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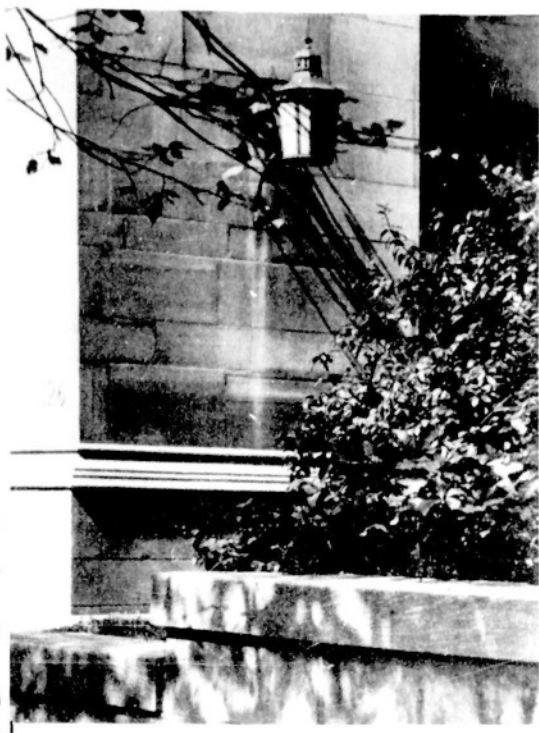
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MECHANICAL APTITUDE IV
DESCRIPTION OF INDIVIDUAL TESTS

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10/10/49

~~THE~~ PSYCHOMETRIC LABORATORY,
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This report contains a description of each of the twenty-five individual performance tests that were used in our factorial study of mechanical aptitude. In addition to the individual tests the subjects were given a temperament schedule, which is also listed in this report. The description is intended to be sufficiently detailed to identify each test, as well as the author and source. A previous report, Psychometric Laboratory Report No. 54, gave corresponding descriptions of the thirty-two group tests. Subsequent reports will describe the factorial analysis and group comparisons that were made with these group tests and individual tests.

The individual tests were assembled in a rather extensive study of available performance tests in the mechanical aptitude field. The analysis of performance tests and the compilation of the present battery were done by Mr. Thomas E. Jeffrey, Mr. John Byrne, Professor Thomas Harrell of the University of Illinois, and Mr. James W. Degan.

INDIVIDUAL TEST BATTERY

The tests used in the Individual Test Battery will be listed in the order that is followed in the analysis of the test results. Each test will be listed by name with the name of the author of the test and the publisher. This will be followed by a brief description of the test, the method used in administering the test, the scoring method used, and a frequency distribution of scores for each of the two groups tested.

TEST 1

STENCIL DESIGN TEST 1

Author: Grace Arthur, Ph.D.

Publisher: Psychological Corporation

Description: This test consists of twenty designs each three inches square, and eighteen colored stencils, also three inches square, to be used to reproduce the designs. Each of the twenty designs can be duplicated by placing certain of the stencils on top of one another in the correct order. The task of the subject is to thus duplicate each of the designs by the proper selection and assembly of stencils as quickly as possible.

Administration: The test was administered substantially in accordance with the instructions in the manual of directions with the following variations:

- (1) The time limit allowed for each design was increased from the recommended four minutes to ten minutes. If a subject exceeded ten minutes he was scored as failing the item.
- (2) Instead of stopping the test after three successive designs were failed every subject was taken completely through the test.
- (3) In the event the subject was close to completion of the design when the time limit was reached he was not stopped but was allowed to finish although the item was scored as failed at the ten minute time limit.
- (4) In case the subject became discouraged before the time limit was reached he was encouraged to go on and try to complete the item.

Scoring method: The scoring method recommended by the author is to count all of the designs correctly solved in four minutes or less. As the time limit had been increased in the administration of the test this method was not applicable.

