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To the Graduate Council:

I am submitting herewith a thesis written by Virgil Collins Chew entitled "Investigation of Predictor Variables in the Sewing Trade." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Industrial Management.

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INVESTIGATION OF PREDICTOR VARIABLES IN THE SEWING TRADE

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Virgil Collins Chew

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ABSTRACT

Application blank data, test scores, and on-the-job performance data were obtained for sewing workers (N = 120) of a company in the Southeastern United States. The information obtained at the time of employment was compared with performance measures obtained later to determine whether employment data might be used to predict success or failure on the job. The sample was comprised of equal numbers of persons who failed to remain employed for six months and of those who had remained for six months or more.

Several items from the application blank showed possible value for selecting potentially successful employees. Further work is needed to validate these items before they can be recommended for use in the selection of employees. The test scores did not show significant or practical relationships with success or performance on the job.

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CHAPTER I

INTRODUCTION

A study was made of predictor variables for a group of employees in the sewing trade. Using data obtained at the time of hiring, a study was made of an equal number of employees considered successful (N = 60) or unsuccessful (N = 60). Test scores and other information included in the data sets had been used in the selection of employees; and, therefore, the range was restricted in that only data for hired employees were available. Thus, the study was exploratory in nature.

The predictor variables were of two types. One set of variables resulted from test scores, and the other variables were coded scores from application blank data.

Several measures of relative success were also available. The primary measure was continued employment beyond six months, while other measures of performance were also available. The company considered that employment and training costs were recovered for employees who remained employed for six months or longer.

I. THE PROBLEM

The problem was to determine which, if any, of the predictor variables was of value in selecting employees.

Selecting successful persons, as measured by continued employment, was the primary objective. Such secondary criteria as work output relative to production and training standards as well as attendance were also studied.

II. IMPORTANCE OF THE STUDY

There is considerable expense involved in hiring persons in industry. Advertising for help, interviewing, testing, physical examinations, paperwork, etc., are all time consuming and costly. There is also expense caused by unsatisfactory employees who learn slowly, produce less, or produce work of quality less than standard. Terminations are unpleasant for both the employer and employee and may cause bad feelings. Since all applicants for jobs do not make satisfactory employees, a company can reduce potential costs, improve product quality, help its public image, and improve long-term satisfaction of its employees if it can more accurately identify and hire those applicants who will become satisfactory employees.

If information obtained from applicants before hiring can be systematically related to their success or nonsuccess, employment costs can be reduced; and benefits to customers, employees and the company can be substantial.

III. DEFINITION OF TERMS

Several terms are used in the study which will require definitions.

Reliability is a measure of consistency or repeatability of a test or other measure of an applicant.[1]

Predictor Variable is a test score or application blank response which potentially may be used to predict applicant success on the job.

Criterion is an actual measure of job success or failure.

Validity[2] is the degree to which a predictor variable actually relates to a criterion. There are several types of validity:

Content Validity is determined by judgment of the apparent relationship of the predictor variable and the criterion.

Concurrent Validity is determined by comparison of scores of current employees in relation to their success on the job.

Feedback Validity is determined by comparing scores for employees based on success of those same employees.

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[1]Robert M. Guion, Personnel Testing (New York: McGraw-Hill Book Company, Inc., 1965), pp. 29-30.

[2]Guion, pp. 123-128.

Predictive Validity is determined by using a predetermined method of comparing applicant responses with the criteria.

Selection Ratio is the ratio of employees hired to those applying and available for hire.[3]

IV. METHODOLOGY

Employee data were obtained from company files with the cooperation of the company.[4] Various statistical methods were used to relate test scores at time of employment to later employee success and performance. Items from the application blanks were coded, and the coded application blank data were used to develop weighting scores based on later success. The results of these analyses were analyzed and summarized. In Chapter III, the methodology is reviewed in more detail.

V. ORGANIZATION OF THE STUDY

A review of pertinent literature is contained in Chapter II. The methodology, including methods of data

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[3]L. E. Albright, J. R. Glennon, and W. J. Smith, The Use of Psychological Tests in Industry (Cleveland: Howard Allen, Inc., 1963), pp. 80-81.

[4]Thanks are given to the company for its cooperation in providing free access and use of the data with no limitations except that the company name not be given.

gathering, is described in Chapter III. The results of the study and a discussion of these results are given in Chapter IV. The study and the conclusions drawn are presented in Chapter V.

CHAPTER II

LITERATURE SURVEY

Selection, utilizing test data and application blank data has been studied widely. There are many articles and books on the subject, and the brief survey given here is not meant to be a comprehensive survey. Sources for the information on the methods, procedures, and commercially available tests useful in selection are cited. Several representative selection studies, including one of sewing workers in the garment industry, are reviewed. Several review articles are also cited.

Guion[1] gave an extensive review of personnel tests, testing and methods, and selection and placement procedures. He also provided historical background for weighted application blanks. His work was used for background and definitions in much of this work. Guion gave detailed procedures for evaluating tests, establishing reliability, and determining validity by various methods.

England[2] presented a concise procedure for developing a weighted application blank and developing weights and

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[1]Robert M. Guion, Personnel Testing (New York: McGraw-Hill Book Company, Inc., 1965).

[2]George W. England, Development and Use of Weighted Application Blanks (Dubuque, Iowa: William C. Brown Co., 1961), 55 pages.

cutting scores. He recommended the use of holdout groups to establish validity. He issued several warnings to beware of changing conditions and emphasized the need to check validity at, perhaps, two-year intervals.

Dunnette[3] presented a program for personnel selection and discussed methods of measurement of people and jobs, strategies for personnel selection (including test selection and validation), and gave examples of strategies. He included an extensive list of references.

In another work, Guion[4] gave a general review of personnel selection and described trends noted from studying other literature. He gave 157 references and mentioned the legal aspects of selection arising from the Civil Rights Act of 1964.

