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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 is included. (AG)

TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

TURRET LATHE OPERATOR 604.782
DRILL PRESS OPERATOR 606.782
PUNCH PRESS OPERATOR I 615.782

B-262 or S-32

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STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY FOR TURRET-LATHE OPERATOR 604.782 DRILL PRESS OPERATOR 606.782 PUNCH PRESS OPERATOR I 615.782

S-30

Summary

The GATB was administered to 51 workers in the Trimming Department of the Titan Metal Manufacturing Company, Bellefonte, Pennsylvania, in June, 1950. The purpose was to develop test norms to select entry workers who could be transferred from job to job as production bottlenecks developed. A total of 31 Machine Tool Operators (26 men and 5 women) were selected from the original sample as the final sample on which to develop the test norms as these were the main skill occupations in the department wherein job transfer would be chiefly effected. The employees were rated by the Division and Department Foremen. In addition, production efficiency ratings based on work produced were obtained. The aptitudes found to be significant for the job were Intelligence, Aiming, and Manual Dexterity.

GATB Norms for Turret-Lathe Operator 604.782, Drill Press Operator 606.782, and Punch Press Operator I 615.782

Table I shows the minimum acceptable score for each aptitude included in the test norms for Turret-Lathe Operator 604.782, Drill Press Operator 606.782, and Punch Press Operator I 615.782.

TABLE I
Minimum Acceptable Scores for B-1001

Aptitude	Tests	Minimum Acceptable Aptitude Scores
G	CB-1-H CB-1-I CB-1-J	70
A	CB-1-C CB-1-K	60
M	CB-1-M CB-1-N	75

Effectiveness of Norms

The data in Table V indicate that 9 of the 13 poor workers, or 69% of them, did not achieve the minimum scores established as cutting scores on the recommended test norms. This shows that 69% of the poor workers would not have been hired if the recommended test norms had been used in the selection process. Moreover, 15 of the 19 workers who made qualifying test scores, or 79%, were good workers.

TECHNICAL REPORT

I. Problem

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms for the occupations of Turret-Lathe Operator 604.782 , Drill Press Operator 606.782 and Punch Press Operator I 615.782 .

II. Sample

The experimental sample on which the norms were standardized consisted of 31 Machine Tool Operators, (26 men and 5 women), all of whom had 20 or more months experience in these operations. The breakdown by occupation is 10 Turret-Lathe Operators, Class I, 4 Turret-Lathe Operators, Class II, 10 Punch Press Operators or Blankers, and 7 Drill Press Operators.

The main problem in the Trimming Department was to develop norms which would select individuals who could be interchangeable in the various jobs as this is a "job" plant and workers must be able to transfer from one machine to another when bottlenecks develop in order to complete the job on time. Although small samples of all workers in the department were secured, the final norms developed were for Machine Tool Operators as these were the skilled operations and comparable production efficiency ratings were available for these individuals. Most of the other jobs are unskilled and individuals usually are not trained to transfer to Machine Tool Operation in peak periods.

A total of 51 of the 100 employees in the Trimming Department were tested at the time of collating preliminary data. This was the total available sample after elimination of 31 workers over 45, five transfers to other departments, and 13 others not tested due to sickness, absence or no experience in machine tool operation. Of the 51 tested, 7 were eliminated as they were engaged in unskilled occupations (1 Scrap Man, 2 Truckmen, and 4 Picklers) and there was no basis for comparing them with Machine Tool Operators; 1 Set-up Man was eliminated as there was no available production efficiency ratings to compare him with Machine Tool Operators; 1 Drill Press Operator was eliminated because of over-age, and 5 Lathe Operators, Class II, 1 Drill Press Operator, 2 Punch Press Operators, and 2 Grinders were eliminated due to insufficient experience. A scatter diagram indicated workers with less than one year experience with the exception of one Grinder, which is the entry job, scored below the critical production efficiency rating. Experience in this inexperienced group ranged from 3 to 11 months. There was a 9 month gap between this group and the least experienced worker left in the sample. The scattergram indicated that inclusion of this group would seriously affect correlations for the sample.

Selection for workers in this department is based on an interview and general physical examination. The interview determines economic necessity to work, desire for job, interest, mental alertness, mechanical inclination, etc. There are no experience requirements; educational requirements are 6th grade or better; minimum height 5'4", and weight minimum 130 lbs. No other selection devices are used.