The time scores for each individual were converted to "reversed standard scores" over each of the twenty test items. Any time score exceeding ten minutes or any item which the subject failed to solve was considered to be ten minutes. Since the shorter time required for solution of any item was to be given the higher score the formula, $-z = (M - X)/\sigma$, was used and will here be designated as a "reversed standard score." The sum of these reversed standard scores for the twenty items was obtained for each subject. The largest negative value so obtained was arbitrarily assigned a zero score and the absolute value of this negative sum was added to the sums for all other individuals. This was done to make all scores positive. These final values were rounded to the nearest whole number and used as the arbitrary score for each individual on this test. The range of scores was from 0 to 54.

Scoring formula:
$$\left(\sum_{i=1}^{20} - z_i \right) + 42.045 = \text{Arbitrary score}$$

where i = test item

Frequency chart: Class interval equals 3.

Score	From	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54
	To	2	5	8	11	14	17	20	23	26	29	32	35	38	41	44	47	50	53	56
Group I (N = 42)		1	0	0	1	1	1	0	3	1	2	4	4	5	4	3	6	3	3	0
Group II (N = 43)		0	0	0	0	0	0	0	0	1	0	1	0	2	0	1	11	8	14	5

TESTS 2 and 3

PURDUE PEGBOARD

Author: Joseph Tiffin, Ph.D.

Publisher: Science Research Associates

Description: The test consists of a board in which two lengthwise columns of holes have been drilled. At the top of the board are four shallow cups containing the pins, collars, and washers used in the test.

Administration: Two tests, insertion and assembly, are given with the pegboard. In insertion the subject is asked to place the pins, one at a time, in the right hand column using the right hand. In the second trial he is to do the same with his left hand placing the pins in the left hand column. In the third trial he places the pins as rapidly as possible in both columns using both hands.

In the assembly test the subject is required to place a pin in the top hole of the board and assemble on it a washer, collar, and washer using both hands alternately. He is to complete as many such assemblies as he can in a period of one minute. Two assembly trials are given.

The procedure for administering the tests followed the published instructions exactly.

Scoring method: Two scores were obtained from this equipment.

(1) Insertion total score: the total number of pins placed with the right hand plus those placed with the left hand added to the number of pairs of pins placed with both hands. Range of scores was from 37 to 55.

(2) Assembly total score: the total number of complete assemblies made in both trials was used for this score. Range of scores was from 13 to 25.

Frequency chart: Class interval equals 1.

INSERTION - TEST 2

Score	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
Group I (N = 42)	1	0	1	3	6	0	1	2	7	7	4	3	3	2	1	0	1	0	0
Group II (N = 43)	0	0	1	4	2	4	4	4	5	4	4	4	0	2	3	1	0	0	1

ASSEMBLY - TEST 3

Score	13	14	15	16	17	18	19	20	21	22	23	24	25
Group I (N = 42)	1	0	1	2	2	3	4	9	9	6	3	2	0
Group II (N = 43)	0	0	0	0	1	2	11	4	8	8	6	2	1

TEST 4

FREEMAN'S PUZZLE BOX

Author: Frank N. Freeman
Publisher: Marietta Apparatus Co.

Description: This test consists of a small shallow box with a glass top allowing the subject to see the pattern of levers contained in the box. Each lever projects outside of the box so that it may be manipulated by the subject. The levers interlock in such a fashion that they are all held immovable unless the subject manipulates them in the correct sequence. If the subject discovers the correct sequence the movement of the last lever in the series will release a small spring door on the side of the box.

Administration: Without allowing the subject any previous examination the locked box was placed on the table before him with the following instructions:

"This is a puzzle box. If you move the levers (examiner points) in the right order this door (examiner points) will spring open. Study the box carefully so that you will move the levers in the right order. Do not use force; if you move the correct lever it works easily. Do it as quickly as you can. Any questions? Ready? Begin!"