Stone and Kendall[5] presented a rather complete survey of hiring procedures. They gave the specific steps for developing a weighted application blank and determining applicable usage.[6] They stated that application blank

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[3]M. D. Dunnette, Personnel Selection and Placement (Belmont, California: Wadsworth Publishing Company, Inc., 1966), 239 pages.

[4]Robert M. Guion, "Personnel Selection," Annual Review of Psychology, 18 (1967), 191-216.

[5]C. H. Stone and W. E. Kendall, Effective Personnel Selection Procedures (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1956).

[6]Stone and Kendall, pp. 145-181.

information is generally reliable, particularly if applicants expect their answers to be checked.[7] They also reviewed many tests in use as well as instructions in how to choose and use tests. They warned, as did others, that tests are better able to predict failure than success.[8]

Albright, Glennon and Smith[9] reviewed the meaning, selection, and use of psychological tests and included tables for interpreting statistical tests.

Yoder, Heneman, Turnbull, and Stone[10] presented a section on "Selection, Placement, and Induction." This section gave procedures for developing a weighted application blank as well as a short section on tests and testing.

Tiffin and McCormick[11] discussed personnel selection, evaluation and use of application blank data, and tests and testing.

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[7]Stone and Kendall, p. 174.

[8]Stone and Kendall, p. 234.

[9]L. E. Albright, J. R. Glennon, and W. J. Smith, The Use of Psychological Tests in Industry (Cleveland: Howard Allen, Inc., Publishers, 1963), 192 pages.

[10]Dale Yoder, H. G. Heneman, Jr., John G. Turnbull, C. Harold Stone, Handbook of Personnel Management and Labor Relations (New York: McGraw-Hill Book Company, Inc., 1958), Section 8.

[11]Joseph Tiffin and E. J. McCormick, Industrial Psychology (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1958), 584 pages.

Buros[12,13] provided several books listing tests with author, source, a short description, price, reviews, and references. The lists of tests were quite extensive. The referenced yearbook was the most recent of a series.

Many works provided tables for evaluating the significance of various calculated statistics. Among these were tests by Davies[14] and Huntsberger.[15]

Tiffin, Parker, and Habersat[16] reported an early study of application blank data. The study compared application blank data of optical workers of tenure greater than nine months with those who terminated in less than three months. Differences were found, but weights were not developed.

Scott and Johnson[17] reported the development of a weighted application blank in selecting canning trade

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[12]Oscar Krisen Buros (ed.), Tests in Print (Highland Park, N.J.: The Gryphon Press, 1961), 479 pages.

[13]Oscar Krisen Buros (ed.), The Sixth Mental Measurements Yearbook (Highland Park, N.J.: The Gryphon Press, 1965), 1714 pages.

[14]Owen L. Davies (ed.), The Design and Analysis of Industrial Experiments (New York: Hafner Publishing Company, 1963), 636 pages.

[15]David V. Huntsberger, Elements of Statistical Inference (Boston: Allen and Bacon, Inc., 1961), 291 pages.

[16]Joseph Tiffin, B. T. Parker, and R. W. Habersat, "The Analysis of Personnel Data in Relation to Turnover on a Factory Job," Journal of Applied Psychology, 31, 6 (1947), 615-616.

[17]R. D. Scott and R. W. Johnson, "Use of Weighted Application Blank in Selecting Unskilled Employees," Journal of Applied Psychology, 5, 5, Part 1 (1967), 393-395.

applicants who would be long-term employees. Through factor analysis, they determined favorable factors of age, dependents, and home ownership. It was their opinion that the blank would prove successful.

Inskeep[18] discussed labor turnover and specifically reported a research study relating application blank data and turnover in the garment industry with special emphasis on the sewing trade. He stated that turnover rates greater than 100 percent per year are not uncommon in apparel plants. After reviewing economies and some of the general background history and situation, he recommended a statistically guided selection approach. More specifically, he recommended study of employment data for both long- and short-tenure employees. He stated that important relations should be demonstrated with a Chi-square test. The important items from the application blank should then be weighted and applicants' scores used to guide hiring with or without specific cutting scores. He warned that conditions change and that reappraisals are necessary. He stated: "Weighted application forms are seldom valid for more than two years."[19]

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[18]Gordon C. Inskeep, "Statistically Guided Employee Selection: An Approach to the Labor Turnover Problem," Personnel Journal, 49, 1 (January, 1970), 15-24.

[19]Inskeep, 21.

In Inskeep's case study from a southern garment industry, he used a sample of over 1900 persons with nearly one-half being long-term employees. He found the following favorable characteristics.[20]

1. Home ownership
2. Age between thirty and thirty-nine years
3. Youngest child over six years of age
4. Over thirty-six months of prior work experience
5. Nine years or less of formal education

Economically beneficial results were not clearly demonstrated at the time of writing.

Shuh[21] reported a study using application blank items and turnover for a group of salesmen (N = 151). The results were not favorable, and reported church attendance was the only discriminating variable.

Many articles were written to report the results of studies with weighted application blanks in business situations. Many of these were summarized in reviews. Shuh[22] included studies of several sets of production workers, but none was for members of the sewing trades.

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[20]Inskeep, 24.

[21]Allen J. Shuh, "Application Blank Items and Intelligence as Predictors in Turnover," Personnel Psychology, 20, 1 (Spring, 1967), 59-63.

[22]Allen J. Shuh, "The Predictability of Employee Tenure: A Review of the Literature," Personnel Psychology, 20, 2 (Summer, 1967), 133-152.

Owens and Jewell[23] reviewed many "representative classical selection studies." They gave 143 references, but none was in the sewing trades.

Bennett[24] discussed problems of sampling, criteria, reliability, and validity in making validity studies. He concluded that more information on test validity is needed but that improperly prepared studies are actually detrimental.

Goldstein[25] reported substantial disagreement between application blank responses and information supplied by former employers. In studying nurses aid applications (N = 111), he reported that duration of employment and pay most often showed discrepancies.