Table II shows the means, standard deviations, ranges, Pearson product-moment correlations with the criterion, and standard errors of correlation for age, education, and experience on the job. Because of the small number in each sample, no separate computations were made for the individual jobs.

TABLE II

Means (M), Standard Deviations (σ) Ranges, Pearson Product-Moment Correlations with the Criterion (r), and the Standard Errors of Correlation (σ_r) for Age, Education and Experience

Turret-Lathe Operator 604.782
Drill Press Operator 606.782
Punch Press Operator 615.782
N=31

	M	σ	Range	r	σ_r
Age (years)	34.4	7.8	21-45	.122	.180
Education (years)	9.5	1.7	7-12	.413	.151
Experience (months)	113.0	65.4	20-211	.363	.159

The mean age of 34.4 with a standard deviation of 7.8 does not indicate that age is operating as a selection factor. However, workers in this department tend to be in the higher age brackets. The age factor is controlled at 45 for this sample, and, therefore, age has not affected efficiency to any great extent as indicated by the low correlation between age and production efficiency ratings of .122 with a standard error of .180. The low correlation and slightly higher standard error indicate that age is not affecting the criterion and is not related to success on the job.

The mean of 9.5 on education with a standard deviation of 1.7 and range of 7-12 does not seem to indicate that education is serving as a selection factor. The significant correlation with production efficiency ratings of .413 with a standard error of .151 seems to indicate that education is important to the job and that a measure of intelligence is important for predicting success.

This high correlation is not the result of mechanical ability as demonstrated by success in high school vocational courses as the only courses indicated by the persons in the sample are general or academic. Because of the small sample, it was not possible to hold education constant.

The mean of 113.0 months for experience and standard deviation of 65.4 indicate a high degree of experience for most workers on the job. The correlation of .363 with a standard error of .159 indicates either that experience is affecting production efficiency ratings, or that experience is important for success on the job. It was not possible to hold the experience factor constant because of the small size of the sample.

III. Job Descriptions

Turret-Lathe Operator (Class I) 604.782

Job Summary:

Operates a Turret Lathe, performing various machining operations on forgings, die castings, and stock of brass and bronze metals; cuts, threads, forms, shapes, drills, reams, etc., these metals to specifications provided by blueprints from the Engineering Department. Set-up on machines make operations relatively simple for lathe hand; machine is fitted with stops, machine feed, semi-automatic tools, etc., requiring a minimum of judgment by the operator. Work varies in exactness of tolerance from .002" to .010". (G, N, S, A, F, M)

Work Performed:

Inserts metal forgings, castings, or stock in holding fixture of chuck. This is usually done manually using compressed air chuck or lever controlled chuck. (A, M)

Selects appropriate spindle and shifts spindle to perform first operation, moves cutting tool to position for first cut, then adjusts machine feed or performs cutting operation manually. (G, N, A, F, M)

Reverses turret and/or cross slide from working position at end of each operation by turning hand wheels or moving levers. (M)

Rotates (indexes) turret and/or cross slide to present proper tools for next step in operations. Carries through each step until all operations have been performed. (G, N, A, F, M)

Removes finished part, inspects and repeats operation using new part to be processed. (N, P, M)

Set-up Man (Head) assigns jobs according to difficulty of work performed. Experienced operators are expected to make minor adjustments and alterations to machines without aid from the set-up man; when tools become dull,

operator is expected to remove them, have them sharpened and set up the job in its original form. Once the job has been set up and the operator takes over, he is supposed to know the requirements of the job and produce parts on the machine without further aid.

Turret-Lathe Operator (Class II) 604.782

Job Summary:

Performs work on same machines as Turret-Lathe Operator (Class I) but type of work is not nearly so close or exacting. Typical jobs include facing, couplings, chasing threads, threading internal diameters, drilling, boring, and finishing cuts on internal and external surfaces.

Work Performed:

Major differences in this worker's job and that of Operator (Class I) are the type of work done (tolerances) and adjustments made to machine. When job is not functioning properly, operator or inspector calls it to attention of set-up man who makes necessary changes in machine operation such as altering stop distance, increasing and decreasing cutting distance or diameter of form tools, reamers, etc.

Makes periodic inspection of parts processed using gages provided by Inspection Department. Work is frequently checked by Machine Inspector assigned this job by the Chief Inspector.