Scoring method: Time was recorded in hundredths of a minute. The maximum time allowed was fifteen minutes. The maximum time was given any subject who did not complete the task in this time or who gave up before the time limit elapsed. A distribution of time scores was made using class intervals of twenty-five hundredths of a minute. An arbitrary scale was established assigning zero at the greatest time score and increasing serially by class interval to the shortest time score. Range of arbitrary scores was from 0 to 57.

Frequency chart: Class interval equals 4.

Score	From	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56
	To	3	7	11	15	19	23	27	31	35	39	43	47	51	55	59
Group I (N = 42)		7	0	0	1	1	1	0	2	3	2	7	6	9	3	0
Group II (N = 43)		1	0	1	0	0	0	0	0	1	2	3	3	12	14	6

TEST 5

ALEXANDER'S PASSALONG TEST

Author: W. P. Alexander
Publisher: C. H. Stoelting and Co.

Description: The test consists of four shallow trays of different sizes, thirteen blocks of different sizes, some red and some blue, and a set of eight colored diagrams showing the final positions for each of the nine sub-tests. In each of the nine sub-tests the subject is given one of the trays containing several of the small blocks. One end of the tray is colored red and the opposite end blue, and the problem is to move the red block from the blue end to the red end of the tray without lifting or rotating any of the blocks but by sliding them within the limited space left in the tray. The blocks all have a definite size relationship, and the combination of blocks varies in each tray. As a result the problems vary in difficulty and the aim has been to make the problems increase in difficulty throughout the series.

Administration: The test was administered in accordance with the instructions contained in the published manual with only one deviation. When a subject failed a sub-test the next sub-test was presented to him without any demonstration of the solution of the sub-test he had just failed.

Scoring method: The scoring method used was that described as "method 2" in the manual of instructions. The table which follows the frequency chart is used to convert time scores, in hundredths of a minute, to point scores.

The point score for each item is determined by the time required for the solution of the item. The sum of all point scores was used as the score of the individual on this test.

Frequency chart: Class interval equals 5.

Score	From	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
	To	24	29	34	39	44	49	54	59	64	69	74	79	84	89	94
Group I (N = 42)		0	0	0	1	2	5	1	11	14	4	3	1	0	0	0
Group II (N = 43)		1	0	0	2	0	0	3	3	11	6	4	5	4	3	1

Item No.	Time																			
	.00 - .25	.26 - .50	.51 - .75	.76 - 1.00	1.01 - 1.25	1.26 - 1.50	1.51 - 1.75	1.76 - 2.00	2.01 - 2.25	2.26 - 2.50	2.51 - 2.75	2.76 - 3.00	3.01 - 3.25	3.26 - 3.50	3.51 - 3.75	3.76 - 4.00	4.01 - 4.25	4.26 - 4.50	4.51 - 4.75	4.76 - 5.00
1	2	2	2	2	1	1	1	1												
2	8	7	6	5	4	3	2	1												
3	8	7	6	5	4	4	3	3	2	2	1	1								
4	12	11	10	9	8	7	6	5	4	3	2	1								
5	12	11	10	9	8	7	6	5	4	3	2	1								
6	12	11	10	9	8	7	6	5	4	3	2	1								
7	12	11	10	9	8	7	6	5	4	3	2	1								
8	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1				
9	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

TEST 6

KENT-SHAKOW FORM BOARD

Authors: Grace H. Kent and David Shakow
Publisher: C. H. Stoelting and Co.

Description: The test consists of a wooden frame 22 by 10 inches having five recesses, each of which is fitted with eight complete sets of blocks a little thicker than the depth of the recess. All the recesses are quadrilaterally symmetrical, and they are intended to be approximately equal in distinctiveness of outline. For each of the sub-tests the subject is given a tray containing the appropriate set of blocks and is asked to put the blocks in the appropriate recesses as quickly as possible.

Administration: The test was administered in accordance with the instructions in the published manual obtainable through C. H. Stoelting and Company, Chicago, Illinois.

