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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 1969 United States Training and Employment Service Technical Report S-448

Development of USTES Aptitude Test Battery

for

Model Maker

(aircraft mfg.) I 693.381

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION

Technical Report on Development of USTES Aptitude Test Battery

For . . . . .

Model Maker (aircraft mfg.) I 693.381

S-448

(Developed in Cooperation with the

Washington State Employment Service)

Manpower Administration
U. S. Department of Labor

November 1969

FOREWARD

The United States Training and 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.

GATB#2775

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

For

Model Maker (aircraft mfg.) I 693.381-018

S-448

This report describes the research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Model Maker (aircraft mfg.) I 693.381-018. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
S - Spatial Aptitude	90
P - Form Perception	75
M - Manual Dexterity	90

RESEARCH SUMMARY

Sample:

62 trainees (55 males and 7 females) in a series of five week Model Maker I courses maintained and supported in Seattle Community College, Seattle, Washington, as part of The Boeing Company's job training program. Minority status data could not be collected for the early classes, but could be collected for the last 32 trainees. 8 males and 1 female were Spanish American; 2 males were Oriental, 15 males and 5 females were non-minority classifications; one male refused to divulge his ethnic origin. 34% of the last 32 trainees were minority group members.

Criterion:

Instructor's ratings

Design:

Longitudinal (test data were collected before one week of training had elapsed and criterion data were collected at the end of each five-week training program).

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

Predictive Validity:

Phi Coefficient = .57 ($P/2 < .0005$)

Effectiveness of Norms:

Only 81% of the non-test-selected trainees used for this study were good trainees; if the trainees had been test-selected with the above norms, 96% would have been good trainees. 19% of the non-test-selected trainees used for this study were poor trainees; if the trainees had been test-selected with the above norms, only 4% would have been poor trainees. The effectiveness of the norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Trainees	81%	96%
Poor Trainees	19%	4%

SAMPLE DESCRIPTION

Size:

N = 62

Occupational Status:

Trainees

Work Setting:

Trainees were enrolled in a series of five-week training programs in Seattle Community College, Seattle, Washington. This course is maintained and supported as part of The Boeing Company's job training program and the instructor is one of the company's proficient model makers.

Selection Requirements:

Age: 18 years or over
Education: High achool graduate or equivalent experience (sample contained an eighth grader).
Previous Experience: Ability to use basic wood and metal working tools.
Tests: None
Other: Interview to determine interest in mechanica, hydraulics, electronics, or other technical subjects.

Principal Activities:

The training activities are shown in the course outlines in the Appendix and Fact Sheet and involve the making of model sections. The job duties are shown on the Fact Sheet.

Minimum Experience:

All trainees were tested before one week of training had elapsed. Most tests were administered before the start of training.

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)[1/]	29.0	10.9	18-60	-.237
Education (years)[2/]	12.3	1.4	8-16	.074

1/ N = 60
2/ N = 56

EXPERIMENTAL TEST BATTERY

All twelve tests of the GATB, B-1002B, were administered to the validation sample during the period May 1965 through December 1968.

CRITERION

The criterion data consisted of the instructor's ratings of job proficiency made at the end of the 5-week training program.

Rating Scale:

An adaptation of USTES Form SP-21T, Descriptive Rating Scale for Trainees (see appendix). The scale consists of seven items covering different aspects of training performance with five alternatives for each item.

Reliability:

No measure of criterion reliability was obtained--a single rating at course completion.

Criterion Score Distribution:

Raw Score Possible Range: 7-35
Raw Score Actual Range: 7-34

For the 28 steps of 7 to 34, 25 of them had scores for 1 to 8 individuals. These 25 steps or ranks were converted to linear scores by tables.

Criterion Score Possible Range: 11-89
Criterion Score Actual Range: 11-89
Mean: 54.3
Standard Deviation: 17.0

Criterion Dichotomy:

The criterion distribution was dichotomized into high and low groups by placing 19% of the sample in the low criterion group to correspond with the percentage of trainees considered marginal or unsatisfactory. Trainees in the high criterion group were designated as "good trainees" and those in the low criterion group as "poor trainees." The critical criterion score is 42.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitude Q was included because of its high mean and low standard deviation. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis

(Based on the job description and observation of the job, the aptitudes indicated appear to be important to the work performed.)

Aptitude	Rationale
S - Spatial Aptitude.	.Working from blueprints and sketches.
P - Form Perception	.Shaping and finishing metal, plastic and wooden material from visualization of blueprints and sketches. Working to precise tolerances.
K - Motor Coordination.	.Using various types of woodworking equipment and hand tools requiring eye-hand coordination.
M - Manual Dexterity.	.Performing soldering and general bench work such as drilling, forming, filing, polishing, etc. To layout and fabricate models using all types of metal and woodworking equipment and related power and hand tools.