Drill Press Operator (Class II) 606.782

Job Summary:

Operates a single spindle drilling machine which drills holes in brass and bronze forgings; also finishes holes by reaming, countersinking, counterboring, or spot facing.

Work Performed:

Wipes machine with cotton waste to remove dirt, drillings, and chips.

Lifts work to drill table manually and places piece to be drilled in jig which is fastened to drill table.

Pulls down hand feed lever to force rotating tool into work until cut has been made to proper depth. Reverses hand lever to withdraw rotating tools from cut.

At times work is fastened in jigs which can be swung from one drill spindle to the next and under such circumstances the operator handles a two-spindle drill press.

Note: Drill Press Operator I is assigned further duties of Set-up to assist Set-up Man, 4-75.160, when needed. Works from blueprints.

Punch Press Operator I 615.782

Job Summary:

Operates and sets up punch press to trim flashing and excess metal from brass forgings and castings. Performs stamping, piercing, sizing, shaping, bending, and cold striking of a variety of brass rods, strip forgings, casting and automatic parts.

Work Performed:

Sets up machine by selecting die manufactured in Tool Room for specific job and fastens same to bed of press using bolts, clamps and hand wrenches. Dies are stored by number corresponding to part number in Die Crib. Attendant or Operator selects the assembly.

Attaches upper half of die (commonly called cutter or punch) to bottom end of ram with contact facing downward.

Adjusts ram upward or downward by means of adjusting nut attached to ram head. Guide pins attached to lower half of blanking die are used to align upper half of die and lower half. Adjustment of ram must be made to prevent guide from damaging upper half of die. This involves correct clearance and alignment.

Lifts box of forged, cast sawed parts to work table. Proceeds to perform the specific operation whether blanked, pierced, sized, shaped, bent, or cold struck. Lifting is aided by Hand Trucker who has primary responsibility for moving material.

Places empty box under chute to catch finished parts or on work table on opposite side of punch press where parts are trimmed.

Snaps together rings attached to straps worn on wrist of each hand. These rings are attached to safety cords which pull the hands away from die opening when upper half of die is descending.

Places part to be processed on lower die; steps on pedal with right foot. This action engages clutch which causes crank to rotate. This rotation moves the die assembly attached to the head downward and forces the part through the stationary die. A blast of compressed air may be used to automatically eject the part into a chute.

Helps load boxes filled with parts trimmed, etc., by lifting upon skid.

May make minor adjustments to machine such as adjusting clutch, clearance, air lines, etc.

IV. Experimental Battery

All of the tests of the GATB, with the exception of Part E, were administered to the sample group.

V. Criterion

The criterion used consists of Production Efficiency Ratings based on the Titan Measured Daywork Plan. Under this plan the Production Efficiency Rating is the number of actual hours worked divided into the number of computed standard hours of production. A standard hour of production is the number of items produced in a normal hour of production determined by time and motion study or other statistical formulae. The standard hours of production for a worker for the day is determined by dividing the total number of pieces by the standard hour rate. The efficiency rating when checked against a table will indicate the amount of bonus to be paid during the next period. Bonus payments start at 85% efficiency and progress to 124%. At this point the worker is profitable to the company and the bonus rate increases.

Supervisory ratings were also secured. They consisted of a combined rating by the Division Foreman and the Department Foreman. These ratings were not used as they included the non-production workers and the lesser experienced workers who were eliminated from the final sample. No effort was made to secure a rerating of those in the final sample as it was believed that the final efficiency ratings received would serve as an adequate criterion and also because it was believed that the two Foremen were too far removed from the actual operations. The Trimming Department Foreman supervises almost a hundred workers and the Division Foreman has additional departments under him.

The criterion used for the study was the efficiency ratings for the period August through November 1950. A few persons included in the sample did not have efficiency ratings for this period due to promotions, transfers, or illness and their ratings were computed from the latest efficiency rating available. The cut-off point between superior and satisfactory workers was set at 125% efficiency. It is at this point that the company pays an additional bonus rate. To establish norms for predicting success it is necessary to use this cut-off point for superior workers; it is necessary to use the combined sample of the various jobs to determine the overall occupational aptitude pattern.

