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An Evaluation of Certain Tests in Predicting Mechanic Learner Achievement

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AN EVALUATION OF CERTAIN TESTS IN PREDICTING MECHANIC LEARNER ACHIEVEMENT

by

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INTRODUCTION AND STATEMENT OF PROBLEM

Demands for increased industrial and educational efficiency in modern times have necessitated more careful selection and guidance of personnel in preparation for and entrance into industrial activities. As a means to this end, there are being developed numerous tests designed to measure abilities and to aid in prediction of potential successes in various fields. This problem is intensified in the preparation of workers in war industries.

Early in World War II it became very apparent that air power would be a primary determinant in the outcome of the war. The United States, in order to achieve air superiority, inaugurated an immense program of expansion in aircraft industry. A portion of this expansion consisted of the construction and maintenance of a vast network of air depots and their subsidiaries for the repair and servicing of aircraft.

This expansion created a growing need for skilled aircraft mechanics, which need could be fulfilled only through an extensive training program specific to the task. The United States Offices of Education, operating through the school system, sponsored a National Defense Training Program. Under this program, workers are trained for skilled and semi-skilled services needed in the principal defense industries.

Beginning in June 1941, the Utah program of training was devoted largely to the training of mechanics to work in civilian status for the Army Air Corps at the Ogden Air Depot or at other air depots as needs required. Men and women, having passed entrance examinations, were employed through the Civil Service Commission at a salary of nine hundred dollars per year to learn any of the aircraft trades. After completion of the training, they were eligible for reclassification to mechanic helpers, from which level they might be advanced as improvement was shown.

That portion of the total training program which provided incentive and data for the present study was carried on at the Utah State Agricultural College. Here students were trained in most of the eleven crafts into which the broader field of aircraft skills was subdivided.

The Civil Service Examinations, taken by all Mechanic Learner candidates, were designed for the purpose of eliminating those apparently least capable of achieving success. Additional methods were necessary to place learners in those subdivisions of the training program for which they were best adapted. A personnel system involving extensive use of tests, interviews, and personal records was already in operation in Utah defense schools when this study was undertaken. This testing program had proved valuable for the elimination of very slow learner, a process which was necessary in order to make the limited training facilities available for learners with greater potentialities for success. Economy and practicability suggested the extension of existing personnel procedures to the additional function of selecting the individuals for training in each of the specific skills offered in the training program.

Test validity is relatively specific. The validity of any test for a specific purpose must be determined experimentally or by correlation with tests whose validity have been previously established. Since no battery of tests had been validated for prediction of achievement in the Mechanic Learner program, it was necessary to determine this validity for a selected group of tests designed to predict achievement in related fields. The central problem of this study is to check the validity of certain tests as predictors of the achievement of Mechanic Learner trainees as determined by ratings of instructors.

Well established procedures in test validation are utilized. They consist essentially of three principal steps:

1. The definition of criteria of validity, or the achievements to be predicted;
2. The description of the instrument to be validated;
3. Correlation of measures of achievement with scores on the tests to be validated.

Subsequent sections of the study are devoted to these three processes.

This study is isolated from a complex and practical program of measurement. Many problems worthy of intensive study are closely interrelated and will influence the results of this one. These can merely be recognized and their influence hypothetically considered.

THE CRITERIA OF ACHIEVEMENT

Five Mechanic Learner classes training at the Utah State Agricultural College provided a sufficient sample of cases for separate study of each class. Data were collected from groups in training through the months of September 1941 to June 1942. The classes involved were Aircraft Instrument Repair, Aircraft Engine Overhaul, Aero Repair Mechanics, Machine Shop and Aircraft Electricity. These classes were made up of male students ranging in age from seventeen to forty-four years. Although women were eligible for training, none were included in this study because of their scarcity in the early months of the training program. The average education of the subjects was high school graduation, although individual cases varied from attendance in high school to attendance in college.

Before showing how achievement within the craft was judged, it is necessary to point out the general course content to indicate the areas within which the trainee was to achieve.

Mechanic Learner Classes. All classes considered were of approximately five hundred and eighty clock hours duration. In an eight hour day, two hours were spent in lecture and study for technical and related subjects of the craft. The trainees spent the remaining six hours in the various shops doing laboratory work. Here instruction was mainly individual explanation and demonstration. As a part of the five hundred and eighty hours, each class studied approximately thirty hours of Blueprint Reading, five hours of Safety, and five hours of General Orientation. One class, Machine Shop, included thirty hours of Shop Mathematics, five hours of instruction on Materials and sixty hours of Use of Precision Tools.

A general topical outline for each class as taken from <u>Plan for Training Mechanic Learners for the Ogden Air Depot</u>, with minor alterations made by local instructors and/or supervisors, is as follows:

Aircraft Instrument Repair

Unit One: Pressure Instruments
- A. Basic theory (principles of elementary physics on mechanics, hydraulics, hydrostatics and gases)
- B. Basic electricity and A and N standards
- C. Air speed indicator
- D. Suction gages
- E. Rate of climb indicator
- F. Manifold pressure gage
- G. Altimeter
- H. Oxygen regulator
- I. Engine gage indicator

Unit Two: Miscellaneous Instruments
- A. Magnetic Compass
- B. Chronometric tachometer
- C. Clocks
- D. Turn and Bank indicator

Aircraft Engine Overhaul

Unit One: Related Information
- A. Tools and Equipment
- B. Elementary Theory
- C. Nomenclature
- D. Engine parts listings
- E. Technical orders
- F. Clearances
- G. Torque valves
- H. A. N. standards and numbers

Unit Two: Shop Practice
- A. Disassembly
- B. Cleaning
- C. Inspection
- D. Rework and fitting
- E. Reassembly
- F. Timing

Aero Repair Mechanics

Unit One: Disassembly and Assembly
- A. Placing aircraft in flight position
- B. Removing and replacing control surfaces
- C. Removing and replacing wings
- D. Removing and replacing empennage section
- E. Removing and replacing center section
- F. Fuselage

Unit Two: Engine Change
- A. Cowling
- B. Lines and Controls
- C. Engine removal and installation

Unit Three: General Aircraft Equipment
- A. Oil system
- B. Fuel system
- C. Deicers
- D. Heating system
- E. Oxygen equipment

Unit Four: Cable Splicing and Swaging
- A. Splicing
- B. Swaging
- C. Soldering splices
- D. Cable stretching

Unit Five: Rigging
- A. Installation of cable
- B. Control Column
- C. Alignment of adjustable surfaces

Machine Shop

Division 1 Plan Reading
- A. Blueprint Reading
  - Unit One: Basic Principles of Blueprint Reading

Division 2 Related Technical
- A. Machine Shop Mathematics
  - Unit Two: Problems with Fractions, Common and Decimal
  - Unit Three: Problems with Geometric Construction Applied
  - Unit Four: Reading Tables of Equivalents, etc.
- B. Precision Measurements
  - Unit Five: Line-graduated Instruments
  - Unit Six: Use of Gage Blocks and Plug, Ring and Snap Gages
  - Unit Seven: Use of Thread Gages
  - Unit Eight: Use of Deal Gages and Test Indicators
  - Unit Nine: Use of Micrometers and Verniers
  - Unit Ten: Use of Surface Plates
  - Unit Eleven: Use of Angle Measuring Instruments

C. Materials
    Unit Twelve: Irons and Steels
    Unit Thirteen: Other Materials
D. Safety
    Unit Fourteen: Machine Shop Safety Practices

Division 3 Shop Practice

A. Machine Operation
    Unit Fifteen: Drill Press Operation
    Unit Sixteen: Lathe Operation
    Unit Seventeen: Milling Machine Operation
    Unit Eighteen: Shaper Operation
    Unit Nineteen: Planer Operation
    Unit Twenty: Grinder Operation
    Unit Twenty-one: Bench Work

Aircraft Electricity

Unit One: Shop Conduct
- A. Housekeeping
- B. Rules and regulations of shop
- C. Safety
- D. Responsibility of the Aircraft Electrician
- E. Tools and their use

Unit Two: Fundamentals of Electricity
- A. Electrical energy
- B. Batteries
- C. Solution of circuit
- D. Magnetism
- E. Currents
- F. Conductors and insulators

Unit Three: Electrical Measuring Instruments and Testing
- A. General
- B. Galvanometer
- C. Ammeter
- D. Voltmeter
- E. Wattmeter
- F. Ohmmeter
- G. Other types of testing devices
- H. Remote indicating systems