Scoring method: Only the last six items of this test were used to determine each individual's score in this test, the first two items being considered as a fore-exercise. On items 6, 7, and 8 a time of ten minutes was assigned when the individual could not do the item or required more than ten minutes to solve the item.

Time scores over each item were converted to reversed standard scores. The sum of these scores over the six items was obtained for each individual. The greatest negative sum

was set equal to zero and the absolute value of this negative sum added to all other subjects' scores. These values for each individual were divided by 0.3 and then rounded to the nearest whole number. These arbitrary point scores were then used as each individual's score.

$$\text{Scoring formula: } \frac{\sum_{i=3}^8 - z_i + 15.670}{0.3}$$

where i = test item

Frequency chart: Class interval equals 5.

Score	From	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
	To	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74
Group I (N = 42)		2	0	0	1	2	4	2	3	2	7	9	7	1	2	0
Group II (N = 43)		0	0	0	0	0	0	0	0	0	2	4	13	11	7	6

TEST 7

TWEEZER DEXTERITY, U.S.E.S.

Publisher: United States Employment Service

Description: This test consists of a black plastic board 8 inches square by 7/8 of an inch thick. Drilled into the surface of the board are two banks of fifty holes each. The subject's task is to transfer, with tweezers, the fifty pins in the upper bank of holes to the lower, empty bank of holes in a prescribed order as quickly as he can.

Administration: The test was given in accordance with the instructions available from the United States Employment Service. Instead of giving the subject two trials, however, only one was given, and the time was taken in hundredths of a minute rather than in seconds.

Scoring method: A distribution of time scores using a class interval of .05 of a minute was made for the entire population. An arbitrary scale was used setting the greatest time required equal to zero and increasing serially by class interval to the shortest time.

Frequency chart: Class interval equals 3.

Score	From	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51
	To	2	5	8	11	14	17	20	23	26	29	32	35	38	41	44	47	50	53
Group I (N = 42)		1	0	1	1	0	0	1	3	4	2	5	12	3	6	1	1	0	1
Group II (N = 43)		0	0	0	0	0	0	1	0	2	4	3	4	13	8	6	1	1	0

TESTS 8 and 9

WIGGLY BLOCKS

Author: Johnson O'Connor

Publisher: C. H. Stoelting and Co.

Description: The test consists of a rectangular block of wood sawed lengthwise into nine irregularly shaped pieces. The pieces are laid before the subject in a specific order and it is his task to assemble them into the original block as quickly as possible. The sets of blocks used in this experiment were painted a flat black in order to eliminate cues arising from the grain of the wood. Each piece was then numbered, the numbers running from one to nine. The number was stamped on one end of each piece, and on the black surface they were hardly noticeable. On several occasions, however, the subjects did notice the presence of the numbers. The pieces were numbered in such a way that when the block was assembled the numbers on the corner and center pieces all appeared on the same end of the block while the numbers on the side pieces all appeared on the other end of the block.

Administration: The method of administering the test departed considerably from that recommended in the manual of instructions obtained from the publisher. The instructions furnished each examiner give a complete description of the method and are as follows:

Subject and examiner are on opposite sides of the table. Subject is shown the assembled block which is placed on the table with one end (not side) toward the subject. Examiner says: "Notice carefully how this block is made. It is cut through into three piles, with three pieces in each pile. (Examiner cuts the block into three separate sections by moving the two end piles away from the center pile, and then pushes them together again.) It is also cut through into three layers with three pieces in each layer. (Examiner picks up the top layer, sets it to the left of the block, then picks up the middle layer and sets it to the right. He then reassembles the block.) Remember that the block is three pieces high (examiner touches the three pieces, top to bottom), and three wide (examiner touches the three pieces, left to right)." Examiner now covers assembled block with a cloth or box and shows the subject the disassembled block (the pieces in a row, the numbers facing the examiner and running from number 1 on his left to number 9 on his right) at the other end of the table.