Kirkwood[26] reviewed the increasing legal complications associated with testing. Increasing interest in individual civil rights and equal employment opportunities for minorities have brought legal pressure to insure that privacy is

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[23]W. A. Owens and D. O. Jewell, "Personnel Selection," Annual Review of Psychology, 20 (1969), 419-446.

[24]G. K. Bennett, "Factors Affecting the Value of Validation Studies," Personnel Psychology, 22, 3 (1969), 265-268.

[25]Irwin L. Goldstein, "The Application Blank: How Honest Are the Responses," Journal of Applied Psychology, 55, 5 (1971), 491.

[26]John H. Kirkwood, "Selection Techniques and the Law: To Test or Not To Test," Personnel, 44, 6 (November-December, 1967), 18-26.

not unnecessarily invaded and that items of cultural bias are not used to discriminate in hiring.

Roach[27] reported a double cross validation of a weighted application blank selection procedure over time. The blank was used to predict tenure of clerical employees (N = 154). "A substantial loss in predictive power was found in the additional cross validation."[28] Changes in various conditions were considered to have had an effect. He recommended periodic reappraisals of the effectiveness of the procedure.

There is a very large amount of information available for use in developing selection procedures. Information on application blank questions and evaluation, as well as information on available tests and their use and evaluation, are included. Many studies are reported of particular selection procedures and their evaluation. There are many problems and pitfalls to be avoided. The overall indication is that effective selection procedures often may be developed. Effective selection procedures are apparently very distinctive for a particular situation at a particular time and must be very carefully developed, validated, and updated to be of value.

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[27]Darrel E. Roach, "Double Cross Validation of a Weighted Application Blank Over Time," Journal of Applied Psychology, 55, 2 (1971), 157-160.

[28]Roach, 157.

CHAPTER III

METHODOLOGY

I. DATA GATHERING

The data for this study were furnished by the company. Data concerning the first 60 successful employees hired and the first 60 unsuccessful employees hired in 1971 were obtained. A successful employee is defined as one who was still employed at the time the data were obtained in February, 1972. The hiring period was almost identical for the successful and unsuccessful groups. Successful and unsuccessful employees were hired in each month through July. The last successful employee was hired on July 28, 1971, and only one unsuccessful employee was hired (August 3, 1971) after that.

The sewing company was located in the South, and several jobs with different duties and slightly different pay rates were filled. Since the employment market was tight at the time, the new employees were put into jobs or labor grades according to need without matching their employment data or test scores with the jobs to be filled. Approximately 80 percent of the applicants were hired, giving a selection ratio near 0.8.

The available data for study can be grouped into several categories:

General employment data. Such data include employee number, labor grade, and date of hiring. These data were not used in the analysis. There were five labor grades with several jobs within each grade. Most of the jobs were machine operations. Wages were paid by the hour for all jobs.

Test scores. Several tests were given at the time of application. The test scores were used in determining which individuals would be hired. This limits the usefulness of the data through restriction of range. No cutting scores were used as such; and with the high selection ratio, the range of scores was large. It was hoped, therefore, that the restriction of range would not seriously limit the value of the analysis.

Application blank data. The company application blank was reviewed thoroughly with company management. Arbitrary code numbers were assigned to the various responses on the application blank. The chosen codes and categories were considered most appropriate by company management. A number of biographical items were chosen for analysis. These included: distance to work, home telephone situation, length of time of residence, number of relatives and friends

employed by the company, year of birth, highest year completed in school, area of previous residence, length of previous residence, previous employment with the company, height, weight, marital status, ages of children, and the work shift started when employed. The application blank did not ask the applicant's sex or race.

Performance information. Several measures of performance in the first six months of employment were made available. The items were time in weeks to first 100 percent of standard, number of weeks above training standard, number of weeks below training standard, number of training extensions granted, total number of months employed and number of days absent and times tardy.

Success. The continued employment or termination was the measure of success of the employee. Data were available for 60 successful and 60 unsuccessful employees.

II. STATISTICAL ANALYSIS

Test scores. The scores of the several tests given at employment were analyzed statistically. The use of tests has probably been the subject of more research studies than any other selection device. "Each test must prove its

merits in a specific situation."[1] Tests are considered more effective in predicting failure than in predicting success. A lack of a specific aptitude measurable by a test might indicate a future failure; but motivation or outside problems which are not measurable might also prevent success. Tests have been used successfully in many occupations, but they must be carefully considered for specific cases to be used successfully. Several factors are important when considering tests.[2] The ones which seem to be present in this situation are high turnover, sufficient sample size (N greater than 50) to permit a meaningful study, some criterion of success in the job, and a high proportion of unsatisfactory employees.[3]

The available test scores were analyzed for relation to success or failure as defined and relation to various performance measures. Several statistical methods were used. Mean and standard deviations were calculated for all test scores for the successful employee group, the unsuccessful (terminated) employee group, and for the total group. Correlation coefficients were calculated for test scores with

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[1]D. Yoder, H. C. Henneman, Jr., J. C. Turnbull, C. H. Stone, Handbook of Personnel Management and Labor Relations (New York: McGraw-Hill Book Company, Inc., 1958), pp. 8-25.

[2]Yoder, Henneman, Turnbull and Stone, pp. 8-26.

[3]Yoder, Henneman, Turnbull and Stone, pp. 8-26.

performance measures and for test score interrelationships. These were also calculated separately for the successful, unsuccessful, and total group. The Student t Test was used to determine if significant differences in mean score were found for successful and unsuccessful employee groups. A stepwise multiple regression analysis was made using the test scores with each of the performance measures. The stepwise multiple regression procedure enters the test showing the greatest predictive power first and shows its correlation. The procedure then selects from the remaining tests, the one with the greatest predictive potential for the performance measure, considering the effect of the test selected first. This process is repeated step by step until all tests are considered. The effect of each test coming into the computation is obtained so that only those tests making significant contributions are chosen. The calculations, performed by The University of Tennessee computer facilities, used the multiple-regression analysis subprogram regression of the Statistical Package for the Social Sciences, version of March 13, 1971. The subprogram was designed and programmed by William C. Mitchell.