Unit Four: Electrical Symbols and Blueprints
- A. Introduction to blueprints in general
- B. Abbreviations, symbols, and basic circuits
- C. Construction with the use of blueprints
- D. Proper coordination between installation and wiring diagram prints

Unit Five: Cables, Relays, Switches, and Lighting Systems
- A. Introduction to wiring, soldering and forming
- B. Repair and test of low tension cables
- C. Repair and test of high tension cables
- D. Repair and test of relays and solenoids

Unit Six: Generators and Motors
- A. Current generation
- B. Types of airplane generators
- C. Construction, repair and test of generators
- D. Motors and their use

Unit Seven: Lighting, Switches, and Conduit Wiring
- A. Lighting systems and conduit wirings
- B. Switches

Method of Rating Achievement. Within each class, trainee achievement was rated periodically by the instructors. Ratings were marked on the "Mechanic Learner Appraisal Scale." (Appendix 1) This scale was an end product of numerous scales previously used in various local defense training programs. It was finally constructed by a committee composed of representatives from Weber College, Ogden Vocational Center, Salt Lake City, and the Ogden Air Depot. The rating scale was primarily intended as an appraisal to inform foremen, who would later be in charge of the individuals, of the degree of achievement attained by each of the learners in the training situation. Copies of these ratings were recorded on a "Rating Profile Sheet" and filed in the trainee's individual record file at the training center.

The scale involves ratings on seven separate traits: Learning, Speed and Coordination, Workmanship, Working Relations, Responsibility, Interest and Enthusiasm, and Personal Fitness for Occupation. Each trait is divided into a ten point scale with five verbal descriptions, ranging from low to high, under the numerical scale, to aid the instructor in making a more qualitative judgement in quantative values.

Ratings were obtained after the first two weeks of training and each month thereafter until training was completed at the school. During a learner's period of training, three, and many times four, ratings of his achievement were recorded.

One method for obtaining greater reliability was to average these ratings, making for one overall criterion to correlate with the predictive devices instead of using three or four different periodic ratings. Most ratings on one individual involved only the ratings of one instructor, but within one class, Aircraft Engine Overhaul, as many as five instructors contributed ratings by reason that near this number of classes were training during the same period of time. In some cases ratings on one individual may involve ratings by two or three instructors due to substitutions and replacements on the instructional staff.

It is known that some fairly objective tests were given in the classes and the results of these tests served partly as the bases for ratings on achievement. All ratings on performance of laboratory work could be judged only by the instructors. It is quite certain that, for a majority of instructors, judgement on performance is valid because of their numerous years of experience in industry observing apprentices in their particular craft. Acceptance of such measures of achievement seems to be a common practice, and in this instance, the instructor ratings are the best available criteria of achievement in these classes.

<u>Interdependency of Achievement Ratings.</u> To determine the interdependency among rated traits, intercorrelations were made from the traits rated by

instructors in Aircraft Instrument Repair and in Aircraft Engine Overhaul. Ratings of Total Fitness were correlated with all other traits in the class of Aero Repair Mechanics. The results are given in tables 1, 2, and 3. (Distributions of achievement ratings for all classes may be found in tables 21 to 27.)

It is clearly disclosed in the charts that there is a high intercorrelation among all traits. The lowest correlation, Speed with Working Relations, is $.59 \pm .05$[1]. Most intercorrelations are .80 or above, meaning that most ratings are quite significantly interrelated.

There are two possible explanations for these high intercorrelations. One is that the traits are actually correlated to the extent shown, that is, if an individual possesses one trait, he tends to possess others in somewhat like amounts. The other explanation is that the instructor, having rated an individual on one trait, tends to be influenced in rating all other traits by his initial judgement. This condition is commonly referred to as the "halo effect."

After these high intercorrelations were noted, a brief survey of instructor opinions was made to more accurately determine the trait, if any, which was the greatest influence in determining the general trend of other rated traits. A majority of the instructors replied that they had tried to keep the traits independent of one another but many made the general reply that "If a student is good in one thing, he generally does 'pretty well' in all things."

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1. All corrections are reported in the form of probable error.

Table 1. Intercorrelations among Trait Ratings for Trainees in Aircraft Instruments (N=95)

	Speed	Workmanship	Working Relations	Responsibility	Interest	Total Fitness
Learning	.75 ± .03	.75 ± .03	.61 ± .04	.81 ± .02	.79 ± .03	.77 ± .03
Speed		.83 ± .02	.59 ± .05	.75 ± .03	.74 ± .03	.74 ± .03
Workmanship			.67 ± .04	.84 ± .02	.74 ± .03	.80 ± .03
Working Relations				.76 ± .03	.69 ± .04	.68 ± .04
Responsibility					.91 ± .01	.87 ± .02
Interest						.95 ± .01

Table 2. Intercorrelations among Trait Ratings for Trainees in Aircraft Engines (N = 83)

	Speed	Workmanship	Working Relations	Responsibility	Interest	Total Fitness
Learning	.88 ± .02	.90 ± .01	.85 ± .02	.90 ± .01	.83 ± .02	.84 ± .02
Speed		.89 ± .02	.85 ± .02	.85 ± .02	.85 ± .02	.83 ± .02
Workmanship			.86 ± .02	.93 ± .01	.87 ± .02	.84 ± .02
Working Relations				.94 ± .01	.83 ± .02	.83 ± .02
Responsibility					.93 ± .01	.90 ± .01
Interest						.90 ± .01

Table 3. Correlations between Total Fitness and Separate Trait Ratings for Trainees in Aero Repair Mechanics (N = 95)

	Learning	Speed	Workmanship	Working Relations	Responsibility	Interest
Total Fitness	.90 ± .01	.91 ± .01	.95 ± .01	.84 ± .02	.97 ± .00	.89 ± .01

A determination of whether these traits actually tend to correlate highly or whether "halo effects" accounted for the high relationship may prove an interesting study, but it is too lengthy for further discussion in this study.

The fact remains, as the statistics show, that a report on one trait would be a good indication as to how the individual would be rated on any other trait. Correlations in the latter three classes were made with only one trait, Total Fitness for Occupation, rather than making correlations with all seven traits as were used in Aircraft Instruments and Aircraft Engines.

PREDICTIVE DEVICES

The method of judging achievement in the various Mechanic Learner classes having been shown, the tests with which achievement is intended to be predicted will be discussed.

Tests. Since many types of skills are needed within any one class, it would appear futile to try to predict total achievement with any one type of test. For this reason a large battery was chosen. Each test will be briefly discussed and citations made of previous studies on the validation of the test.

Pressey Senior Classification and Pressey Verifying Tests. Patterson, et al, give a comprehensive picture of the two Pressey tests.[1]

> The Senior Classification Test consists of four types of test items: Opposites, information, practical arithmetic and practical judgement, arranged in cycle order for convenience in giving and scoring. It is a brief examination for measuring abstract intelligence or ability to do schoolwork.

While the content of the Verifying test differs somewhat, the construction is similar to that of the Classification test.[2]

> The Senior Verifying Test is designed to serve as an alternate form of the Classification Test. It consists of four types of test items: Recognition vocabulary, concept recognition, number series and letter series completion, information arranged in cycle order.

The reliability and validity of these two tests are reported by these same authors.[3]

> The reliability of the Pressey Classification Test can be assessed indirectly by noting the correlation

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1 Patterson, Schneidler and Williamson. Student Guidance Techniques p. 63
2 Ibid p. 65
3 Ibid p. 65

> between this test and the Pressey Verification Test. For 334 men in the Standard Sample (selected to be representative of the gainfully occupied) the correlation coefficient is .91± .01; for 131 women, .90± .02. This evidence would incline one to assert that these two tests possess a highly satisfactory degree of reliability.
>
> * * * Repeated use of the Pressey tests in advanced classes in group intelligence testing in the College of Education, University of Minnesota, has shown that the Pressey tests correlate as well with such standard intelligence tests as Otis, Miller, Alpha, Terman Group, etc., as each of these correlates with each other. For 57 University High School freshmen, the Pressey Senior Classification Test correlated .92 with the mean of nine other tests, and it was found to yield higher validity coefficients (correlation with academic grades) than most of the nine tests used.

Realizing the significance of intelligence as a predictor of achievement in any learning situation involving use of abstract concepts, one might reasonably assume that an intelligence test should be used in the selection battery. Due to the fact that these two tests are adapted for use in grades seven to twelve and for unselected adults, these tests were chosen.