Trial 1. "These pieces, when properly assembled, will make a block like the one you have just seen. Put this block here and build around it. (Examiner takes block number 5 and places it directly before the subject, the numbered end still toward the examiner.) Put them together as quickly as you can. Do you have any questions? Ready? Begin!" Time was recorded in hundredths of a minute.

Trial 2. Examiner disassembles block and arranges the pieces in previous order. "Put this block here and build around it. (Examiner takes block number 8 and places it directly before the subject, numbered end still toward the examiner.) See if you can do it faster this time. Ready? Begin!" Time was recorded in hundredths of a minute.

Scoring method: Two scores were obtained from this equipment.

TEST 8. Trial 1 plus Trial 2: the time required for solving Trial 1 was added to the time required for Trial 2. A frequency distribution of time scores using class intervals of .25 of a minute was made. An arbitrary score set up with zero at the greatest time score and increasing serially by class interval to the shortest time was used.

TEST 9. Trial 1 minus Trial 2: this score was determined by taking the algebraic difference between the time required for Trial 1 and Trial 2. This was done in an attempt to get some measure of learning from Trial 1 to Trial 2. A distribution of these differences was made using a class interval of .25 of a minute. An arbitrary scale with zero at the greatest negative difference and running serially by class interval to the greatest positive difference was employed.

Frequency chart: Class interval equals 5.

TEST 8

Score	From	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
	To	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84	89
Group I (N = 42)		1	1	1	0	0	2	2	1	2	5	5	5	5	5	2	1	3	1
Group II (N = 43)		0	0	0	0	0	0	1	0	0	1	1	0	4	6	1	6	15	8

TEST 9

Score	From	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	To	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84
Group I (N = 42)		4	0	1	2	0	3	4	5	5	6	4	4	2	0	0	1	1
Group II (N = 43)		0	0	1	0	0	1	4	10	12	9	2	2	2	0	0	0	0

TEST 10

BLOCK - DESIGN TEST

Author: S. C. Kohs
Publisher: C. H. Stoelting and Co.

Description: The test equipment consists of eighteen 2 by 3 inch cards and sixteen vari-colored wooden blocks one inch on a side. Printed on each card is a colored design which is square in outline. The blocks are painted with one side blue, one side red, one side yellow, and one side white. The remaining two sides have two colors each with the colors separated along the diagonal of the side. One side is half red and white while the other is half yellow and blue. All sixteen blocks are the same in size and coloring.

The subject is first presented four blocks and is instructed to arrange the blocks in such an order as to reproduce the design shown on the card. The first card is a practice item and is not scored as part of the test. The first nine test designs are reproduced using four blocks, the next two using nine blocks, and the last six using sixteen blocks. The time limits used were those printed on each of the design cards.

Administration: The test was administered as outlined by S. C. Kohs in his publication on "The Block-Design Tests" with the following exceptions:

- (1) After three designs were failed successively, no more were presented and the subject was scored as failing to solve the remaining items.
- (2) The number of moves made in solving the designs was not recorded. Time score only was recorded.

Scoring method: The time limit listed on each design card was used as the maximum time allowed for solving that design. Designs 1, 2, and 3 have a time limit of 1.5 minutes each; designs 4 through 9 a time limit of 2 minutes each; design 10 a time limit of 3 minutes; designs 11 through 14 a time limit of 3.5 minutes each; and designs 15, 16, and 17 a time limit of 4 minutes each. The time limit was assigned as an individual's score for all items he failed to solve.

These time scores were converted to reversed standard scores for each design separately over the total population. These values were then combined for each individual over the seventeen items. An arbitrary scale was established assigning a zero score to the individual with the largest negative combined score. The absolute value of this negative combined score was then added to the combined scores of all other subjects to make all scores positive. These resulting values for each individual were multiplied by two and then rounded to the nearest whole number. The range of scores was from 0 to 95.

$$\text{Scoring formula: } 2 \left[\left(\sum_{i=1}^{17} -z_i \right) + 31.197 \right] = \text{Arbitrary score}$$

where i = test item

Frequency chart: Class interval equals 5.