Results of these calculations and significance tests were reviewed and summarized.

Application blank data. The various coded scores from the application blanks were analyzed statistically.

Information from application blanks have long been considered of value in predicting success in jobs. In 1919, the Phoenix Mutual Life Insurance Company began weighting the application blank items. Goldsmith developed weights for application blank items in 1922. Since that time, many occupations have been studied using weighted scores from application blanks to predict future job success.[4] Each situation must be considered separately. The application blank data were analyzed to determine utility for prediction of success or termination of employees. Frequently tables were also devised of the various responses for successful, unsuccessful, and all sample employees. Chi-square tests were used to determine if significant relations existed between various answers of the coded scores and success or termination on the job. These calculations were made at the computer facilities of The University of Tennessee using the program, Statistical Analysis System, prepared by Anthony J. Baer and James H. Goodnight in May, 1971.[5]

In some cases, a consolidation of codes seemed advisable for the Chi-square tests; and these calculations were done

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[4]Robert M. Guion, Personnel Testing (New York: McGraw-Hill Book Company, Inc., 1965), p. 382.

[5]A. J. Baer and J. H. Goodnight, SAS Statistical Analysis System (Raleigh: Student Supply Store, North Carolina State University, 1971), 55 pages plus appendixes.

by hand, as described by Guion,[6] with significance determined from appropriate tables.[7] Weights were determined for the coded answers of the application blank using the system as described by England.[8] The application blank information was then scored for each individual, and the selection ratios and percent of successful individuals were calculated assuming that different cutting scores were used for the application blank scores. The results of these calculations are then summarized.

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[6]Guion, pp. 147-148.

[7]O. L. Davies, The Design and Analysis of Industrial Experiments (London: Imperial Chemical Industries, Limited, Oliver and Boyd and New York: Hafner Publishing Company, 1963), p. 597.

[8]George W. England, Development and Use of Weighted Application Blanks (Dubuque, Iowa: William C. Brown Company, Publishers, 1961), 55 pages.

CHAPTER IV

RESULTS AND DISCUSSION OF RESULTS

As calculations were made and analyzed, certain items were found to be significant in relation to success and performance. The purpose of this chapter is to point out these significant items. The results of statistical analysis are given in the Appendix (Tables IX, X, XI and XII) without discussion.

I. APPLICATION BLANK DATA

Identification of Application Blank Codes

The codes which were analyzed are reviewed below:

1. Distance to Work. The distance from the plant to the home of the applicant is coded as follows: from 2 to 5 miles, 1; from 6 to 15 miles, 2; from 16 to 25 miles, 3; and from 26 miles and farther, 4.

2. Telephone. A code is given for the telephone situation listed by the applicant: no telephone, 1; a telephone in the home, 2; a neighbor's telephone, 3.

3. Length of Residence. The length of time the applicant has lived at his current address is coded: less than one month, 1; one to twelve months, 2; longer than twelve months, 3.

4. Relatives. A direct count of the number of relatives employed by the company is used as a code. If more than nine, then nine is used as the code.

5. Friends. A direct count of the number of friends employed by the company is used as a code. If more than three, four is used as the code.

6. Year of Birth. The last two numbers in the year of birth are used directly as a code.

7. Highest Grade Completed in School. The last year (grade) completed in school is taken directly as a code.

8. Area of Previous Residence. The area of previous residence is coded as follows: local area, 1; West Tennessee or out of state, 2.

9. Length of Previous Residence. The length of previous residence is coded as follows: less than one year, 1; one to three years, 2; over three years, 3.

10. Previous Employment. Previous employees of this company are given a code of 1; others are coded 2.

11. Height. The height in inches is taken as a code number directly.

12. Weight. The weight in pounds is taken as a code number directly.

13. Marital Status. The marital status is coded as follows: single, 1; married, 2; separated, 3; engaged, 4; widowed, 5; divorced, 6.

14. Children's Ages. Children's ages are coded as follows: preschool, 1; grade school, 2; both preschool and grade school, 3; does not apply (none, etc.), 4.

15. Shift Started. Employees starting work on day shift are coded 1, and employees starting on night shift are coded 2.

Important Relations of Application Blank Data and Success

1. Year of Birth. When the Chi-square test was run using every possible year, no significant relation with success was found. When the data were condensed to ten-year intervals, the Chi-square value was 11.5 with 3 degrees of freedom. This shows a significant relation of year of birth and success at the 0.01 level.

Table I shows the number of successful and terminated employees with percent successful by year of birth.

TABLE I

NUMBER OF SUCCESSFUL AND TERMINATED EMPLOYEES WITH PERCENT SUCCESSFUL BY YEAR OF BIRTH RANGE

Year of Birth Range 19--	Number Successful	Number Terminated	Percent Successful
15 to 24	6	0	100
25 to 34	9	10	47
35 to 44	14	6	70
45 to 53	31	44	41
Total	60	60	50

The important items to note are that persons whose year of birth was between 1915 and 1924 were all successful in this sample, while those employees who were youngest and born between 1945 and 1953 were proportionately less successful than the average.

2. Highest Grade Completed in School. When the Chi-square test was used with every possible year, no significant relation to success was found. When data were condensed to four sets, the Chi-square value was 6.44 with 3 degrees of freedom. This still fails to reach significance at the 5 percent level but is cited because it will appear later in the weighting of the application blank. The number of successful and terminated employees with percent successful by the different years completed in school is given in Table II.

TABLE II

NUMBER OF SUCCESSFUL AND TERMINATED EMPLOYEES WITH PERCENT SUCCESSFUL BY HIGHEST GRADE COMPLETED IN SCHOOL RANGE

Highest Grade Completed in School Range	Number Successful	Number Terminated	Percent Successful
4 - 7	4	3	57
8 - 11	28	34	45
12	28	19	59
12 - 15	0	4	0
Total	60	60	100

In this table, note that those few employees (N = 4) with more than high school education were all unsuccessful.