TABLE 4

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB.
N = 62

Aptitude	Mean	SD	Range	r
G - General Learning Ability	107.5	15.3	72-142	.339**
V - Verbal Aptitude	104.2	12.0	76-131	.128
N - Numerical Aptitude	100.4	16.0	69-147	.214
S - Spatial Aptitude	117.7	18.8	65-156	.523**
P - Form Perception	109.0	17.1	71-138	.281*
Q - Clerical Perception	107.3	14.2	81-136	-.0002
K - Motor Coordination	102.6	16.9	66-144	.141
F - Finger Dexterity	94.0	19.6	33-134	.255*
M - Manual Dexterity	105.0	24.2	44-148	.338**

*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
Irrelevant									
Relatively High Means	3			1	2	4			
Relatively Low Standard Deviations		1				2			
Significant Correlation with Criterion	**			**	*			*	**
Aptitudes to be considered for Trial Norms	G			S	P	Q		F	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, S, P, Q, F, and M at trial cutting scores were able to differentiate between the 81% of the sample considered good trainees and the 19% considered poor trainees. Trial cutting scores at the five point interval nearest to one standard deviation below the mean for each aptitude are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude norms, minimum cutting scores slightly higher than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores of

slightly lower 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 S-90, P-75, and M-90 provided optimum differentiation for the occupation of Model Maker (aircraft mfg.) I 693.381-018. The validity of the norms is shown in Table 6 and is indicated by a Phi Coefficient of .57 (statistically significant at the .0005 level).

TABLE 6

Predictive Validity of Test Norms, S-90, P-75, and M-90

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Trainees	7	43	50
Poor Trainees	10	2	12
Total	17	45	62

Phi Coefficient (ϕ) = .57 Chi Square (X^2y) = 20.0

Significance Level = $P/2 < .0005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study did not meet the requirements for incorporating this occupation 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 atptiude patterns.

A P P E N D I X

SP-21T
5/69 (Wn Rev.)

UNITED STATES EMPLOYMENT SERVICE

DESCRIPTIVE RATING SCALE FOR TRAINEES

(For Trainees Used in Aptitude Test Development Studies)

Score_____

RATING SCALE FOR MODEL MAKER (aircraft mfg.) I 693.381
(DOT Title and Code for Training Course)

Training Center's Title Wind Tunnel Model Maker

Directions: Please read the "Suggestions to Raters for Rating Trainees" then complete this rating scale. In making your ratings, only one box should be checked for each question.

Name of trainee (print)_____
(Last) (First)

Sex: Male_____ Female_____

A. How much aptitude or facility does he have for the vocational training? (Trainee's adeptness or knack for performing the work easily and well.)

- ☐ 1. Has great difficulty doing the work.
- ☐ 2. Usually has some difficulty doing the work.
- ☐ 3. Does the work without too much difficulty.
- ☐ 4. Usually does the work without difficulty.
- ☐ 5. Does the work with great ease.

B. How much ability does he have for maintaining adequate production in the vocational activity for which he was trained?

- ☐ 1. Capable of very low work output.
- ☐ 2. Capable of low work output.
- ☐ 3. Capable of fair work output.
- ☐ 4. Capable of high work output.
- ☐ 5. Capable of very high work output.

C. How good was the quality of his work during the vocational training?

☐ 1. Performance was inferior and almost never met minimum quality standards.

☐ 2. Performance was usually acceptable but somewhat inferior in quality.

☐ 3. Performance was acceptable but usually not superior in quality.

☐ 4. Performance was usually superior in quality.

☐ 5. Performance was almost always of the highest quality.

D. How quickly did he learn the instructional units of the vocational training?

☐ 1. Needed careful and repeated instructions.

☐ 2. Learned the work somewhat slower than most.

☐ 3. Learned most of the work in the usual amount of time.

☐ 4. Learned most of the work quickly.

☐ 5. Needed only the minimum amount of training or instructions for even the difficult aspects.

E. How much ability does he have for using equipment of the vocational training?

☐ 1. Has limited ability.

☐ 2. Has a little ability.

☐ 3. Has a moderate amount of ability.

☐ 4. Has high ability.

☐ 5. Has a very high ability.

F. How large a variety of job duties can he perform efficiently?

- ☐ 1. Cannot perform different operations adequately.
- ☐ 2. Can perform a limited number of different operations efficiently.
- ☐ 3. Can perform several different operations with reasonable efficiency.
- ☐ 4. Can perform many different operations efficiently.
- ☐ 5. Can perform an unusually large variety of different operations efficiently.

G. Considering all the factors already rated, and only these factors, how acceptable was his performance during vocational training?

- ☐ 1. Performance was unsatisfactory.
- ☐ 2. Performance was not completely satisfactory.
- ☐ 3. Performance was satisfactory.
- ☐ 4. Performance was good.
- ☐ 5. Performance was outstanding.