No production records are available showing the efficiency of workers on the various types of machines which they may have operated. In fact during the period August-November, all workers worked only on their own machines. The relative values of different kinds of shop work have been carefully compared and established. This means a Drill Press Operator with a production efficiency of 125 has the same relative position in his group as a Lathe Operator with the same production has in his group. It does not mean that the Drill Press Operator will have the same efficiency if put on lathe work.

VI. Statistical and Qualitative Analysis

Table III shows the means, standard deviations, Pearson product-moment correlations with the criterion, and the standard errors of correlation for the aptitudes of the GATB. Table IV shows the means, standard deviations, standardized means, standardized standard deviations, Pearson product-moment correlations with the criterion, and standard errors of correlation for the tests of the GATB.

The means and standard deviations of the aptitudes and standardized means and standard deviations of the tests are comparable to general population norms with a mean of 100 and a standard deviation of 20.

TABLE III

Means (M), Standard Deviations (σ), Pearson Product-Moment Correlations with the Criterion (r), and Standard Errors of Correlation (σ_r) for the Aptitudes of the GATB

Turret-Lathe Operator 604.782
Drill Press Operator 606.782
Punch Press Operator I 615.782

N=31

	Aptitude	M	σ	r	σ_r
G	Intelligence	88.903	17.609	.315	.164
V	Verbal Aptitude	83.677	13.841	.417	.151
N	Numerical Aptitude	93.645	19.865	.318	.164
S	Spatial Aptitude	88.452	17.639	.048	.182
P	Form Perception	84.032	17.342	.218	.174
Q	Clerical Perception	77.548	14.836	.171	.177
A	Aiming	78.065	19.804	.425	.150
T	Motor Speed	77.097	18.415	.493	.138
F	Finger Dexterity	97.548	19.650	.124	.180
M	Manual Dexterity	96.452	19.706	.473	.142

TABLE IV

Means (M), Standard Deviations (σ), Standardized Means (M'), Standardized Standard Deviations (σ'), Pearson Product-Moment Correlations with the Criterion (r), and Standard Errors of Correlation (σ_r) for the Tests of the GATB

Turret-Lathe Operator 604.782
Drill Press Operator 606.782
Punch Press Operator I 615.782

N=31

		M	σ	M'	σ'	r	σ_r
A	Tool Matching	16.968	4.666	85	16	.305	.166
B	Name Comparison	48.548	14.836	77	15	.171	.177
C	H Markings	37.710	7.158	83	19	.361	.159
D	Computation	23.839	7.076	93	19	.309	.165
F	Two-Dimensional Space	18.484	5.875	90	22	.072	.182
G	Speed	116.871	18.845	82	18	.447	.146
H	Three-Dimensional Space	13.645	5.834	89	17	.012	.182
I	Arithmetic Reason	8.129	3.415	97	20	.316	.164
J	Vocabulary	13.323	6.357	84	14	.414	.151
K	Mark Making	59.581	9.591	76	20	.426	.149
L	Form Matching	20.710	7.595	86	19	.026	.182
M	Place	88.581	7.299	101	17	.446	.146
N	Turn	95.806	10.609	88	24	.399	.154
O	Assemble	26.903	4.775	97	21	.009	.183
P	Disassemble	28.871	3.220	100	18	.328	.163

From Table III it may be seen that aptitudes G, N, S, F, and M have the highest mean scores for this sample. All the standard deviations are below the general population norm of 20, although the sigmas of aptitudes N, A, F, and M round to that figure.

The correlations with the criterion of aptitudes T and M are significant at the 1% level of confidence. Aptitudes V and A correlate significantly with the criterion at the 5% level.

The statistical results were analyzed in the light of significant aptitude requirements as indicated in the job analysis. On the basis of all data, aptitudes G, A, and M appear to have the greatest significance for this occupation.

Aptitude Q, which has a low mean and a low correlation with the criterion, does not appear important in the job analysis and so was eliminated from further consideration. Aptitude V has a significant correlation with the criterion, but does not appear significant in the job analysis. Therefore, it was also eliminated.

Based on all the foregoing considerations, those aptitudes which appear to warrant further consideration are G, N, S, P, A, T, F, and M.

Aptitudes G, A, and M were selected for inclusion in the final norms for the following reasons:

Aptitude G, which has a high mean and a correlation with the criterion of .315, is an effective selection device for these jobs. It is important on the basis of job analysis and discriminates effectively within the sample.