3. Weight. The weight data were condensed into ten-pound range categories. When this was done, the Chi-square value was 9.32 with 5 degrees of freedom. This is not significant but is cited because it will appear later in the weighting of the application blank. The number of successful and terminated employees and percent with successful by weight range is given in Table III.

TABLE III

NUMBER OF SUCCESSFUL AND TERMINATED EMPLOYEES WITH PERCENT SUCCESSFUL BY WEIGHT RANGE

Weight Range, Pounds	Number Successful	Number Terminated	Percent Successful
90-110	12	10	54
111-120	11	9	55
121-130	12	15	44
131-140	5	13	28
141-150	13	4	77
more than 150	7	9	44
Total	60	60	50

The item to note is the relative success of those employees in weight range 141-150 pounds.

4. Marital Status. When the Chi-square test was run using all marital status categories, no significance was found. The data were then condensed to married, single, or

other. The Chi-square value in this case was 7.16 with 2 degrees of freedom. This was significant at the 5 percent level. Table IV gives the number of successful and terminated employees with percent successful by marital status. Note that married employees were less successful than the average and that employees in the "other" category were more successful.

TABLE IV

NUMBER OF SUCCESSFUL AND TERMINATED EMPLOYEES WITH PERCENT SUCCESSFUL BY MARITAL STATUS

Marital Status	Number Successful	Number Terminated	Percent Successful
Single	18	12	60
Married	32	45	42
Other (separated, engaged, widowed, divorced)	10	3	77
Total	60	60	50

5. Children's Ages. When a Chi-square test was made using all categories separately, there was no significance shown. When the categories were collapsed to preschool-age children only and those of other categories, the Chi-square value was 6.4 with 2 degrees of freedom. This is significant at the 2.5 percent level. Table V gives the number of successful and terminated employees with percent successful by children's ages.

TABLE V

NUMBER OF SUCCESSFUL AND TERMINATED EMPLOYEES WITH PERCENT SUCCESSFUL BY CHILDREN'S AGES

Children's Ages	Number Successful	Number Terminated	Percent Successful
Preschool only	9	21	43
Other (grade school, both preschool and grade school, and does not apply)	51	39	57
Total	60	60	50

The relatively low success level of employees with preschool-age children only is of note here.

6. Other Items. No other applicaton blank items showed significant results when the Chi-square test was used.

Weighting of Application Blank

Using the procedure for weighting application blanks as described by England,[1] a set of weights was developed for the categories of each application blank item. These weights were developed using the relative percentages of successful and unsuccessful employees in each category. For most categories of most variables, the assigned weight was one (1). A weight of one (1) indicates no difference

[1]George W. England, Development and Use of Weighted Application Blanks (Dubuque, Iowa: William C. Brown Company, Publishers, 1961), 55 pages.

in rate of success related to that item. Some categories of items were scored as being more often associated with successful employees, and these categories were assigned weight two (2). Other categories of certain items were scored to be unfavorable or associated with termination. These categories were assigned weight zero (0). Table VI lists all categories of application blank responses which had assigned weights other than one (1).

TABLE VI

APPLICATION BLANK CATEGORIES WITH ASSIGNED WEIGHTS OTHER THAN ONE (1)

Item	Category	Weight
Year of Birth	1915 to 1924	2
Year of Birth	1945 to 1953	0
Marital Status	Separated, engaged, widowed or divorced	2
Marital Status	Married	0
Weight	141 to 150 pounds	2
Highest Grade in School	13 to 15	0
Children's Ages	Preschool only	0

Of the five items showing categories important by the weighting procedure, only year of birth, marital status, and children's ages showed significant relations with success. Highest grade in school and weight range did not show significant relations with success.

Application blanks for all sample employees were then scored for all items to show the important relations of application blank information. Each employee was given a 0, 1, or 2 for each of the five items shown significant. A total was obtained for each employee. The number of employees at each total score is listed in Table VII below by successful and unsuccessful employees.

TABLE VII

APPLICATION BLANK SCORES FOR SUCCESSFUL AND TERMINATED EMPLOYEES

Score	Number Successful Employees	Number Terminated Employees
12	4	21
13	6	12
14	33	22
15	9	4
16	4	1
17	3	0
18	1	0

There is a relation evident between score and success. To indicate the effect of the relation, Table VIII is given to show the effect of cutting scores. It indicates the number of employees which would have been hired from the sample, the selection ratio, and the percent employees successful at each possible cutting score.

The cutting score is dependent on several things including the minimum selection ratio necessary in the given situation. England[2] suggested the calculation of an optimal score using a holdout group. No holdout group was set aside for this analysis, and no optimal cutting score was determined. The analysis gives so-called feedback validity only and is, therefore, not directly usable until predictive validity can be established. Interesting and possibly valuable relationships are shown, however.

TABLE VIII

TOTAL NUMBER OF EMPLOYEES HIRED, SELECTION RATIO, AND PERCENT SUCCESSFUL FOR EACH CUTTING SCORE

Cutting Score	Total Number Hired	Selection Ratio, Percent	Percent Successful
12	120	100	50
13	95	79	59
14	77	64	65
15	22	18	77
16	9	7.5	89
17	4	3.3	100

II. TEST SCORES

Test Identification

Analyses were calculated for the tests given at the time of employment. Six scores are from a series of tests from

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[2]England, pp. 31-36.

the Factored Aptitude Series prepared by Joseph E. King and published by Industrial Psychology, Inc. They are listed in Tests in Print[3] as well as in The Sixth Mental Measurements Yearbook.[4] The first three scores are from the three parts of one of these tests, entitled Dexterity, which has a copyright date in 1956 and a prior copyright date in 1949.