Course Outline — Hours

1. Introduction and Orientation — 4
   A. The role that Wind-Tunnel Testing programs play in the design and development of aerodynamic products.
   B. The model maker's duties and responsibilities.
   C. The scope of the training.
   D. The importance of punctuality and attendance.

2. File Nomenclature and Filing Techniques — 3
   A. The file handle in the prevention of on-the-job injuries; safely seat and remove the file handle.
   B. Know the size, shape and cut of files best suited for the rapid removal of material when filing a convex contour and when draw filing a reference surface.
   C. Use acceptable practices in the use, handling, cleaning and storage of files.

3. Step Project — 6
   A. Layout work to .010" using the combination square for layout and checking.
   B. File a square reference corner and edge on dural template stock to a tolerance of .002" when checked with a feeler gauge.
   C. Lay out a series of intersections with the accumulated error by successive dimensioning from the reference edgea to have a total error of .010" or less.
   D. Bandsaw the template without under-cutting the layout or leaving over .030" excess for filing.
   E. Draw file the finished surfaces to a tolerance of plus .000" to minus .010" leaving a smooth, aquare, single surfaced edge.

4. Drilling, Tapping, and Reaming — 4
   A. Utilize tables of decimal equivalents and tap drill sizes to determine the tap drill necessary to obtain the designed grip strength when the percentage of bearing and the thread form are known.
   B. Identify the size of pilot drill required to prepare a project for reaming when the material and finished hole size are known.

5. Drill and Tap Project — 8
   A. Use a Vixen file on dural plate stock to develop a reference corner with a tolerance of .002" on edges and corner.
   B. Use a combination square, scribe, and dividers to layout a series of hole patterns to a tolerance of .010".
   C. Use the necessary tools, and drill, tap and ream with a tolerance of .010" to the hole-pattern layout and with an angular tolerance of 2 degrees off perpendicular to the surface of the work.

D. De-burr parts for safe handling without damage to edges or threads.

6. Precision Measurement 6
   A. Identify the principal parts of the micrometer and the vernier scale.
   B. Apply good tool handling practices.
   C. Read the 6-inch scale in fractions and hundredths.
   D. Read or establish 3 place decimal settings on a training model micrometer.
   E. Read or establish settings on a training model vernier scale with a tolerance of .001".
   F. Read 56 sample settings on the scale, micrometer and vernier scales in 30 minutes.

7. Woodworking Power Tools 4
   A. Identify the bandsaw, jointer, planer, table saw and disc sander, and describe their functions and use.
   B. Select the power tools best suited to the job requirements and make the necessary set-ups and adjustments.
   C. Operate these basic woodworking power tools in an effective manner while complying with all safety requirements.

8. Drafting Terms and Air Foil Ordinate Terminology 6
   A. Obtain the job charge, type of work, number of parts or assemblies required, the materials and tolerances involved from information on the model design drawings.
   B. Describe and use water line, station line and buttock line as they apply in model dimensioning.
   C. Identify wing reference plane, percentage station, upper and lower ordinates, wing chord, leading edge radius, etc., as they apply to air foil templates, and answer questions on template construction.

9. Casting Pattern Project 24
   A. Trim mahogany stock to project requirements using woodworking power tools.
   B. Layout a planform on wooden pattern material with a .030" tolerance.
   C. Make full male templates with the excesses and tolerances described in flag notes on drawings.
   D. Use woodworking techniques to contour both sides of a mahogany pattern to within .005" when checked through percentage stations.
   E. Add excess to pattern to allow for shrinkage of metal in casting.

10. Sealing and Priming 4
   A. Apply metal etching primer as a reference coat prior to any filing or surfacing operations.
   B. Mix and apply resin or lacquer base fillers to correct surface defects in preparation for finish spray painting.

C. Apply primer surfacer and wet block sand across percentage stations to develop a smooth and fair contour without violating the reference surface.

11. Resin Selection and Gram Scale Use 2
    A. Use a model-shop resin chart to select the correct type and percentage of resin and hardener to produce the desired cure.
    B. Use the gram scale in measuring resins and hardeners to insure accurate formulation.
    C. Work with epoxy resins, hardeners and solvents with minimum personal contact, safe handling and good housekeeping.

12. Plaster Mixing and Handling 3
    A. Prepare for plaster work by greasing hand tools and mixing equipment, covering work benches, and spreading oiled sawdust on the floor.
    B. Mix plaster to water in a ratio to obtain the desired density and period of plasticity.
    C. Completely clean the floor, benches, tools and equipment before proceeding to the next project.