<u>Bennett's Test of Mechanical Comprehension</u>. This test is designed to measure the ability of an individual to understand various types of physical relationships. This type of ability is important in many trade courses. Tiffen further describes the test by saying,[1]

> The person tested is required to make a judgement from an examination of a drawing or schematic diagram. No mathematical or arithmetical computations are required, and the verbal or reading element is reduced to a minimum. As modern industry hires vast numbers of persons with practical mechanical experience but without formal education, the test fills a definite need in enabling an employment manager to measure mechanical ability among such persons.

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1 Tiffen, Joseph. <u>Industrial Psychology</u>. p. 61

The author, Bennett, relates that[1]

> The self-correlation of the test, corrected by the Spearman-Brown formula is .84 for a single grade (ninth grade boys).

Tiffen reports one validity rating.[2]

> In an unpublished study by the author, a correlation of .47 was found between the Bennett Test of Mechanical Comprehension and foremen's ratings of job performance for a group of forty-seven paper machine operators.

To pick out persons with mechanical ability but without much formal education was the main purpose of using this test as a part of the battery for predicting achievement.

Arithmetic Prognosis Test. The Arithmetic Prognosis Test is made up of a sampling of arithmetic problems which represent the fundamental skills of mathematics usually considered essential for the performance of general mechanics. It consists of items of addition, subtraction, multiplication, division, decimals, fractions, problem situations, algebraic signs, and problems with simple geometric figures. The test was arranged locally by Dr. Arden Frandsen for use in the College guidance program. Although no data on it have been published, it had been found to correlate significantly with college freshmen grades in mathematics and in chemistry.[3] Early results on the test also showed that it provided a normal distribution of scores. These data were an indication of its probable usefulness in this situation.

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1 Bennett, George K. Manual of Directions for Test of Mechanical Comprehension. p. 4

2 Tiffen, Joseph op. cit. p. 74

3 Data supplied by the author of the test.

Revised Minnesota Paper Form Board. The description of the Paper Form Board test given by Patterson, et al, is quite thorough.[1]

> In each of the two comparable forms (A-A; and B-B) the examinee is presented with sixty-four items, each consisting of a diagram of from two to five disarranged parts of a geometrical figure. In each item, there are five diagrams indicating how these parts might appear if fitted together. Only one of the five choices is correct. The test presumably measures the same ability as is required in the test of spatial relations. It measures ability to visualize spatial patterns in two dimensions. The paper and pencil task involves more of the linguistic type of intelligence, however, than does the form board. This is disadvantageous when individuals with less than average intelligence are examined.

Reliability for the test is reported as being about .92 using the split half method of comparison.

Indications of reasonable validity are given for the Form Board Test in Student Guidance Techniques.[2]

> A number of findings point to the probability that the test at least approaches its predecessor in validity. In the first place, it appears to be measuring about the same traits, as indicated by a corrected correlation of .89 with the earlier device. The norms for different groups reveal differences in the expected direction. For example, engineering students score about six points higher on an average than do arts college students. There is considerable overlapping of scores between populations, however.
>
> The authors report a correlation of .49 obtained between scores made on the revised form and mechanical drawing grades for 174 students.

Spatial relations has been considered an important factor in mechanical ability for some time. Because the paper test is supposed to measure somewhat of the same skill as the actual form boards and because of the lack of time for comprehensive individual testing, the

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1 Patterson, Schneidler and Williamson op. cit. p. 227-228
2 Ibid. p. 229

state program adopted this test as one of its required tests.

Finger Dexterity Test. The apparatus for the Finger Dexterity Test consists of a metal plate in which 100 holes are drilled. Each of these holes is large enough to hold three small metal pins. The task involves picking up three pins at a time, from a shallow tray attached to the plate, and placing them into the holes as quickly as possible. The score is a measure of the speed with which a person can use his fingers in work requiring fine eye-hand coordination.

Patterson, et al, give these reports concerning the test's reliability and validity:[1]

> Sufficiently consistent results for use with individuals may be expected with this instrument. Spearman-Brown corrected reliability coefficient was .93 for 475 men and .90 for 215 women representing a normal occupational sampling from Minnesota.
>
> Correlations between Finger and Tweezer Dexterity Tests reveal the fact that there is some element in common, although the relationship is not marked, as indicated by correlations of about .56 for a large and heterogeneous group of men and .33 for women.

Viteles and Thompson report in the Nineteen Forty Mental Measurements Yearbook that[2]

> Independent studies have shown the Finger Dexterity Test to be useful in selecting competent women shopworkers, watchmakers and various assembly jobs. * * * independent studies have shown that the test has an acceptable degree of validity for certain jobs involving rapid manipulation of small objects, etc.

Many Mechanic Learner classes involved fine hand and finger work. The test was used as a member of the battery to pick out individual performance of finger dexterity.

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1 Patterson, Schneidler and Williamson op. cit. p. 236-7

2 Buros, Oscar K. The Nineteen Forty Mental Measurements Yearbook p. 436

Tweezer Dexterity Test. The Tweezer Dexterity Test is similar to the Finger Dexterity Test. The reverse side of the metal plate is used. A tweezer is used to place a single pin in each hole. The score on the test is a measure of the speed and skill with which the person is able to manipulate a small tool in work requiring fine eye-hand coordination.

It is reported by Patterson, et al, that[1]

> Although no exact figures are available, there are substantial indications that this device yields results which are equally consistent as those secured when the reverse of the board is used for measuring dexterity with the fingers.
>
> The author claims that the test is sampling activities analagous to those employed by laboratory workers and persons who use fine instruments, such as physiologists, designing engineers, dentists, small parts repairmen, jewelry and watch repairmen, etc.

An interesting criticism of the test is given by Viteles and Thompson.[2]

> The present equivocal position of the test as an instrument for forecasting vocational achievement is well reflected in Bingham's statement that 'with the exception of workers engaged in fine instrument assembly jobs, the actual test achievements of large numbers of people succeeding or failing in........ occupations have not been published; and so the counselor has to rely on his good sense to guide him when considering what level of tweezer dexterity might be desirable in a specific occupation.'

Many Mechanic Learner classes involved use of fine tools. This test and the Finger Dexterity Test, built into one apparatus, as it were, appeared to be the best standardized measures of fine precision dexterity available.

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1 Patterson, Schneidler and Williamson op. cit. p.239
2 Buros, Oscar K. op. cit. p. 455

Minnesota Manual Dexterity Test (Placing and Turning). Patterson, et al, give a comprehensive discussion of these tests.[1]

> The apparatus for this test consists of a board measuring $39\frac{1}{2}$ inches by $10\frac{1}{4}$ inches. There are 4 rows of 58 round holes in the board and the examinee is instructed to replace the blocks in the board in a specified manner and as quickly as possible. Four trials are allowed and the time for each recorded.
>
> A second task, called the Turning Test, was devised. For this group of four trials the blocks are presented in their positions in the board. The examinee is instructed to start at one end of the board and to turn each block over by lifting with one hand and replacing with the other until all 58 blocks have been turned. The two parts measure speed of arm and hand movements in picking up and placing blocks in uniform holes.

The same authors report reliabilities and validities of these two tests.[2]

> Darley has shown that the test as a whole, and the Placing and Turning tests separately, are reliable for both men and women. The consistency of an individual's score is more stable, however, when the first trial is used as a fore-exercise practice trial. (This method was used in Mechanic Learner Testing). The coefficients, when corrected by the Spearman-Brown formula, are, for the most part, .90 or above for groups representing a normal occupational sampling of urban population.
>
> The test's main claim for validity is that rather large differences in average scores have been found among different occupational groups. Persons in occupations calling for a high rate of speed in hand and arm movements have been found, on the average, to make strikingly higher scores than those in jobs not requiring such rapid coordination.....Furthermore, these workers are not differentiated from the general population by the O'Connor Finger and Tweezer Dexterity Tests.

A measure of gross hand and arm movements seemed as vital as a measure of fine finger and small tool dexterity. These tests were chosen to predict the larger dexterity which is needed in some of the Mechanic Learner classes.

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1 Patterson, Schneidler and Williamson op. cit. p. 240-2

2 Ibid. p. 242

Crawford's Test of Tridimensional Structural Visualization. This test is another measure of spatial relations, but it involves insight for the third dimension, which is known to be a valuable ability in some mechanical fields. The test itself is a large nine piece tridimensional puzzle which is to be fitted onto a base board with depressions and projections. It is designed to measure the insight factor relatively more than the manipulative factor.

Crawford reports briefly on its reliability and validity.[1] Form One correlates with Form Two (equal but reversed form) .89 ± .02 using a sample of forty-eight. High school drafting rank and scores on the test are reported to correlate .91 ± .02.