They are:

1. Maze. This score is from the first page of three pages entitled Dexterity. A continuous line is traced through a maze without touching the darkened areas of the maze. There is a time limit with scoring based on the number of openings passed without touching points in the darkened areas.

2. Checks. This score is from the second part of the test Dexterity mentioned above. Two check marks are placed in each square on a page of squares. The number completed in the time allowed is the raw score.

3. Dots. This score is from the third part of the test Dexterity mentioned above. A dot is to be placed in each of a series of small triangles without touching the sides. The number correctly placed in a given time is the raw score.

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[3] O. C. Buros, Tests in Print (Highland Park, N.J.: The Gryphon Press, 1961), p. 186.

[4] O. C. Buros (ed.), The Sixth Mental Measurements Yearbook (Highland Park, N.J.: The Gryphon Press, 1965), p. 1035.

4. Numbers. This is the score from a test named Numbers which is from the Factored Aptitude Series. It has a copyright date in 1956 and prior copyright date in 1948. Two consecutive arithmetic computations are made, and a selection of the correct answer is made from a choice of four. The test is timed at five minutes, and the number of correct answers is the raw score.

5. Precision. This is the score from a test named Precision which is from the Factored Aptitude Series. It has a copyright date in 1957 and has prior copyright dates in 1948 and 1953. This is a five-minute test of noting details in pictures. In each of a series of problems, an "X: is to be placed on one of four pictures which is exactly like the stimulus picture on the left."

6. Parts. This is the score from a test named Parts which is from the Factored Aptitude Series. It has a copyright date in 1956 with a prior copyright date in 1949. This is a five-minute test to identify a figure made up of separately shown parts. In each of a series of problems, a cross is to be placed on one of four figures to identify it as the one assembly made from separated parts shown to the left.

Three scores are from the Purdue Pegboard prepared by the Purdue Research Foundation under the direction of Joseph Tiffin, Science Research Associates, Inc., in 1941 and 1948.

It is listed in Tests in Print[5] and in The Sixth Mental Measurements Yearbook.[6] The Purdue Pegboard is a test of dexterity using one or both hands in an assembly-type operation with pins, washers, and collars. Reliability is reported as 0.60 to 0.76 on a retest basis. Validity has been reported over a very wide range but usually with small numbers of persons involved. The test is reported to be very specific and is of value in only certain situations.[7] Of several possible scores, the following were obtained at employment and are listed as numbered in order with the other employment tests used in this study.

7. Right Hand Purdue Pegboard.

8. Left Hand Purdue Pegboard.

9. Assembly Purdue Pegboard.

10. Crissey Dexterity Test. A score is obtained from the Crissey Dexterity Test prepared by Orlo L. Crissey with copyright date in 1964 by Psychological Services, Inc. This is a pegboard test where, in two 45-second intervals, pegs are to be removed from one end of a pegboard with both hands in a certain order and then turned over and reinserted in

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[5]Buros, Tests in Print, p. 263.

[6]Buros, The Sixth Mental Measurements Yearbook, p. 1310.

[7]Robert M. Guion, Personnel Testing (New York: McGraw-Hill Book Company, 1965), pp. 291-292.

the other end of the pegboard in another set order. Norms and some reliability and validity data are given with the test sheet.[8]

Performance Score Identification

Several performance measures were available for comparison with the test scores. They are as follows:

1. Time in Weeks to First 100 Percent of Standard. This is a stated number of weeks in general. Many terminated employees and one successful employee are coded as zero (0) although they did not reach standard.

2. Number of Weeks at or Above the Training Level. This is the number of weeks in the first six months in which the employee reached the standard training level. Twenty-four was the maximum possible and is a common score. Some errors were evident in the scores.

3. Number of Extensions. This is the number of extensions granted substandard performance employees during the training period.

4. Total Number of Months Employed. The number of months to termination is given for terminated employees. The number of months from hire to time of data gathering is given for continuing employees.

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[8]Orlo L. Crissey, Crissey Dexterity Test (Los Angeles: Psychological Services, Inc., 1964), 4 pages.

5. Number of Weeks Below Standard in First Six Months. This figure is the number of weeks below the training standard in the first six months. Some errors are evident in the scores.

6. Number of Days Absent in the First Six Months.

7. Number of Times Tardy in the First Six Months.

All data were gathered from existing records maintained by the company and were tabulated by company personnel who were familiar with the record system but somewhat less familiar with the coding process and the interrelationships among some measures used. Although some minor errors were detected, most of the recorded information appears fairly accurate.

Characterization of Test Scores and Performance Measures

The averages and standard deviations are given for all test scores and performance measures in the Appendix, Table IX. Intercorrelations of the test scores for all employees are given in the Appendix, Table X. There is considerable communality indicated among the various test scores. Correlation coefficients between test scores and performance measures for successful employees are given in the Appendix, Table XI. Intercorrelations of performance measures for successful employees are given in the Appendix, Table XII.

Relationships of Test Scores and Success and Termination

The means and standard deviations for each test were calculated separately for successful and terminated employees, and the Student's t Test was calculated for the significance of the difference in means for each test.

There were no significant differences in the mean value of any of the tests for the two groups.

Relations of Test Scores and Performance Measures

The relations between test scores and performance measures were examined. There are several complicating factors which prevented direct use of the performance measures for all employees. These are discussed separately for terminated and successful employees.

1. Successful Employees. The relations found between test scores and performance measures are presented and discussed below:

a. Weeks to First 100 Percent of Standard. The Assembly Purdue Pegboard score gave a correlation coefficient of 0.216 with Weeks to First 100 Percent of Standard. This was significant at the 5 percent level. High test scores correlated with poorer performance. No other test gave a significant simple correlation coefficient. Using the

stepwise multiple correlation procedure, two successive tests showed significant relations with Weeks to First 100 Percent of Standard. Those chosen were Assembly Pegboard and Crissey Pegboard. R-square for this correlation was 0.136 so that these two tests together accounted for 13.6 percent of the variability in Weeks to First 100 Percent of Standard. The regression equation was:

Weeks to First 100% of Standard = 8.5 + 0.110

(Assembly Pegboard score) - 0.147 (Crissey score)

The F ratio of the multiple correlation was 4.5 which was significant at the 2.5 percent level. The standard error was 4.28.