Aptitude A has a relatively low mean for this sample. The standard deviation indicates a population only as homogeneous as the general population. However, the high correlation of .425 with a standard error of .150 indicates a high degree of significance for predicting success on the job. The job analysis data indicate that this aptitude is required for success on the job. In analyzing this aptitude, if the critical score is set at the mean, it eliminates 10 of the 13 low workers and only 3 of the 18 high workers which indicates that this aptitude definitely distinguishes between poor and good workers. There is also an indication that the extremely low scores of the low efficiency group are pulling down the mean of the sample on this aptitude. The mean for the 18 high efficiency workers is 86.278 with a standard deviation of 14.586, whereas the mean of the low efficiency group is 66.692 with a standard deviation of 20.443. The difference between the means is 19.586 which is significant at the 1% level. For this reason, the low critical score set one standard deviation below the mean may not be selective in the applicant population. A follow-up study on these selectees may indicate the need for an upward adjustment of the critical score on this aptitude. Since the aptitude is indicated in the job analysis data, has a high correlation with the criterion, and discriminates effectively within the group, it is recommended for inclusion in the final norms to select for these jobs.

Aptitude M, with a high mean of 96 and a standard deviation of 20, appears to be very important on the basis of job analysis. Also aptitude M has a correlation with the criterion of .473 with a standard error of .142. This indicates a high degree of significance for success on the job.

Aptitudes N, S, P, T, and F were eliminated for the following reasons:

Aptitude N, with a high mean and a correlation of .318, was found to have some significance in the job analysis. However, it does not appear to be as important as aptitudes G, A, and M, and the inclusion of aptitude N decreases the predictive efficiency of these norms.

Aptitude S, with a mean score of 88 and a standard deviation of 18, has a correlation with the criterion of .048 and a standard error of .182. There is some indication of spatial perception in the job analysis data, but this is mainly related to the job of Set-up Man. The number of workers in the set-up job does not merit a separate measure of this aptitude. The low correlation of .048 indicates little or no relationship with job success for this sample.

Aptitude P with a mean of 84 and a standard deviation of 17 is indicated in the job analysis, but it does not appear to be a critical aptitude. The low correlation of .218 does not indicate much significance for success in these jobs. Inclusion of this aptitude would decrease the efficiency of the final norms selected.

Aptitude T has a high correlation with the criterion. However, it has a low mean and does not appear important in the job analysis. The inclusion of aptitude T decreases the predictive efficiency of the norms.

Aptitude F has a high mean score. However, this aptitude is not indicated strongly in the job analysis. The low correlation of .124 with a standard error of .180 does not indicate a significant relationship with the job.

On the basis of all the foregoing data, the aptitudes recommended for inclusion in the final norms are G, A, and M. Critical scores were set one sigma below the mean and rounded to the nearest five point level, resulting in minimum scores of G-70, A-60, and M-75. In order to evaluate the norms by means of the tetrachoric correlation and chi square techniques, the criterion was dichotomized at 125 as the critical criterion score. At this point the worker is profitable to the company and the bonus rate increases. The workers in the high group have been designated as "good workers" and those in the low group as "poor workers."

Table V shows the relationship between test norms consisting of aptitudes G, A, and M with critical scores of 70, 60, and 75, respectively, and the criterion with a critical score of 125 for Turret-Lathe Operator 604.782, Drill Press Operator 606.782, and Punch Press Operator I 615.782.

TABLE V

Relationship between Test Norms Consisting of Aptitudes G, A, and M with Critical Scores of 70, 60, and 75, Respectively and Criterion with a Critical Score of 125 for Turret-Lathe Operator $_{604.782}$, Drill Press Operator $_{606.782}$, and Punch Press Operater $I_{615.782}$.

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	3	15	18
Poor Workers	9	4	13
Total	12	19	31

$r_t = .75$ $\qquad$ $x^2 = 6.715$

$\sigma_{r_t} = .29$ $\qquad$ $\frac{p}{2} < .005$

The tetrachoric correlation coefficient of .75 with a standard error of .29, and the chi square value of 6.715 which yields a $\frac{p}{2}$ value of less than .005 indicate a high degree of probability that the relationship between these norms and the criterion is significant for this sample.

VII. Conclusions

1. On the basis of all the foregoing considerations, aptitudes G, A, and M with critical scores of 70, 60, and 75, respectively are recommended as test norms for these jobs.

2. It is further recommended that check studies be conducted on these occupations to verify these norms.