Although reports on the validity of this test are not extensive, the ease and rapidity with which the test can be given seems argument enough to give the test a fair trial in a new situation.

California Test of Personality. This test is composed of questions divided into two major categories, one dealing with personal adjustment, the other with social adjustment. Each of the two is divided into six subsections of fifteen questions each. The questions require an answer of 'yes' or 'no'. A correlation of .78 ± .03 was found between self-adjustment and social adjustment scores. Because of this high relationship between the component parts, all other correlations involving this test were made only with the total adjustment scores.

The manual of directions accompanying the California Test of Personality

1 Crawford, John E. "A Test for Tridimensional Structural Visualization" Journal of Applied Psychology 44:482-492, August 1940

indicates the test's main use is for revealing the quality of an individual's adjustment. This would further indicate that it would likewise discriminate the maladjusted within a training program or even in an occupational situation. Similar tests have been used in aircraft industries with reports of supposed success. Because of the recent increasing use of personality tests in the aircraft industries, state authorities encouraged the use of this test. For this reason it was used to some extent, but lack of sufficient samples limited its study to the Aircraft Instruments class.

Interdependency of Predictive Devices. To find the interdependency of the various predictive measures discussed in the foregoing pages, intercorrelations were made from test scores made by students in the Aircraft Instruments classes, a sample of 92 cases.

A survey of table 4 will substantiate the generalization that there is little interrelationship between the tests. However, some results show that a few of the tests are measuring common factors, at least to a small degree. The correlation of $.39 \pm .06$ between the Pressey tests and the Arithmetic Prognosis Test reveals the probability that both are measuring, somewhat, the same traits. The correlation is not sufficiently high to conclude that one is a duplication of the other. Their significance as individual predictive devices would be the determining factor in evaluating their multiple use.

There is also an indication of interrelationship between the Mechanical Comprehension Test and the Arithmetic Prognosis Test, as shown by the correlation of $.24 \pm .07$. The relationship is obviously too small

Table 4. Intercorrelations among Predictive Measures for Trainees in Aircraft Instruments (N = 90)*

	II Arithmetic Prognosis	III Minnesota Paper Form Board	IV Finger Dexterity	V Tweezer Dexterity	VI Tridim. Structural Visualiz.	VII Mechanical Comprehension	VIII California Test of Personality	IX Placing Test	X Turning Test
I	.39 ± .06	.02 ± .07	.07 ± .07	.16 ± .07	.08 ± .07	.16 ± .08	-.18 ± .07	.16 ± .07	.12 ± .08
II		-.01 ± .07	.08 ± .08	.06 ± .07	.11 ± .07	.24 ± .07	-.21 ± .07	.08 ± .07	.10 ± .08
III			.14 ± .07	.10 ± .07	.20 ± .07	.00 ± .07	.06 ± .07	.06 ± .08	.00 ± .08
IV				.17 ± .07	.22 ± .07	-.04 ± .08	.05 ± .08	.21 ± .08	.06 ± .08
V					.11 ± .07	.14 ± .08	.02 ± .08	.26 ± .07	.20 ± .08
VI						.18 ± .08	-.10 ± .08	.19 ± .08	.11 ± .08
VII							-.14 ± .08	.21 ± .09	.14 ± .09
IX									.27 ± .07

I Pressey Tests
II Arithmetic Prognosis
III Minnesota Paper Form Board
IV Finger Dexterity
V Tweezer Dexterity
VI Tridimensional Structural Visualization
VII Mechanical Comprehension
VIII California Test of Personality (Total Adj.)
IX Placing Test
X Turning Test

* Because it was impossible to administer all tests to every individual, the sample is not always the same. In one instance the sample was just 64, while in others it was 95, but in a majority of cases, N = 90.

to exclude either test on the basis that it is being duplicated by the other.

Some of the manipulative tests have some degree of correlation such as, Finger Dexterity with Tridimensional Structural Visualization, $.22 \pm .07$; and Tweezer Dexterity with the Placing Test, $.26 \pm .07$. These relationships, as generally conceived, are somewhat significant, but not to the degree that one test may be substituted for another.

A further generalization might also be made that where relationship is shown, it occurs between two manipulative tests or between two measures involving abstract thinking, rather than between a measure of abstract thinking and a manipulative test.

Because there is little or no duplication in the area of skills and abilities which each of the described tests measure, they have all been retained as measures of prediction in the present study. (Distributions of test scores for each class may be found in tables 11 to 20).

RESULTS AND PREDICTIVE SIGNIFICANCE OF TESTS IN DETERMINING MECHANIC LEARNER ACHIEVEMENT

In the preceding chapters, the achievement criteria and the predictive devices used in the study have been discussed. The logical relation has been inferred, but only by the application of statistical procedures can the relationship between these two factors be accurately evaluated.

Table 5 gives coefficients of correlation for each test with the various ratings of achievement for the class in Aircraft Instruments. It may be noted that each test correlates somewhat within the same range with each of the rated traits. For example, the Turning Test correlates from .06 to .12 with any of the seven traits, making little difference whether the rated trait is Speed, Learning, or any of the other factors. Beyond the evidence shown in table 1, this is a further indication that the instructors were rating a common skill, regardless of the named trait.

With table 6 offering more evidence of this situation, one additional step was taken in order to eliminate superfluous statistical computations. An average of all ratings was made for the Aero Repair Mechanics class. Correlations involving this Average rating were made and compared with correlations involving the Total Fitness rating. Since the difference is negligible in most cases, it was decided that further correlations would be made only with the Total Fitness rating. So, for each class, discussion will be limited mainly to the Total Fitness ratings.

To eliminate extensive discussion of predictive significance for each resulting correlation, it will generally be considered that if a correlation is three times as large as its probable error, it will be considered

Table 5. Correlations between Predictive Measures and Trait Ratings for Trainees in Aircraft Instruments (N = 90)*

Predictive Measure	Learning	Speed	Workmanship	Working Relations	Responsibility	Interest	Total Fitness
Pressey Tests	.38±.06	.27±.06	.34±.06	.32±.06	.46±.06	.50±.05	.55±.05
Arithmetic Prognosis	.34±.06	.15±.07	.25±.07	.18±.07	.30±.06	.33±.06	.28±.07
Minnesota Paper Form Board	.07±.07	.00±.07	.00±.07	-.05±.07	-.03±.07	-.07±.07	.00±.07
Finger Dexterity	.00±.07	.03±.07	.03±.07	.06±.07	-.03±.07	.03±.08	-.02±.07
Tweezer Dexterity	.22±.07	.25±.07	.32±.06	.36±.06	.32±.06	.29±.07	.32±.06
Tri. Structural Visualization	.11±.07	.14±.07	.11±.07	.19±.07	.20±.07	.19±.07	.26±.07
Mechanical Comprehension	.38±.07	.32±.07	.33±.07	.29±.07	.27±.07	.22±.07	.35±.07
Placing Test	.03±.08	-.04±.08	.08±.08	.11±.08	.06±.08	.04±.08	.07±.08
Turning Test	.08±.08	.06±.08	.09±.08	.06±.08	.09±.08	.06±.08	.12±.08
Cal. Test of Personality (Self Adj.)	-.10±.07	-.07±.07	-.11±.07	-.12±.07	-.03±.07	-.14±.07	-.11±.07
Cal. Test of Personality (Social Adj.)	-.22±.07	-.13±.07	-.20±.07	-.16±.07	-.18±.07	-.21±.07	-.17±.07
Cal. Test of Personality (Total Adj.)	-.18±.07	-.16±.07	-.12±.07	-.12±.07	-.14±.07	-.19±.07	-.16±.07

* Some tests provided samples as few as 75 cases and some as many as 94, but in most instances N = 90.