The tests are not of important value in predicting Weeks to First 100 Percent of Standard.

b. Number of Weeks Above Training Level. The Parts test error gave a correlation coefficient of 0.228 with Number of Weeks Above Training Level. This was significant at the 5 percent level. High test scores correlated with good performance. No other test gave a significant simple correlation coefficient. Using the stepwise multiple correlation procedure, two successive tests showed significant relations with Number of Weeks Above Training Level. Those tests were: Parts and Maze. R-square for this

correlation was 0.103 so that the tests together accounted for 10.3 percent of the variability in Number of Weeks Above Standard. The regression equation was:

Weeks Above Standard = 13.8 + 0.225 (Parts score) -0.077 (Maze score).

The F ratio of the multiple correlation was 3.28 which was significant at the 5 percent level. The standard error was 4.26.

The tests are not of important value in predicting Weeks Above Training Level.

c. Number of Extensions. The Left Hand Purdue Pegboard score gave a correlation coefficient of -0.225 with Number of Extensions. This was significant at the 5 percent level. High scores on Left Hand Purdue Pegboard score correlated with good performance. No other test gave significant correlations by simple correlation or by stepwise multiple correlation. R-square of the correlation was 0.05 so that Left Hand Purdue Pegboard score accounted for 5 percent of the variability in Number of Extensions. The regression equation was:

Number of Extensions = 2.6 - 0.045 (Left Hand Purdue Pegboard score).

The F ratio of the correlation by the stepwise method was 3.1 which does not reach significance at the 5 percent level. The standard error was 0.026.

The tests were not of important value in predicting number of extensions.

d. Number of Months Employed. This was not related to performance for successful employees and was not analyzed.

e. Number of Weeks Below Standard. No tests gave significant correlations with the Number of Weeks Below Standard. Some apparent coding errors prevented this performance measure from bearing the expected simple relation with Number of Weeks Above Standard.

f. Number of Days Absent. Two tests showed significant relations with the Number of Days Absent. The Right Hand Purdue Pegboard score showed a correlation coefficient of 0.284, which was significant at the 2.5 percent level. The Crissey score showed a correlation coefficient of 0.280, which was also significant at the 2.5 percent level. High scores on both tests correlated with poor performance.

Using the stepwise multiple correlation procedure, three successive tests showed significant relations with Number of Days Absent. Those tests are: Right Hand Purdue Pegboard, Numbers, and Crissey. R-square for this correlation was 0.178 so that the tests together accounted for 17.8 percent

of the variability in Number of Days Absent. The regression equation was:

> Number of Days Absent = 19.7 + 0.347 (Right Hand Purdue Pegboard score) -0.156 (Numbers score) + 0.134 (Crissey score).

The F ratio of the multiple correlation was 4.07, which was significant at the 2.5 percent level. The standard error was 5.42.

The tests were not of important value in predicting Number of Days Absent.

g. Number of Times Tardy. Three tests showed significant simple correlations with Number of Times Tardy. The Left Hand Purdue Pegboard score gave a correlation coefficient of 0.321, which was significant at the 1 percent level. The Crissey score gave a correlation coefficient of 0.311, which was also significant at the 1 percent level. The Right Hand Purdue Pegboard score gave a correlation coefficient of 0.270, which was significant at the 2.5 percent level. A high test score correlated with poor performance in each case.

Using the stepwise multiple correlation procedure, a number of the successive tests proved significant; and three tests showed enough effect to report. These tests were: Left Hand Purdue Pegboard, Crissey, and Assembly Pegboard.

R-square for this correlation was 0.169 so that the tests together accounted for 16.9 percent of the variability of Number of Times Tardy.

The regression equation was:

Number of Times Tardy = 9.55 + 0.212 (Left Hand Purdue Pegboard score) + 0.070 (Crissey score) -0.038 (Assembly Purdue Pegboard score).

The F ratio of the last step was 3.79, which was significant at the 2.5 percent level. The standard error was 2.5.

The tests were not of important value in predicting Number of Times Tardy.

h. Summary of Test Scores and Performance Measures. Although statistically significant correlations occurred, no single test consistently correlated with performance measures. No group of tests correlated with any of the performance measures to an important degree.

2. Terminated Employees. The Weeks to First 100 Percent of Standard was not used because in almost one-third of the cases, a 0 was coded to indicate that standard was never reached. This code was not consistent with others for correlation purposes. Also, the time these employees needed to reach standard was not known. The Number of Weeks Below

Training Level, Number of Weeks Above Training Level, Days Absent, and Times Tardy were not used because the totals were only taken from employment date to termination date; the numbers were, therefore, related to length of employment as much as to performance. The average number of absences and times tardy were essentially the same for successful and terminated employees, although the terminated employees reached this average in a much shorter average length of employment. The number of months employed was strongly related to success or termination, and it would be redundant to study separately. Extensions were granted to only one-quarter of the terminated employees. No value was seen for determining these relations.

No relations between test scores and performance of terminated employees seemed to show potential value because of the nature of the data.

CHAPTER V

SUMMARY AND CONCLUSIONS

For this company, application blank data from sewing trade workers showed relations with success as measured by continued employment beyond six months. The relations are shown with coded weights developed for year of birth, marital status, highest grade completed in school, and children's ages. At best, feedback validity is indicated. Until predictive validity is shown by further studies of employees, the relations developed should not be used. Although cross-validation studies generally result in reduced strength for initially determined relations, it may be that economically valuable application blank weights may be developed for selecting employees.

