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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

November 1968 United States Employment Service Technical Report S-426

Development of USES Aptitude Test Battery for Electro-Mechanical Assembly Curriculum

70 XX; 72 XX

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION

Technical Report on Development of USES Aptitude Test Battery

For . . . .

Electro-Mechanical Assembly Curriculum 70XX; 72XX

S-426

(Developed in Cooperation with the
California State Employment Service)

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November 1968

FOREWORD

The United States Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance, For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

Charles E. Odell, Director
U.S. Employment Service

GATB Study #2714

DEVELOPMENT OF USES APTITUDE TEST BATTERY

FOR

Electro-Mechanical Assembly Curriculum 70XX; 72XX

S-426

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for Electro-Mechanical Assembly Curriculum 70XX; 72XX. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
N - Numerical Aptitude	70
S - Spatial Aptitude	70
F - Finger Dexterity	70
M - Manual Dexterity	80

RESEARCH SUMMARY

Sample:

50 male Electro-Mechanical Assembler students enrolled in MDTA training classes at Santa Monica City College, Santa Monica, California.

Criterion:

Instructor's ratings.

Design:

Longitudinal (sample was tested before training and criterion data collected at end of training).

Minimum aptitude requirements were determined on the basis of an analysis of the course outline and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Predictive Validity:

Phi Coefficient = .51 ($P/2 < .0005$).

Effectiveness of Norms:

Only 66% of the non-test-selected students used for this study were good students; if the students had been test-selected with the above norms, 85% would have been good students. 34% of the non-test-selected students used for this study were poor students; if the students had been test-selected with the above norms, only 15% would have been poor students. The effectiveness of the norms is shown graphically in Table 1.

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Students	66%	85%
Poor Students	34%	15%

SAMPLE DESCRIPTION

Size:

N = 50

Occupational Status:

Students

Training Facility:

Students were enrolled in MDTA training at Santa Monica City College, Santa Monica, California.

MDTA Selection Requirements:

Education: None stipulated.

Previous Experience: None.

Tests: None required.

Principal Activities:

The curricula for each student while in school are comparable to that shown in the course outline in the Fact Sheet.

Minimum Experience:

None.

TABLE 2

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age and Education.

	Mean	SD	Range	r
Age (years)	34.3	10.8	19-56	.225
Education (years)	10.6	2.0	4-14	.164

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B (NCS), were administered between December 1965 and July 1967, prior to the start of training.

CRITERION

The criterion data consisted of instructors' ratings of each student's classroom proficiency made midway through the course and upon completion of the course. First ratings were made after three months by the instructor in charge of the mechanical phase of the course. Second ratings were made independently after six months by the instructor in charge of the electrical phase of the course. Ratings were combined for the final criterion score.

Rating Scale:

Modification of USES Form SP-21, "Descriptive Rating Scale." (See Appendix.) The scale consisted of nine items representing all aspects of the training with a final overall rating. Each item contained five alternative responses corresponding to different degrees of classroom proficiency. Weights of one to five were assigned to each alternative so that the possible range of scores was nine to forty-five.

Reliability:

The coefficient of reliability between the two ratings for the sample was .822 indicating a significant relationship. The final criterion consisted of the sum of the two ratings.

Criterion Score Distribution:

Possible Range	18-90
Actual Range	26-86
Mean	56.2
Standard Deviation	15.7

Criterion Dichotomy:

The criterion distribution was dichotomized into low and high groups by placing 34 percent of the sample in the low group to correspond with the percentage of students considered unsatisfactory or marginal. Students in the high criterion group were designated as "good students" and those in the low group as "poor students". The criterion critical score is 51.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were considered for inclusion in the norms on the basis of a qualitative analysis of the course outline and a statistical analysis of test and criterion data. Aptitude M, which does not have a significant correlation with the criterion was considered for inclusion in the norms because the qualitative analysis indicated that it was important for the training course and the sample had a relatively high mean score on this aptitude. Aptitudes P and F were considered for inclusion in the norms since these aptitudes were considered to be of critical importance for learning the curriculum. With students, a relatively high mean score may indicate that some preselection has taken place, though this may merely indicate a correlation between the awareness of a student of his own mechanical inclinations and his election to enroll in a course with a title which would seem to indicate a requirement for mechanical ability.