Table 6. Correlations between Predictive Measures and Trait Ratings for Trainees in Aircraft Engines (N = 78)*

Predictive Measure	Learning	Speed	Workmanship	Working Relations	Responsibility	Interest	Total Fitness
Pressey Tests	.09±.08	.15±.08	.11±.08	.16±.08	.11±.08	.10±.08	.08±.08
Arithmetic Prognosis	.04±.08	.05±.08	.05±.08	.06±.08	.06±.08	.06±.08	.02±.08
Minnesota Paper Form Board	.15±.07	.15±.07	.11±.07	.17±.07	.17±.07	.20±.07	.18±.08
Finger Dexterity	.09±.08	.14±.08	.01±.08	.06±.08	.08±.08	.05±.08	.10±.08
Tweezer Dexterity	.00±.08	.04±.08	.01±.08	-.02±.08	-.02±.08	.08±.08	.04±.08
Tri. Structural Visualization	-.10±.08	-.04±.08	-.07±.08	-.08±.08	-.11±.08	-.09±.08	-.07±.08
Mechanical Comprehension	.22±.08	.13±.08	.18±.08	.12±.08	.20±.08	.16±.08	.11±.08
Placing Test	.15±.08	.21±.08	.15±.08	.26±.07	.18±.08	.15±.08	.11±.08
Turning Test	.15±.08	.25±.07	.16±.08	.24±.07	.17±.08	.13±.08	.12±.08

* Some tests provided samples as few as 64 cases and some as many as 86, but in most instances N = 78.

significant. Such a consideration can be made on the basis that with this ratio, the correlation would not be diminished to zero 95.7 percent of the time. Correlations with critical ratios less than three should not be considered entirely insignificant, because the percentage of probability in 90.8 where the critical ratio is 2.5. The probability of increased accuracy rises as the size of the probable error diminishes. That is to say further, that if a critical ratio is 4.5 the percentage of probability rises to 99.8.

For brevity and undue repetition, correlations with the critical ratio three or greater will be considered significant without reporting the specific probability in each case.

Inasmuch as each class involves, in the main, different skills, each will be considered separately.

Aircraft Instruments. Table 5 shows that some tests are fairly reliable predictors of rated achievement in the Aircraft Instruments class. The Pressey tests, a measure of abstract intelligence, correlate .55 ± .05 with the Total Fitness rating. This is relatively significant as a predictor of achievement in this class. The Mechanical Comprehension, Arithmetic Prognosis, Tridimensional Structural Visualization, and Tweezer Dexterity tests seem also to bring fairly significant correlations.

The correlation involving the Pressey tests appears logical upon reconsideration of the skills needed in the class. From the amount of learning entailed in the physics and other abstract learning situations involved, it is evident that at least an average general intelligence would be needed to succeed in the instrument craft.

The Arithmetic Prognosis and Mechanical Comprehension tests involve more specific skills but are also based on the abstract thinking concepts and likewise were found to have predictive significance.

It is interesting to note that the Tweezer Dexterity test shows some significance as a predictor, whereas most other manipulative tests show no significance. Much work is done in the instrument craft involving use of small tools, whereas larger or gross hand and arm movements are used very infrequently.

Some insight involving three dimensions is used in repair of instruments. Probably for this reason the Tridimensional test has proved itself not altogether useless in the Aircraft Instrument field.

The other tests, Revised Minnesota Paper Form Board, Finger Dexterity, Placing and Turning, indicated that they could not be relied upon to predict Aircraft Instrument achievement during the learning period.

The California Test of Personality, and each of its two parts, correlated negatively with the achievement ratings. However, they are not significantly negative and therefore there is no suggestion that a low score on the test would be very indicative of a high rating on achievement. It is only fair to relate that the authors of the test do not directly state that it is intended to predict any type of achievement. The inference is made by the writer that if a test reveals maladjusted individuals, those individuals would, in all probability, be so affected in their classwork that they would be doing poor work. If this were the case, the test should, in turn, be predictive of achievement. However, regardless of the findings, there can be no basis for negative criticism of the test.

Similar tests may prove valuable in situations where personality factors are given greater consideration.

Aircraft Engines Overhaul. For the Aircraft Engines Overhaul class, correlations made between tests and ratings yield quite different results from the ones shown for the Instruments class. With the highest correlation for Total Fitness being $.18 \pm .07$ on the Revised Minnesota Paper Form Board, one can logically conclude that none of the tests significantly predict rated achievement in the Aircraft Engines class.

One major factor which may have tended to lower all correlations in this group is that the amount of previous related experience was not a controlled factor. It is agreed by most industrialists that all classes involving the internal combustion engine are similar and related. It was an observed fact that many individuals entering the Aircraft Engine class had been trained in Automobile Engine Mechanics prior to their enrollment. For this reason it is entirely possible that the previous training factor outweighed the native aptitude factor, thus lowering the predictive significance of the test in this situation. If actual job ratings were available one might find that in due time the factor of previous line training would tend to equalize itself among all individuals, and aptitude might prove the distinguishing factor. If and when such ratings are available, a further study may prove significant.

Aero Repair Mechanics. Results of correlations for the Aero Repair Mechanics class, presented in table 7, show, with less significance, the same tendency that was exhibited in the Aircraft Instruments class. That is, tests involving abstract concepts again prove to be the best predictors of rated

Table 7. Correlations between Predictive Measures and Two Measures of Achievement for Trainees in Aero Repair Mechanics (N = 90)*

Predictive Measure	Total Fitness	Average Rating
Pressey Tests	.34 ± .06	.33 ± .06
Arithmetic Prognosis	.29 ± .07	.31 ± .06
Minnesota Paper Form Board	.03 ± .07	.01 ± .07
Finger Dexterity	.14 ± .07	.19 ± .07
Tweezer Dexterity	.19 ± .07	.19 ± .07
Tri. Structural Visualization	.00 ± .07	.00 ± .07
Mechanical Comprehension	.30 ± .08	.30 ± .08
Placing Test	.15 ± .07	.15 ± .07
Turning Test	.11 ± .07	.13 ± .07

* With the Mechanical Comprehension Test N = 66. All other test samples ranged from 90 to 94 cases.

achievement. The Pressey tests, Mechanical Comprehension, and Arithmetic Prognosis tests bring correlations of $.34 \pm .06$, $.30 \pm .07$ and $.29 \pm .06$, respectively. Although these correlations are low, they are slightly significant. With the exception of the Tweezer Dexterity test, all manipulative tests and the Paper Form Board test indicate that they could not be relied upon to predict achievement in this situation.

It is reasonable to expect these results in the Aero Repair training period, because there is much memory work and the situation is largely one involving verbal learning. No task becomes so routine in the primary training period for one to impress an instructor with speed and dexterity on a repair job.

In some cases instructors would confer with the personnel director concerning individual cases. When the trainee concerned had low test scores on mental ability and mathematics, it was suggested to the instructor that the trainee be given some routine tasks to perform. In many cases this suggestion would result in better adjustment for the trainee. This, to some degree, was evident in all classes, but more so in the Aero Repair class. For example, a trainee may be assigned to the unit of cable splicing and here do good work. The instructor, in turn, rates the individual higher although he is not technically achieving the standards of the class, as a whole, which is still expected to work on all units of training.

This factor would probably tend to lower the correlations, but it actually shows a use for the tests. Statistical validation of this and similar incidents is not practicable, but should offer some argument for continued use of such tests.

Machine Shop. Correlations of tests with Machine Shop rated achievement (table 8) again show two of the tests involving problems of abstract thinking to be the best predictors. The Arithmetic Prognosis test is the best predictor of Machine Shop work. This should be reasonable expected from noting that, of the 580 clock hours, the Machine Shop course outline allows 30 hours for the actual study of shop mathematics. It is logical to assume that because of the knowledge of mathematics needed in order to operate power machines that the Arithmetic Prognosis test, and probably similar tests, would be of distinct value in predicting Machine Shop achievement.

The Mechanical Comprehension test also offers some fair predictive significance. A study of the actual operations involved in machine work and an examination of the specific questions in this test reveals a relationship through simple mechanical concepts.

No other correlation coefficients on table 8 show predictive significance of tests for machine work. The larger probable error was due to a smaller number of cases available for this class.