Score	From	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
	To	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84	89	94	99
Group I (N = 42)		1	2	2	1	2	3	1	1	4	4	4	1	2	2	3	5	3	1	0	0
Group II (N = 43)		0	0	0	0	0	0	0	0	0	1	3	3	4	0	7	4	7	9	4	1

TESTS 11 and 12

RATE OF MANIPULATION

Source: Department of Labor, United States Employment Service

Description: The "Worker-Analysis Pegboard Apparatus Test (A1)" obtained from the United States Employment Service was used to obtain two scores in this study. The test equipment consists of two boards each 10 by 22 by 1 1/4 inches which are hinged on the long side so that the test can be carried easily. Each board has a rectangular array of holes, 5/8 of an inch in diameter by 1 1/8 inches deep, drilled in the board. The array is eight holes long by six holes wide, making a total of forty-eight holes in each board. Both boards are identical in construction. Sixty wooden pegs 1/2 of an inch in diameter by 2 1/4 inches long are used with the test. The pegs have half of their length painted red while the other half is left natural wood color.

TEST 11 - TRANSFER TEST. The equipment is laid flat on a table which should be approximately waist high with the near long edge of the board flush with the edge of the table. The holes in the upper board are filled with forty-eight pegs, red end up. For a right-handed subject

the starting point is the bottom pegs in the two left-hand columns. Using both hands, the subject is to transfer these pegs, two at a time, to the corresponding two holes in the lower board. He continues to work up the columns until all pegs in those two columns have been transferred. He then repeats the process on the next two columns to the right until all pegs have been transferred. The procedure is the same for left-handed subjects except that these persons start at the right of the board and work to their left.

TEST 12 - INVERSION TEST. The equipment is laid out as before but with the pegs placed red end up in the lower board. The subject here works across the board by rows instead of columns. For a right-handed subject the starting point is the right-hand peg in the top row of the lower board. He picks up the peg with his left hand, takes the peg with the right hand, and replaces it in the same hole with the red end down. He does the same with each peg in the top row, moving from right to left, until all eight pegs in that row have been inverted. He then starts on the second row, beginning at the right and working to his left. This procedure is repeated until all forty-eight pegs have been inverted. A left-handed subject does the same, starting at the left of the top row and working toward his right. He will pick the pegs up with the right hand and reinsert them with the left hand.

Administration: Test 11 was administered in accordance with the directions contained in Part I of "Directions for Administering and Scoring Worker-Analysis Pegboard Apparatus Test (A1)" with the exception that only one trial was taken as the score and the time for this trial was recorded to the nearest hundredth of a minute.

Test 12 was administered as described in Part II of the above mentioned manual with only one trial being used for score and the trial time recorded to the nearest hundredth of a minute.

Scoring method: TEST 11 - TRANSFER TEST. A distribution of the time scores obtained was made using a class interval of one hundredth of a minute. An arbitrary scale with the zero set at the greatest time score obtained running serially by class interval to the shortest time score was used. Range of scores was from 0 to 27.

TEST 12 - INVERSION TEST. A distribution of these scores was set up in like manner and an arbitrary scale established in the same way. Range of scores was from 0 to 48.

TRANSFER - TEST 11

Frequency chart: Class interval equals 2.

Score	From	0	2	4	6	8	10	12	14	16	18	20	22	24	26
	To	1	3	5	7	9	11	13	15	17	19	21	23	25	27
Group I (N = 42)		2	0	2	1	2	5	5	8	4	4	8	0	0	1
Group II (N = 43)		0	0	1	1	5	5	5	6	5	9	4	1	1	0

INVERSION - TEST 12

Frequency chart: Class interval equals 3.

