity of the original; a compendium.
2. batten - 1. A strip of sawed lumber, used for flooring, etc.
2. A strip of wood used for nailing across 2 other pieces, to cover a crack, stiffen a spar, etc.
3. To furnish or fasten with battens; as, to batten down the hatches.
3. citable - That which may be cited.
4. decalog - The Ten Commandments.
5. engraft - To insert, as a scion of one tree in another for propagation; to graft.
6. finical - Affectedly fine; unduly dainty.
7. gambol - 1. A skipping or leaping about in frolic.
2. To bound or spring as in dancing or play; frisk.
8. handsel - 1. A gift as a token of good luck, especially in an enterprise or experience; as:
a. A first gift on any occasion.
b. A gift at the new year.
2. To give a handsel to.
3. To inaugurate with some token of pleasure.
- infuse slowly.
10. jounce - 1. To shake, esp. by rough riding; to jolt.
2. A shaking bump; a jolt.
11. knar - A knot or burr in wood.
12. libelant - One who institutes a suit by a libel.
13. molt - 1. To shed or cast off the hair, feathers, outer layer of the skin, horns, or the like, the cast off parts being replaced by new growth.
2. To cast off and renew by molting.
3. A molting; also, the cast off covering.
14. niche - 1. A recess in a wall, especially one for a bust, etc.
2. A place, condition, or the like, suitable for a person or thing.
3. To place in, or as in, a niche.

15. obsequious - 1. Compliant; devoted.
2. Servilely attentive; fawning.
16. pommel - 1. A rounded knob, as on the hilt of a sword.
2. The knoblike protuberance at the front and top of a saddlebow.
3. To beat soundly, as with the pommel of a sword or with the fists.
17. qualm - 1. A sudden attack of illness, faintness, or pain, especially nausea; hence, a sudden misgiving or faintheartedness.
2. A scruple; compunction.
18. refractory - 1. Obstinate; contumacious; unmanageable.
2. Resisting ordinary treatment; difficult to fuse, reduce, or the like.
3. A refractory person or thing; especially, a refractory material.
19. sylvan - 1. Of, pertaining to, living, located, or carried on in, the woods; forest.
2. Characteristic of the forest, especially as distinguished from the field or town.
3. Composed of, or abounding in, woods, grooves, or trees.
4. A rustic; a woodsman.
20. trammel - 1. A kind of net; especially, one made of three layers, the middle one fine meshed and slack, so that fish passing through either outer coarse net are pocketed in the center.
2. A kind of shackle used for making a horse amble.
3. Often plural, something impeding activity, progress, or freedom; toil; restraint; check.
~~4. A kind of net used for the fireless crane.~~
~~5. A kind of net used for the fireless crane.~~
~~6. Any of various gauges used for adjusting machine parts, etc.~~
6. To hold as in a net; intercept, with up.
7. To prevent or impede the free play of; hamper; confine.
21. usurp - 1. To seize and hold in possession by force, or without right; - applied to seizure of office, place, functions, powers, rights, etc.
2. To commit forcible seizure of place, power, functions, or the like, without right; to be, or act as, a usurper.
22. victual - 1. Food; specifically, chiefly in plural, food for human beings, especially when prepared for eating; viands.
2. To supply with provisions; to provide or store with food.
3. a. To eat; feed.
b. To supply or take in stores of provisions.

23. waive - 1. Obs. To remove; reject; leave.
2. To put away, or give up, a claim to; to forgo.
3. To refrain from taking advantage of; to neglect; disregard; as, he waived his rights to property.
4. To postpone; defer; as, let's waive this question until later.
5. Law. To relinquish voluntarily, as a right which one may enforce if he chooses.
24. yodel - To sing with sudden changes from chest voice to head voice, or falsetto, and the reverse; to warble.
25. zany - 1. A subordinate fool or acrobat who aped ludicrously the tricks of his principal; hence, a clown; buffoon.
2. A simpleton; a silly fellow.



Scoring Directions: One point
part. 20-

15

14

MANUAL WRITING TEST C

Scoring Directions: One point for the incorrect numbering of each step.
10 - Raw Score x 10 = Weighted Score.

1. a. (5)
 b. (1)
 c. (3)
 d. (2)
 e. (4)
2. a. (3)
 b. (2)
 c. (5)
 d. (1)
 e. (4)

Scoring Directions: One point for each correct answer.
Raw Score x 4 = Weighted Score.

1. 1. 0.1 megohm.
2. 2. a decrease in the FM sound level.
3. 3. 120 cycles.
4. 4. an herringbone pattern in the television picture.
5. 1. positive.
6. 1. a loss of high frequency video response.
7. 1. rises.
8. 2. a defect in the synchronization amplifier stage.
9. 4. to change DC current to pulsating DC current.
10. 1. an incorrect horizontal sweep voltage waveform.
11. 4. 0.025 ohms.
12. 2. the video amplifier.
13. 1. Q=CE.
14. 2. a lack of fine detail in the television picture.
15. 3. quartered.
16. 3. stacked folded dipole antennas with reflectors.
17. 3. quadruples the heat produced.
18. 1. a lack of DC restoration.
19. 2. 75 megacycles.
20. 2. the bias on the oscillator grid.
21. 1. $e = -L \frac{di}{dt}$.
22. 4. transferring a maximum of power.
23. 3. 60 fields.
24. 1. add reflectors and directors.
25. 2. 300 ohms.