Aircraft Electricity. The Aircraft Electricity class again offered a small sample, resulting in a relatively high probable error for most correlations. However, four of the tests in table 9 show indications of being rather significant as predictors of rated electrical achievement. Again, two of three abstract concepts tests prove their worth in the role of prediction. The Pressey tests and Mechanical Comprehension test reveal correlations of $.30 \pm .09$ and $.41 \pm .08$. These results show that the Mechanical Comprehension

Table 8. Correlations between Predictive Measures and Total Fitness Rating for Trainees in Machine Shop (N = 41 to 50, varying with the test)

Predictive Measure	Total Fitness
Pressey Tests	.19 ± .09
Arithmetic Prognosis	.44 ± .08
Minnesota Paper Form Board	.20 ± .09
Finger Dexterity	.17 ± .10
Tweezer Dexterity	.00 ± .11
Tri. Structural Visualization	.00 ± .10
Mechanical Comprehension	.35 ± .09
Placing Test	.01 ± .11
Turning Test	.15 ± .10

Table 9. Correlations between Predictive Measures and Total Fitness Rating for Trainees in Aircraft Electricity (N = 40 to 46, varying with the test)

Predictive Measure	Total Fitness
Pressey Tests	.30 ± .09
Arithmetic Prognosis	.20 ± .10
Minnesota Paper Form Board	.22 ± .10
Finger Dexterity	.31 ± .10
Tweezer Dexterity	.22 ± .10
Tri. Structural Visualization	.38 ± .09
Mechanical Comprehension	.41 ± .08
Placing Test	-.03 ± .11
Turning Test	.17 ± .10

test is again a fairly significant predictor. The correlation of .31± .10 for the Finger Dexterity test shows relationship between the actual work processes and finger dexterity. Aircraft Electricity involves a great deal of small repair work in which fingers are used much more than gross arm movements. This shows the obtained results to be quite logical. To some degree Tridimensional concepts are involved in electrical work, but the results are less explainable than those obtained from the other three tests. It is to be expected that electrical laws and study of currents should show relationship to intelligence tests because both involve thinking in abstract concepts.

The tests estimated to be best for predicting achievement in each of the Mechanic Learner classes are indicated in table 10. Here is shown correlation coefficients for single tests showing some predictive significance, multiple correlation coefficients for the best two tests and multiple correlation coefficients for the best predictive battery of tests.

The best predictor for achievement in Aircraft Instruments was the Pressey tests which brought a correlation of .55. Adding the Mechanical Comprehension test revealed a multiple coefficient of .61 and by using all four tests, the correlation was raised to .64.

Since the single tests used for the Aircraft Engines class showed no predictive significance, multiple correlations derived from them would also have no predictive value.

In the Aero Repair Mechanics class, a multiple correlation of .42 was obtained from the Mechanical Comprehension and Pressey tests. By the addition of a third test, the Arithmetic Prognosis, the multiple correlation

Table 10. Multiple Correlations of Significant Predictive Devices for Each of the Mechanic Learner Classes

Class	Best Combination of Tests	Multiple Correlation using best two tests	Multiple Correlation using best predictive battery
Aircraft Instruments	Pressey Tests (.55) Mechanical Comprehension (.35) Tweezer Dexterity (.32) Arithmetic Prognosis (.28)	.61	.64
Aircraft Engines	No tests resulted in significant predictions.		
Aero Repair Mechanics	Pressey Tests (.34) Mechanical Comprehension (.30) Arithmetic Prognosis (.29)	.42	.46
Machine Shop	Arithmetic Prognosis (.44) Mechanical Comprehension (.35)	.49	.49
Aircraft Electricity	Mechanical Comprehension (.41) Tri. Structural Visualization (.38) Finger Dexterity (.31) Pressey Tests (.30)	.54	.60

was raised to .46.

The Machine Shop class had only two tests showing predictive significance. These tests, Mechanical Comprehension and Arithmetic Prognosis, yielded a multiple correlation coefficient of .49.

The best two predictors in the Aircraft Electricity class were the Mechanical Comprehension and the Tridimensional Structural Visualization tests. They result in a multiple correlation of .54. Adding the Finger Dexterity and Pressey tests raised the multiple correlation to .60.

A combination of the best two predictive devices results in a correlation nearly as significant as multiple correlations of three and four tests. It would seem logical that, unless third and fourth tests were measuring, significantly, very separate traits from the first two, these additional tests would be almost superfluous. In programs where the conservation of time is a necessary aspect, fewer significant predictors might be used to advantage.

The correlations, although quite significant when used as multiples, might be raised still higher if certain influencing variables were known and controlled.

Numerous interviews with instructors and trainees gave evidence that many uncontrolled factors were present. These factors tended to influence all correlations. There is an indication that interest and motivation were influencing factors in individual achievement. Although no statistical evidence is available without further investigation, it is evident, from remarks of instructors, that greater industry was shown by married trainees or trainees having added responsibility which stimulated better work. This is very obvious in a few cases. Many younger trainees (about 17 to 21 in age) seemed to be training principally for the monetary remuneration, rather than for knowledge of the trade, whereas trainees with dependents seemed to realize the opportunity for learning a life's trade and took advantage of it by applying themselves to the task.

In some cases trainees lacked motivation to do their best work. They believed that they would receive their advance in pay only after spending six months as a learner. They thought that "putting in time" was the main factor in receiving promotions, and, to a certain degree, this probably was true.

Considering these aspects as probably lowering the derived correlations, it seems reasonable that further studies on each of the numerous uncontrolled factors might be important.

SUMMARY AND GENERAL CONCLUSIONS

It was the purpose of this study to evaluate each of several tests as predictors of instructor ratings of achievement in Mechanic Learner classes for several aircraft trades. Each test was correlated with a Total Fitness rating, and results differed with each class. The significant findings in each class can be briefly summarized as follows:

Aircraft Instrument Repair. The Pressey tests, Arithmetic Prognosis, Mechanical Comprehension, all tests involving abstract thinking, were found to bring the fairly significant correlations of .55, .28 and .35, respectively. The Tweezer Dexterity test and Tri-dimensional Structural Visualization tests brought correlations of .32 and .26. Other tests showed no significance. By using the best four predictive devices, a multiple correlation of .64 was acquired.

Aircraft Engine Overhaul. No test correlated significantly with the ratings of achievement.

Aero Repair Mechanics. The Pressey tests, Arithmetic Prognosis and Mechanical Comprehension tests correlated .33, .31 and .30, respectively, with the Total Fitness rating of achievement. These three tests brought a multiple correlation of .46.

Machine Shop. The Arithmetic Prognosis and Mechanical Comprehension tests brought correlation coefficients of .44 and .35. All other tests showed no significance. A combination of these two tests resulted in a multiple coefficient of .49.

<u>Aircraft Electricity</u>. The Pressey tests and Mechanical Comprehension test correlated .30 and .41, respectively, with achievement ratings. The Finger Dexterity test and Tridimensional Structural Visualization tests also revealed the slightly significant correlations of .31 and .38. A multiple correlation, using these four predictive devices, was .60.

The general trend shown throughout most classes was for tests of abstract thinking to correlate significantly with the achievement rating. With the exception of the Tweezer Dexterity test and the Tridimensional Structural Visualization test, no other manipulative test or the Minnesota Paper Form Board test indicated predictive significance for use in the Mechanic Learner Program.

Studies of this nature should be made for tests in all new situations. Through this selective approach, tests and their proper interpretation will probably aid greatly in the selection and classification of industrial personnel.

Table 11. Distribution of Pressey Test Scores in Mechanic Learner Classes

Scores	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
90		1			1
85	3	1	1		1
80	5	1	5	2	1
75	5	3	4	3	2
70	11	5	6	4	6
65	12	7	8	3	2
60	15	5	5	5	5
55	14	15	14	9	7
50	8	10	13	9	5
45	12	15	18	4	2
40	6	9	6	4	6
35	4	6	10	3	4
30		4	2	0	0
25		1	1	1	1
20				1	2
15				1	
N	95	83	93	49	45
Mean	60.65	53.80	54.64	55.25	55.90
Sigma	12.70	13.25	13.65	14.35	16.15

Table 12. Distribution of Arithmetic Prognosis Test Scores for Mechanic Learner Classes

Scores	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
48	4	2	2	2	1
44	14	4	5	3	7
40	13	5	12	10	6
36	10	10	5	10	2
32	16	7	5	3	8
28	13	14	15	6	3
24	7	7	13	3	4
20	10	8	9	7	5
16	4	15	10	3	3
12	3	4	6	1	1
8	0	4	6	1	3
4	1	3	2	1	1
N	85	83	90	50	44
Mean	33.46	26.82	27.46	32.22	30.86
Sigma	9.80	10.68	11.36	10.48	11.28

Table 13. Distribution of Minnesota Paper Form Board Test Scores for Mechanic Learner Classes

Scores	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
62	1				1
60	2				0
58	3		6	1	1
56	4	4	1	1	5
54	4	5	4	5	3
52	13	5	3	4	2
50	7	5	6	2	2
48	15	3	7	3	2
46	9	7	5	5	2
44	9	11	13	10	7
42	9	10	7	4	1
40	5	11	7	2	3
38	4	6	14	4	6
36	3	4	8	1	4
34	1	6	2	5	2
32	4	4	3	0	0
30	2	2	1	0	1
28	0	4	2	0	2
26	1	3	1	1	0
24	1		0	0	0
22			2	0	0
20				1	1
N	97	90	85	49	45
Mean	46.30	42.37	43.42	44.50	44.28
Sigma	7.50	7.82	8.28	9.94	9.18

Table 14. Distribution of Mechanical Comprehension Test Scores for Mechanic Learner Classes.