Score	From	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
	To	2	5	8	11	14	17	20	23	26	29	32	35	38	41	44	47	50
Group I (N = 42)		1	0	0	0	0	0	0	0	1	1	7	9	8	4	7	3	1
Group II (N = 43)		0	0	0	0	0	0	0	1	1	4	10	5	10	5	4	3	0

TEST 13

U-BOLT TEST (TC-6A)

Source: War Department
The Adjutant General's Office

Description: This test consists of two L-shaped bolts, a bracket mounted on a base, a threaded sleeve, six hexagonal nuts, and six washers. The unit when assembled is a U-bolt mounted through the bracket. The task for the subject is to disassemble and reassemble the unit as quickly as possible.

Administration: The test was administered by the examiner in accordance with the following instructions:

Subject should be standing. Examiner says: "Here is a complete U-bolt assembly with right-hand threaded bolts and nuts (examiner points). Take this apart as fast as you can. Do you have any questions? Ready? Begin!"

When the subject is finished, examiner sees that parts are not laid out in a definite pattern which would simplify reassembly. When parts have been placed in random order, examiner says: "Now put this together exactly as it was before you took it apart. Work as fast as you can. Do you have any questions? Ready? Begin!"

Examiner checks the assembly to be certain it is correct, then says: "Now, take it apart again as fast as you can. Ready? Begin!"

Examiner again scrambles parts, if necessary, and says: "See if you can reassemble it more quickly this time. Ready? Begin!"

Scoring method: Two trials, each consisting of one assembly and one disassembly, were given in administering this test. A time score was calculated for each individual by adding his fastest assembly time to his fastest disassembly time. A distribution of these time scores was made using a class interval of .10 of a minute. An arbitrary scale with its zero at the greatest time score and running serially by class interval to the shortest time score was established.

Frequency chart: Class interval equals 3.

Score	From	0	3	6	9	12	15	18	21	24	27	30	33	36
	To	2	5	8	11	14	17	20	23	26	29	32	35	38
Group I (N = 42)		2	1	0	2	1	1	2	10	6	8	4	5	0
Group II (N = 43)		0	2	0	1	1	0	1	2	3	14	14	3	2

TEST 14

FORM BUILDING TEST

Publisher: C. H. Stoelting and Co.

Description: This test consists of four sets of black sheet metal pieces and four standard position boards, one for each set of pieces. The metal pieces of each set can be assembled into a

rectangle, and the subject's task is to so assemble the pieces of each set as quickly as possible.

Administration: The test was administered in accordance with the following instructions:

The examiner has the pieces of the first set in place on the standard position board in front of him and says: "This is called a form building test. You are going to make a rectangle out of these metal pieces by taking them off this board and fitting them together on the table. You know what a rectangle is; it is a four-sided figure with right-angle corners, like this. (Examiner describes a rectangle with his finger to illustrate.) Do you understand what you are to do?" If there is no question the examiner pushes the board across the table to subject and says: "Begin!"

When task is completed the examiner puts the board and pieces to one side and presents the second position board to the subject. "Here is another set of pieces which also form a rectangle. Begin!"

Boards 3 and 4 are presented in the same way.

Scoring method: The time in hundredths of a second was taken for each set. A maximum time of ten minutes was assigned to sets 3 and 4. This was assigned as a time score in case of times exceeding ten minutes or in cases where no solution was reached. The time scores were converted to negative standard scores for each set separately. These were combined over the four sets for each individual. The individual with the largest negative combined score was assigned an arbitrary score of zero. The absolute value of this negative combined score was added to all other combined scores. These values were multiplied by five and rounded to the nearest whole number and recorded as the arbitrary score for each individual.

$$\text{Scoring formula: } 5 \left[\left(\sum_{i=1}^4 -z_i \right) + 8.673 \right]$$

Frequency chart: Class interval equals 4.