TABLE 3

Qualitative Analysis
(Based on the course outline, the aptitudes indicated appear to be important to learn the work)

Aptitude	Rationale
G - General Learning Ability	Required to learn, understand, and utilize principles of bench work, measurement and inspection, drill press operations, sheet metal fabrication,

soldering, mechanical assembly, electronic assembly, electronic testing, blueprint reading, schematics and circuit reading, electricity, principles of mathematics and safety practices.

N - Numerical Aptitude — Necessary to compute fractions, decimals, angles, and equations used in solving shop problems.

S - Spatial Aptitude — Needed to visualize shapes and forms from reading blueprints. Needed to perceive spatial relationships through various stages of assembly production.

P - Form Perception — Must perceive details in blueprints, schematic drawings, assemblies, and layout work for sheet metal fabrication. Must be able to see measurements and readings on gages, indicators, meters, and other testing and inspection equipment.

F - Finger Dexterity — Necessary to handle and manipulate electronic parts and components of varying sizes; to solder and wire these components accurately with speed; to hold and place small resistors, capacitors, wires, and gages.

M - Manual Dexterity — Must set up and operate bench and floor grinders and drill presses. Must handle various bench tools, such as hacksaws, saws, reamers, files, rivet guns, and small hand tools in the assembly and installation of component parts.

TABLE 4

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB.

Aptitudes	Mean	SD	Range	r
G - General Learning Ability	87.3	14.1	58-119	.315*
V - Verbal Aptitude	90.6	13.2	68-127	.178
N - Numerical Aptitude	84.1	17.2	55-125	.407**
S - Spatial Aptitude	96.3	16.7	55-127	.285*
P - Form Perception	94.5	21.2	54-141	.129
Q - Clerical Perception	101.3	16.2	72-150	.182
K - Motor Coordination	96.6	20.2	45-155	.143
F - Finger Dexterity	90.7	22.8	45-135	.168
M - Manual Dexterity	106.5	22.5	53-152	.101

*Significant at the .05 level

**Significant at the .01 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X		X	X	X*			X*	X
Irrelevant									
Relatively High Mean				X		X	X		X
Relatively Low Standard Deviation	X	X							
Significant Correlation With Criterion	X		X	X					
Aptitudes to be Considered For Trial Norms	G		N	S	*			*	M

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of aptitudes G, N, S, P, F, and M at trial cutting scores were able to differentiate between the 66% of the sample considered good students and the 34% of the sample considered poor students. Trial cutting scores at five point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly more than one standard deviation below the mean will eliminate about one-third of the sample. For four-aptitude trial norms, cutting scores of slightly less than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of N-70, S-70, F-70, and M-80 provided the highest degree of differentiation for Electro-Mechanical Assembly Curriculum 70XX, 72XX. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .51 (statistically significant at the .0005 level).

TABLE 6

Predictive Validity of Test Norms, N-70, S-70, F-70 and M-80

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Students	5	28	33
Poor Students	12	5	17
Total	17	33	50

Phi Coefficient (ϕ) = .51 Chi Square (X^2_y) = 13.0
Significance Level = $P/2 < .0005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study did not meet the requirements for incorporating the occupation studied into any of the 36 OAP's included in Section II of the Manual for the General Aptitude Test Battery. The data for this sample will be considered for future groupings of occupations in the development of new occupational aptitude patterns.

A-P-P-E-N-D-I-X

- 8 -

DESCRIPTIVE RATING SCALE
(For Aptitude Test Development Studies)

NAME OF STUDENT _____ Score _____

RATING SCALE FOR _____
D. O. T. Title and Code

1. How quickly does the student grasp or learn the subject material the first time it is presented?

   ( ) Almost always needs more time or repeated instruction.