Scores	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
60		2			
58		0			
56	8	2	1	2	4
54	4	2	2	2	0
52	7	5	4	4	3
50	16	6	7	7	5
48	4	3	1	3	7
46	5	3	6	4	3
44	17	13	10	7	2
42	1	8	4	1	7
40	6	9	2	4	1
38	4	6	7	3	1
36	6	1	8	1	3
34	1	1	2	0	2
32	1	3	5	1	4
30	1	1	1	2	2
28		0	3		1
26		1	2		1
24			0		
22			1		
N	97	66	66	41	46
Mean	46.72	44.44	41.46	46.26	43.58
Sigma	6.24	6.86	7.90	6.56	8.16

Table 15. Distribution of Tridimensional Structural Visualization Test Scores for Mechanic Learner Classes

Time in Seconds	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
20		1			
30	2	3	1		2
40	5	2	5	2	2
50	5	4	3	2	2
60	1	7	8	8	6
70	10	5	12	3	3
80	4	4	9	4	4
90	13	5	3	1	3
100	7	7	5	2	2
110	2	8	4	2	3
120	8	7	9	3	1
130	4	1	7	0	1
140	2	4	4	1	1
150	7	3	2	1	0
160	1	5	5	2	0
170	4	0	2	2	2
180	1	3	2	2	1
190	0	2	0	1	3
200	4	2	1	1	1
210	2	2	1	0	0
220	1	1	0	1	1
230	3	3	0	4	2
240			2		
250			6		
N	86	79	91	42	40
Mean	116.60	119.06	118.46	131.70	111.75
Sigma	51.50	54.50	57.30	60.04	53.90

Table 16. Distribution of Finger Dexterity Test Scores for Mechanic Learner Classes

Time in Seconds	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Time in Seconds	Machine Shop	Aircraft Electricity
180	2		1	185		1
190	1	1	0	190		1
200	5	3	5	195		0
210	8	6	4	200	2	0
220	10	9	16	205	1	0
230	10	15	7	210	1	2
240	8	9	13	215	2	2
250	7	12	15	220	0	2
260	5	3	9	225	4	3
270	6	13	5	230	3	3
280	2	6	3	235	6	6
290	2	1	4	240	5	4
300	5	0	1	245	2	1
310	2	3	5	250	4	6
320	2	0	1	255	1	5
330	3	0	1	260	2	2
340	1	2	3	265	3	2
350	3			270	2	0
360	2			275	1	1
370	4			280	0	
380	3			285	1	
				290	0	
				295	0	
				300	1	
N	91	83	93		41	41
Mean	264.20	251.61	253.78		243.60	239.70
Sigma	54.00	30.00	34.45		22.00	19.35

Table 17. Distribution of Tweezer Dexterity Test Scores for Mechanic Learner Classes

Time in Seconds	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
230				1	
240				1	
250		4		0	
260		0		0	
270	3	0	2	0	
280	4	2	0	2	3
290	8	5	5	2	1
300	5	8	9	2	2
310	7	5	7	4	6
320	11	5	12	6	7
330	11	7	7	1	3
340	9	12	6	3	3
350	11	8	6	4	6
360	6	8	4	3	1
370	5	2	3	4	0
380	2	0	7	1	2
390	1	6	7	1	3
400	3	4	3	1	0
410	1	2	6	3	0
420	1	0	2	1	2
430	3	0	2	1	0
440		0	1		1
450		0	4		1
460		4			
N	91	82	93	41	41
Mean	339.20	345.60	356.00	344.70	345.00
Sigma	40.80	46.20	46.07	45.70	41.80

Table 18. Distribution of Placing Test Scores for Mechanic Learner Classes

Time in Seconds	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
170			2		
175			1	1	
180			0	0	
185			0	0	
190	2		0	0	
195	2		1	1	2
200	2	2	2	0	1
205	2	2	5	0	2
210	3	1	8	5	2
215	8	5	6	4	3
220	10	13	8	3	5
225	7	6	12	3	7
230	8	5	13	4	6
235	5	11	8	5	3
240	9	10	4	2	3
245	3	4	9	6	1
250	4	6	4	3	1
255	4	0	2	0	2
260	3	6	2	1	2
265	2	4	2	2	1
270	1	1	2	2	
275		1	2		
280		2			
285		1			
N	75	80	93	42	41
Mean	231.53	238.63	230.50	238.90	229.70
Sigma	18.40	19.05	20.42	20.00	16.95

Table 19. Distribution of Turning Test Scores for Mechanic Learner Classes

Time in Seconds	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
140	1		1		
145	0	1	0		1
150	1	0	2	4	0
155	1	0	2	0	2
160	8	5	3	1	6
165	11	9	7	6	5
170	9	8	9	4	5
175	9	9	16	6	5
180	12	9	13	2	2
185	5	9	8	6	5
190	5	3	7	1	6
195	4	6	7	4	1
200	3	3	3	2	0
205	2	3	4	2	1
210	1	2	5	1	1
215	2	2	1	0	0
220	0	7	1	2	1
225	0	1	0	1	
230	1	0	0		
235		0	1		
240		0	2		
245		2			
N	75	79	92	42	41
Mean	177.73	188.21	185.15	183.05	168.10
Sigma	32.20	20.80	17.63	19.00	15.70

Table 20. Distribution of Scores on the California Test of Personality for Mechanic Learner Classes

Total Adjustment Score	Aircraft Instruments
155	2
150	4
145	6
140	10
135	10
130	10
125	4
120	9
115	4
110	5
105	6
100	3
95	2
90	2
85	1
80	1
75	0
70	1
N	80
Mean	126.43
Sigma	18.40

Table 21. Distribution of Ratings of Learning for Trainees in Three Mechanic Learner Classes

Rating	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics
10			
9.5			2
9	1	4	1
8.5	1	4	2
8	6	4	1
7.5	5	11	0
7	12	13	6
6.5	6	7	11
6	18	11	15
5.5	11	6	14
5	15	11	21
4.5	10	4	9
4	9	4	3
3.5	1	2	3
3		3	3
2.5		2	2
2			1
1.5			1
N	95	86	95
Mean	6.03	6.36	5.66
Sigma	1.24	1.59	1.43

Table 22. Distribution of Ratings of Speed for Trainees in Three Mechanic Learner Classes

Rating	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics
10			
9.5			
9	1	2	1
8.5	1	1	0
8	0	5	3
7.5	5	7	5
7	8	11	3
6.5	9	12	11
6	11	11	20
5.5	21	9	12
5	16	12	19
4.5	10	2	5
4	8	7	6
3.5	4	1	1
3	1	3	4
2.5		1	2
2		1	1
1.5		1	2
N	95	86	95
Mean	5.73	6.07	5.63
Sigma	1.15	1.53	1.41

Table 23. Distribution of Ratings of Workmanship for Trainees in Three Mechanic Learner Classes

Rating	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics
10			
9.5			1
9	1	2	0
8.5	1	2	2
8	6	3	1
7.5	3	9	6
7	7	8	3
6.5	10	16	10
6	14	10	20
5.5	8	8	13
5	18	12	19
4.5	9	7	8
4	14	3	3
3.5	4	1	3
3		3	2
2.5		1	0
2		1	1
1.5			2
1			1
N	95	86	95
Mean	6.11	5.62	5.70
Sigma	1.36	1.44	1.43

Table 24. Distribution of Ratings of Working Relations for Trainees in Three Mechanic Learner Classes

Rating	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics
10			1
9.5			0
9	1	2	1
8.5	1	2	2
8	2	4	6
7.5	3	11	5
7	5	11	6
6.5	11	14	7
6	19	6	19
5.5	12	9	15
5	23	10	16
4.5	7	8	8
4	7	3	3
3.5	2	2	3
3	2	2	0
2.5		1	1
2		1	1
1.5			1
N	95	86	95
Mean	5.76	6.23	5.99
Sigma	1.13	1.48	1.42

Table 25. Distribution of Ratings of Responsibility for Trainees in Three Mechanic Learner Classes