13. Rockford Pattern Project 24
    A. Develop Rockford planer templates from engineering ordinate drawings having the finish surface contours smooth and fair with a tolerance of plus .000" to minus .005".
    B. Develop a planform layout on a tooling plate to a tolerance of .030".
    C. Make a plaster faced Rockford pattern within .005" of control templates.
    D. Vacuum form a .004" glass cover on a Rockford pattern to obtain a smooth, hard surface without resin rich or starved areas.

14. Sheet Metal Layout 4
    A. Define and use terms related to sheet metal templates and their fabrication.
    B. Use appropriate template tables to obtain standard inside bend radii and set-back factors when the type of material is known.
    C. Develop simple flat pattern layouts using appropriate template tables and manuals for reference.

15. Oxyacetylene Handling and Silver Brazing Practices 2
    A. Inspect and clean regulator, tank seats, hose connections and torch components to insure absence of oils and foreign matter.
    B. Prepare the work area for brazing by removing flammable materials, obtain authorized fire extinguisher, and secure authorization to braze.
    C. Clean, assemble and clamp parts to be soldered or brazed.

D. Obtain the non-oxidizing flame necessary for silver brazing by adjusting the oxygen and acetylene supply, and the torch mixing valves, and practice brazing.

16. Pressure Ring Project 12
   A. Calculate the flat pattern lengths of the two concentric rings and layout on sheet metal locating positions for struts and tubes.
   B. Fabricate the detail parts and provide the supporting fixtures for alignment during brazing.
   C. Clean the detail parts, protect with flux, support in alignment, heat and apply silver solder to obtain a clean solid joint with filleting action to a maximum of .015" on perpendicular joints. The finished assembly to be within .030" of drawing's dimensions.

17. Flutter Model Construction 40
   A. Layout and fabricate a flutter model wing section from model design drawings and flutter model detail information sheets.
   B. Select the required weight and grade of balsa using a balsa identification and color code chart.
   C. Prepare, chemically clean, and apply adhesive for bond between clad aluminum parts.
   D. Model evaluated by inspection for correct size and grade of material as detailed for the model, for accuracy of joints, for lack of built-up stresses, and for the kind and quality of bonding used to insure adequate strength and corner fillets not to exceed .015".

18. Plaster Master Model and Fiberglass Lay Up 40
   A. Develop a master model from a model line drawing, doing the layout, template making, header location and final plaster contouring to a smooth and fair condition within .015" of design size.
   B. Build a plastic faced female plaster mold and remove it from the master model without damage to either.
   C. Prepare the female mold and layup a fiberglass part of uniform thickness without voids or resin rich laminate.

19. Final Examination and Outgoing Orientation 4
   A. A 15 question 20 minute examination on information covered in the training.
   B. Orientation on suitable tools and clothing, and types of models to be made in assigned work area.
   C. Information on opportunities available for off-hour training courses by contacting the immediate supervisor and/or reading the shop bulletin board.

Total Course Hours 200

FACT SHEET

Job Title:

Model Maker (aircraft mfg.) I 693.381-018

Job Summary:

Makes scale models of aircrafts, missiles and other aerodynamic items of metal, wood and/or plastics using machines and hand tools.

Work Performed:

Layout aircraft, missile or other aerodynamic item according to blueprints, sketches, or verbal or written instructions. Fabricates item of specified materials such as metal, wood, plastic, etc. Uses woodworking tools such as band saws, circular saws and jointers, all types of metal working equipment, power tools, and hand tools. Works to a tolerance of .001".

Makes scaffolding for models in windtunnels and crates or boxes for transporting models.

Course Outline	Hours
1. Introduction and Orientation	4
2. File Nomenclature and Filing Techniques	3
3. Step Project	6
4. Drilling, Tapping and Reaming	4
5. Drill and Tap Project	8
6. Precision Measurement	6
7. Woodworking Power Tools	4
8. Drafting Terms and Air Foil Ordinate Terminology	6
9. Casting Pattern Project	24
10. Sealing and Priming	4
11. Resin Selection and Gram Scale Use	2
12. Plaster Mixing and Handling	3
13. Rockford Pattern Project	24
14. Sheet Metal Layout	4
15. Oxyacetylene Handling and Silver Brazing Practices	2
16. Pressure Ring Project	12
17. Flutter Model Construction	40
18. Plaster Master Model and Fiberglass Lay Up	40
19. Final Examination and Outgoing Orientation	4
Total	200

Effectiveness of Battery Norms:

Only 81% of the non-test-selected trainees used for this study were good trainees; if the trainees had been test selected with the S-448 norms, 96% would have been good trainees. 19% of

the non-test-selected trainees used for this study were poor trainees; if the trainees had been test-selected with the S-448 norms, only 4% would have been poor trainees.

Applicability of S-448 Norms:

The aptitude test battery is applicable to training situations which include most of the training described above or to entry on jobs similar to the above job description.

GPO 887-740

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION
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