   ( ) Frequently needs more time or repeated instruction.

   ( ) Learns most things in the usual amount of time.

   ( ) Seldom needs repeated instruction.

   ( ) Rarely ever needs repeated instruction.

2. How large a variety of assignments (subjects) can he master efficiently?

   ( ) Very limited variety.

   ( ) Small variety.

   ( ) Moderate variety

   ( ) Large variety.

   ( ) Unusually large variety.

3. What is his understanding of the theory of the work for which he is receiving instruction? (his understanding of what the work is, how it is done, and why it is done)

   ( ) Very little knowledge of the principles and methods of the job.

   ( ) Some knowledge of the principles and methods of the job.

   ( ) Has an adequate knowledge of the principles and methods of the job.

   ( ) Understands most principles and methods of the job.

   ( ) Understands all principles and methods of the job.

INSTRUCTOR _____ DATE _____

4. How often does he complete assignments in the time expected?

( ) Rarely meets expected time limits.

( ) Seldom completes assignments on time.

( ) Completes assignments on time more often than not.

( ) Rarely fails to meet expected time limits.

( ) Always completes assignments on time.

5. How often does he make errors in written tests or quizzes?

( ) Usually fails quiz or test.

( ) Frequently scores below average on quiz or test.

( ) Makes average grades on quiz or test.

( ) Scores above average on most quizzes and tests.

( ) Makes excellent scores on most quizzes or tests.

6. How often does he need special assistance in order to grasp or understand subject material?

( ) Constantly requires individual attention and assistance.

( ) Frequently requires individual attention and assistance.

( ) Occasionally needs individual attention and assistance.

( ) Usually understands subject material when presented to the group.

( ) Almost never needs individual attention or assistance.

7. How well does he apply himself to classroom instruction?

( ) Does not concentrate on instruction; slow to react.

( ) Difficult to hold his attention, is easily disrupted.

( ) Usually sticks to his studies.

( ) Easily maintains his attention; is seldom disrupted.

( ) Very serious about his work; constantly adheres to instruction.

8. How well does he apply himself to classroom instruction?

( ) Doesn't concentrate on instruction.

( ) Easily disrupted. Hard to keep his attention.

( ) Usually sticks to studies.

( ) Seldom disrupted. Attention is easily maintained.

( ) Very serious about his work. Constantly adheres to instruction.

9. Considering all the factors rated above, and only these factors, how satisfactory is his school performance?

( ) One of the weakest students. Always behind rest of students.

( ) Occasionally lags behind rest of students.

( ) Manages to keep pace with rest of students.

( ) Usually does well.

( ) Learns rapidly and well.

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FACT SHEET

Course of Study

Electro- Mechanical Assembly Curriculum 70XX; 72XX

I. Fundamentals of Bench Work 30 Hours
Bench tools, safety practices, measuring tools, layout tools, hacksaws and sawing, files, hand and motor drilling, cutting threads, taps and tapping methods, threading dies, hand reamers and reaming, riveting, rivet removal, burring, stud and screw extractors, bending and forming.

II. Bench and Floor Grinders 20 Hours
Safety practices, dressing the grinder wheel, sharpening hand tools, drill sharpening.

III. Fundamentals of Drill Press Work 30 Hours
Safety practices, drills, drill sizes, cutting speeds, drill points, causes of drill failure, machine reamers, counterbores, countersinks, deep hole drilling methods, power tapping on drill press, tap extractors and their uses, lubricants for various materials.

IV. Measurement and Inspection 20 Hours
Use of micrometer, principle of vernier scale, vernier measuring tools and their uses, vernier bevel protractor, dial test indicator, precision measuring tools for inspection rooms, electrical measuring gages, special inspection equipment.