Test data obtained at employment do not indicate that valuable relations exist or can be established. The employment tests given are not justified for employee selection in this situation.

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APPENDIX

TABLE IX

MEAN AND STANDARD DEVIATION OF PREDICTOR TEST SCORES AND PERFORMANCE MEASURE RESULTS

Measure	All Employees		Successful Employees	
	Mean	Standard Deviation	Mean	Standard Deviation
I. Predictor Tests				
1. Maze	41.5	14.2	41.8	15.1
2. Checks	57.2	9.8	58.3	10.1
3. Dots	75.5	16.3	76.8	17.4
4. Numbers	22.7	10.1	24.3	10.3
5. Precision	28.9	7.8	28.8	8.0
6. Parts	27.5	6.4	27.8	7.1
7. Right Hand Purdue Pegboard	51.2	4.1	51.2	4.1
8. Left Hand Purdue Pegboard	47.5	4.2	47.6	3.7
9. Assembly Purdue Pegboard	123.4	15.7	123.2	15.9
10. Crissey Pegboard	97.0	10.3	97.2	10.6
II. Performance Measures				
1. Time in Weeks to First 100% Standard	5.9	4.7	7.3	4.5
2. No. of Weeks Above Training Level	13.6	7.9	19.0	4.4
3. No. of Extensions	0.5	0.8	0.5	0.7
4. No. of Months Employed	6.4	4.1	10.0	1.8
5. No. of Weeks Below Standard	4.1	4.1	4.8	4.5
6. No. of Days Absent	7.4	5.8	7.4	5.8
7. No. of Times Tardy	2.6	2.9	2.7	2.7

TABLE X

INTERCORRELATIONS OF TEST SCORES FOR ALL EMPLOYEES

	Maze	Checks	Dots	Numbers	Precision	Parts	RH PP	LH PP	ASS. PP
Score No.	1	2	3	4	5	6	7	8	9
1. Maze	1.00								
2. Checks	0.41[e]	1.00							
3. Dots	0.53[e]	0.65[e]	1.00						
4. Numbers	0.41[e]	0.38[e]	0.33[e]	1.00					
5. Precision	0.59[e]	0.44[e]	0.44[e]	0.44[e]	1.00				
6. Parts	0.48[e]	0.41[e]	0.41[e]	0.52[e]	0.69[e]	1.00			
7. RHPP	0.19[b]	0.37[e]	0.35[e]	0.21[b]	0.21[b]	0.21[b]	1.00		
8. LHPP	0.17[a]	0.27[d]	0.24[c]	0.13	0.11	0.18[a]	0.61[e]	1.0	
9. ASSPP	0.26[d]	0.37[e]	0.31[e]	0.40[d]	0.36[d]	0.39[e]	0.49[e]	0.55[e]	1.00[e]
10. Crissey	0.34[e]	0.51[e]	0.39[e]	0.31[d]	0.30[d]	0.33[e]	0.40[e]	0.45[e]	0.50[e]

[a]Significant at 5 percent level.

[b]Significant at 2.5 percent level.

[c]Significant at 1.0 percent level.

[d]Significant at 0.5 percent level.

[e]Significant at 0.05 percent level.

TABLE XI

CORRELATION COEFFICIENTS BETWEEN TEST SCORES AND PERFORMANCE MEASURES FOR SUCCESSFUL EMPLOYEES

Test	No. of Wks. to First 100% Std.	No. of Wks. Above Std.	No. of Extensions	No. of Wks. Below Std.	Days Absent	Times Tardy
Maze	0.09	-0.08	-0.09	0.14	0.03	0.13
Checks	0.02	0.08	0.04	0.00	0.02	0.18
Dots	-0.14	0.13	-0.14	0.00	0.02	-0.02
Numbers	0.17	0.03	0.04	0.00	-0.15	0.09
Precision	0.18	0.07	-0.06	0.31	-0.12	0.13
Parts	0.17	0.23[a]	-0.09	-0.07	-0.08	0.01
RHPP	0.08	0.12	-0.10	0.03	0.28[b]	0.27[b]
LHPP	-0.07	0.01	-0.23[a]	-0.08	0.21	0.32[c]
ASSPP	0.22[a]	-0.03	-0.11	0.06	0.05	0.05
Crissey	-0.16	0.05	-0.04	0.06	0.28[b]	0.31[c]

[a]Significant at 5 percent level.

[b]Significant at 2.5 percent level.

[c]Significant at 1.0 percent level.

TABLE XII

INTERCORRELATIONS OF PERFORMANCE MEASURES
FOR SUCCESSFUL EMPLOYEES

Measure No.	No. of Wks. to First 100% Std. 1	No. of Wks. Above Std. 2	No. of Extensions 3	No. of Wks. Below Std. 4	No. Days Absent 5
1. No. of Wks. to First 100% Std.	1.00				
2. No. of Wks. Above Std.	-0.02	1.00			
3. No. of Extensions	0.07	-0.46[d]	1.00		
4. No. of Wks. Below Std.	0.07	-0.68[d]	0.45[d]	1.00	
5. No. Days Absent	-0.19	-0.15	-0.03	0.26[b]	1.00
6. No. Times Tardy	-0.07	-0.04	-0.14	0.05	0.35[d]

[a]Significant at 5 percent level.

[b]Significant at 2.5 percent level.

[c]Significant at 1.0 percent level.

[d]Significant at 0.5 percent level.

VITA

Virgil Collins Chew was born in East Point, Georgia, on July 22, 1932. He attended elementary schools in that and other cities and was graduated from Russell High School in East Point, Georgia, in 1949. The following September, he entered Georgia Institute of Technology; and in June, 1954, he received a Bachelor of Chemical Engineering Degree. In January, 1954, he accepted employment with Tennessee Eastman Company in Kingsport, Tennessee. He served two years in the United States Army and returned to Tennessee Eastman Company, where he is currently employed.

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He is married to the former Rubye Charlotte Parker of Atlanta, Georgia. They have three children.