Rating	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics
10			1
9.5			0
9		1	0
8.5	5	2	1
8	1	6	4
7.5	6	9	3
7	4	8	7
6.5	12	11	15
6	14	11	16
5.5	15	8	8
5	14	11	16
4.5	11	10	6
4	9	3	8
3.5	3	1	1
3	0	2	3
2.5	0	1	1
2	1	1	3
1.5		1	0
1			1
.5			0
0			1
N	95	86	95
Mean	5.84	6.09	5.74
Sigma	1.29	1.51	1.52

Table 26. Distribution of Ratings of Interest for Trainees in Three Mechanic Learner Classes

Rating	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics
10		1	
9.5		0	1
9		3	3
8.5	2	1	3
8	5	5	2
7.5	3	11	2
7	8	6	5
6.5	10	10	11
6	15	14	21
5.5	13	3	8
5	16	9	16
4.5	8	8	6
4	11	5	6
3.5	2	2	4
3	2	3	2
2.5		2	0
2		2	2
1.5		0	2
1		1	1
N	95	86	95
Mean	5.83	6.04	5.76
Sigma	1.25	1.77	1.64

Table 27. Distribution of Ratings of Total Fitness for Trainees in Five Mechanic Learner Classes

Rating	Aircraft Instruments	Aircraft Engines	Aero Repair Mechanics	Machine Shop	Aircraft Electricity
10		1			
9.5		0	1	2	2
9	2	1	0	3	0
8.5	0	2	4	0	3
8	3	5	1	1	2
7.5	7	6	3	9	0
7	8	10	1	6	4
6.5	10	7	8	8	7
6	13	20	25	2	10
5.5	8	8	14	10	4
5	17	10	16	4	10
4.5	9	4	9	2	0
4	12	4	4	0	2
3.5	3	2	3	0	0
3	2	2	2	0	0
2.5	0	0	0	1	1
2	1	3	0	1	
1.5		1	2		
1			0		
.5			0		
0			2		
N	95	86	95	49	45
Mean	5.77	6.07	5.63	6.65	6.35
Sigma	1.37	1.59	1.54	1.52	1.40

MECHANIC LEARNER APPRAISAL SCALE · OGDEN AIR DEPOT

PREPARED BY A COMMITTEE REPRESENTING WEBER COLLEGE, OGDEN VOCATIONAL CENTER, SALT LAKE CITY; AND THE OGDEN AIR DEPOT, HILL FIELD.

NAME OF LEARNER ____________________. CLASS GROUP # __________ UNIT # __________.

NAME OF RATER ____________________. SCHOOL ____________________.

RE: WORK AT DEPOT SHOP_____ SCHOOL_____.(CHECK CORRECT ONE) CRAFT ____________________.

PERIOD COVERED FROM __________ 194__ TO __________ 194__. APPOINTMENT DATE ____________________.

The Accurate, Unprejudiced Judgement of Instructors and Supervisors on a Student-Worker's Progress is Invaluable in Assisting in His Most Satisfactory Occupational Adjustment.

In Using This Rating Scale, Please First Read and Carefully Consider the Trait and its Several Descriptions. Place a Check Mark (✓) at the Correct Position on the 10 Point Scale. At the End of the Scale is a Space for an Explanation of Unusual Ratings or for Recording Other Significant Observations.

I. APTITUDE FOR LEARNING AS EVIDENCED BY ABILITY TO UNDERSTAND AND APPLY INSTRUCTION TO THE JOB.

10 ' 9 '	8 ' 7 '	6 ' 5 '	4 ' 3 '	2 ' 1 ' 0
Quick to Grasp Instruction. Readily Sees Application to Work. Requires Minimum of Repetition.	Most Instruction Grasped Without Difficulty. Requires Some Repetition on More Difficult Instruction Before Seeing Application Work.	Understands and Applies the Instruction Required for Average Work Performance With Average Amount of Repetition.	Grasps and Applies Instruction Only After Much Repetition.	Unable to Grasp Normal Instruction. Simple Instruction Grasped and Applied to Work Only After Much Repetition and Demonstration.

II. SPEED AND COORDINATION AS EVIDENCED BY ABILITY TO ACQUIRE MUSCULAR OR MANIPULATIVE SKILLS.

10 ' 9 '	8 ' 7 '	6 ' 5 '	4 ' 3 '	2 ' 1 ' 0
Outstanding Ability To Acquire Speed in Muscular Skills. Turns Out Work in a Minimum of Time.	Quickly Acquires Speed in Tasks Requiring Manipulative Capacity.	Is Able to do Standard Work in About Average Time.	Somewhat Slow in Manipulative Processes. Usually Assigned to Work Not Calling for Speed.	Awkward in Most Muscular Movements. Unable to do Work Which Requires Manipulative Dexterity.

III. WORKMANSHIP AS EVIDENCED BY QUALITY AND PRECISION OF WORK DONE.

10 ' 9 '	8 ' 7 '	6 ' 5 '	4 ' 3 '	2 ' 1 ' 0
Work Done is Typically of Very Highest Quality. Checking Rarely Reveals Defects.	Successful in Tasks Requiring More Than Average Precision.	Work Acceptable in Tasks Not Requiring More Than Average Precision. Requires Only Routine Checking.	Does Acceptable Work Only Where Precision Is not Required. Requires Close Checking.	Low Caliber of Workmanship. Jobs Carelessly Done. Close Checking Ineffective.

IV. WORKING RELATIONS AS EVIDENCED BY FRIENDLINESS AND ABILITY TO GET ALONG WITH OTHERS.

10 ' 9 '	8 ' 7 '	6 ' 5 '	4 ' 3 '	2 ' 1 ' 0
Fellow Students Eager to Work With Him. Accept Him as Spokesman. He Inspires Loyalty to The Institution.	Draws Many Friends to Him. Shows Some Traits of Leadership	Generally a Good Fellow and Gets Along With Others Without Difficulty.	Makes No Apparent Effort. Does Not Attract Friends. Does Not Offend.	Disagreeably Unpleasant and "Crabby". Fellow Students Tend to Shun Him.

V. RESPONSIBILITY AS EVIDENCED BY ABILITY TO ACCEPT AN ASSIGNMENT AND CARRY THROUGH WITHOUT SUPERVISION.

10 ' 9 '	8 ' 7 '	6 ' 5 '	4 ' 3 '	2 ' 1 ' 0
Unhesitatingly Accepts Responsibility Which Goes With Authority Delegated or Assignments made.	Accepts and Executes Responsibility Without The Usual Amount of Supervision.	Will Execute Ordinary Responsibilities Outlined by Instructor or Foreman with Success with Only Normal Supervision.	Rarely Takes Responsibility Without Pressure. Often Does Not Carry Through to Completion.	Refuses to Accept Responsibility or Accepts Responsibility but Does Not Carry Through. Closest Supervision Ineffective.

VI. INTEREST - ENTHUSIASM AS EVIDENCED BY EAGERNESS IN GETTING AT A JOB AND STAYING WITH IT.

10 ' 9 '	8 ' 7 '	6 ' 5 '	4 ' 3 '	2 ' 1 ' 0
Reluctant to Leave a Project. Among First to Get Down to Work. Volunteers for Extra Tasks.	Often Among First to Begin and Last to Leave. Enthusiastic in Most Work Assignments.	Starts on Time. Quits on Time. No Unusual Evidence of or Lack of Enthusiasm.	Slow Starting Assigned Tasks. Works Without Enthusiasm. Little Apparent Interest.	Speaks Disparingly of Job. Complainer. Finds Excuses for Leaving Assigned Tasks.

VII. PERSONAL FITNESS FOR THE OCCUPATION. RATE THIS STUDENT'S SUITABILITY TO THE OCCUPATION FOR WHICH HE IS TRAINED. CONSIDER ALL KNOWLEDGE AND INFORMATION YOU HAVE REGARDING HIM. COMPARE HIM TO THE DEMANDS OF THE OCCUPATION, NOT TO THE OTHER MEMBERS OF HIS GROUP.

10 ' 9 '	8 ' 7 '	6 ' 5 '	4 ' 3 '	2 ' 1 ' 0
Endorsed as Outstanding.	Endorsed as Superior.	Endorsed for Continuance and Retention.	Uncertain Regarding Suitability.	Unsuited for This Work. Should be Released.

REMARKS: EXPLAIN ANY OR ALL RATINGS OF THE TRAITS ABOVE. ALSO DESCRIBE EVIDENCES IN THE BEHAVIOR OR ATTITUDES OF ANY PERSON WHICH REFLECTS DISCONTENTMENT, LACK OF PATRIOTISM, LOYALTY, ETC.

DATE ____________________ 194_____. SUBMITTED BY ____________________
(INSTRUCTOR'S SIGNATURE)

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