V. Sheet Metal Fabrication 60 Hours
Safety practices, layout for various metals, use of bench shear, notcher, folding brake.

VI. Mechanical Assembly 120 Hours
Bearings and their applications, precision finishes, allowances, tolerances, standard fits, thread fits, riveting, spot welding, other fasteners, specification procedures, quality control and inspection.

VII. Basic Soldering 100 Hours
Safety practices, wire stripping, wire tinning, mechanical connections, solder connections, cannon type connectors, terminal boards, component installation, J2 and J3 connectors, component breadboard rework.

VIII. Electronic Assembly 120 Hours
Function of the electrical connection, quality of electrical connections, workmanship and reliability, familiarization with electronic components, color codes and circuit symbols, mechanical assembly of electronic chassis, shock-mounting and insulation, characteristics of hook-up wire, insulation, special wires and cables, terminals, terminal boards, and printed circuits, connection devices, plugs, sockets, preparation of wire for soldering, preparation of terminals and circuit boards for soldering, soldering tools, soldering techniques (point-to-point, printed-circuit, cables and connectors), finishing and inspection solder connections, desoldering techniques, mechanical methods of electrical connections, methods of cabling and cable tying, coil winding.

IX. Basic Electronic Testing 50 Hours
Component testing, identification of electronic components, qualify control, use of the ohmmeter to measure resistance and check continuity, use of voltmeter, impedance bridge, "Q" meter, signal generator, oscilloscope.

X. Mathematics 75 Hours
Common fractions (addition, subtraction, multiplication, division), identifying and computing angles, decimal fractions in normal arithmetic processes, fraction systems conversions, rounding off decimal fractions, application of decimals to

shop problems, symbols used in shop, symbols and handbook application, formulas used in shop, equations used in shop, solution of simple equations using normal arithmetic processes, formula applications, ratios, constants, national form thread formulas, tap drill size formulas, basic geometric rules (lines, angles, planes, circles, plane figures, solid geometric shapes), use of handbooks.

XI. Blueprint Reading 75 Hours

Working drawing in mechanical trades, lines, three-view drawings, arrangement of views, one view, two views, auxiliary views, dimensions (size, location), cylinders, circles, arcs, holes, angles, large arcs, base-line, tolerances (fractional, angular, decimal), representing and dimensioning screw threads, dimensioning with shop notes, cutting planes, section-lining, full sections, half sections, partial sections, conventional breaks, sketching vertical, horizontal and slant lines, curved lines, circles, sketching irregular shapes, fillets, radii, rounded corners, edges, orthographic sketches, perspective sketches, multiple view drawings, working drawings (cast parts, auxiliary views, true projection, handbook data, extra views, alterations, special dimensioning practices), assembly and detail drawings, pictorial assembly drawings, working drawings (parts lists).

XII. Schematics and Circuit Reading 50 Hours

What electricity is, interpretation of assembly and schematic drawings, six methods for production of electricity, resistance, resistor color codes, interpretation of I.B.M. wire lists, voltage and current flow theory, direct current series circuits, direct current parallel circuits, electrical power, electrical ground, grounding techniques, capacitance, capacitor color codes, inductance, alternating current, power transmission, relays, switches, fuses, circuit breakers, meaning of AC and DC wave forms, elementary generator, transistors, identification of electronic symbols on actual industrial drawings.

Note: The student, upon completion of the curriculum will qualify for an entry job leading to one of many specific occupations in the electro-mechanical assembly industry, such as electric motor assembler, relay assembler, thermostat and valve assembler, and many more.

Effectiveness of Norms:

Only 66% of the nontest-selected students used for this study were good students; if the students had been test-selected with the S-426 norms, 85% would have been good students. 34% of the nontest-selected students used for this study were poor students; if the students had been test-selected with the S-426 norms, only 15% would have been poor students.

Applicability of S-426 Norms:

The aptitude test battery is applicable to training situations which include most of the curriculum described above.

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