Score	From	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56
	To	3	7	11	15	19	23	27	31	35	39	43	47	51	55	59
Group I (N = 42)		0	2	0	1	0	2	1	2	4	6	5	5	5	9	0
Group II (N = 43)		1	0	0	0	0	0	0	1	1	2	6	7	9	10	6

TEST 15

ROSENSTEIN'S DISC TEST

Author: J. L. Rosenstein

Publisher: C. H. Stoelting and Co.

Description: This test consists of fourteen irregularly shaped blocks contained in a flat, square box. The inner surface of the lid of the box is ridged and recessed in such a fashion that the fourteen removable pieces will go into place upon the lid in the form of a disc eight inches in diameter. It is the subject's task to so assemble the pieces as quickly as possible.

Administration: The test was administered in accordance with the following instructions:

The open box is placed on the table with the pieces well scrambled on the cloth padding of the bottom. Examiner says: "These wooden pieces (points), when properly assembled, will form a kind of circular plate, like this. (Examiner traces a circle.) The plate or disc you make will be about the size of a pie, and is perfectly flat on top. The pieces fit together easily and do not have to be forced. They do fit together snugly, however. This stationary piece shows the edge of the disc to help you get started. Are there any questions? Begin!"

Scoring method: A distribution of time scores using a class interval of .25 of a minute was made. An arbitrary scale was established with zero at the greatest time score and running serially by class interval to the shortest time score.

Frequency chart: Class interval equals 6.

Score	From	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	To	5	11	17	23	29	35	41	47	53	59	65	71	77	83	89	95
Group I (N = 42)		3	0	0	0	0	1	1	0	1	1	7	6	7	8	6	1
Group II (N = 43)		0	0	0	0	0	1	0	0	0	1	1	3	6	8	17	6

TEST 16

PURDUE ASSEMBLY TEST

Author: M. R. Graney

Description: The original Purdue Mechanical Assembly Test as designed by M. R. Graney consisted of two graded series of four boxes each. One series was designated as Form A and the other Form B. A practice box, marked box X, completed the test equipment. The test used in this study was borrowed from the State University of Iowa and included reproductions of all of the original test items with the exception of box 4 of Form A. The physical dimensions of these boxes is approximately 6 by 8 by 2 inches. Each box is supplied with a cover. A different type of mechanical movement or movements is demonstrated by each box when the functioning parts are properly assembled. In every case when the box is correctly assembled movement of the driving element will give reciprocating movement of the driven bar. The only parts which project outside the box are the drive element and the driven element. The drive element may be either a crank which is turned or a bar which is to be pushed. No other type of driving action is used. The final drive or end product is always the sliding action of a bar. In the practice exercise the subject is shown the uncovered box with the working parts correctly assembled. The type of action is explained and demonstrated and then, while the subject watches, the working parts are disassembled and removed from the box. The subject is then given time to reassemble the action before proceeding to the test items. In the test situation the box with all working parts removed and the cover to the box in position is put before the subject. The working parts laid out on a standard position board are placed beside the closed box. The subject is allowed to study the parts without touching them but may not open the box. The time required to complete the item is taken from the time the cover of the box is removed until the subject correctly assembles the parts. Only those parts are removed which can be taken out or replaced without the use of any tool. Therefore, the studs on which gears or wheels turn or on which levers pivot are not removed from the bottom of the box. The order used in presenting the boxes in this study

was: box 2 of Form B was used as the fore-exercise with boxes X, B-1, A-1, A-2, B-3, A-3, and B-4 given in that order comprising the test proper. Box B-2 was used as the fore-exercise since its construction led to several ambiguities which were considered undesirable. The remaining boxes were placed in the order used to obtain an increasing order of difficulty.

Administration: The instructions used in administering this test were essentially the same as those used by Graney. The subject was seated at a table and given the following instructions by the examiner: "This is a test for mechanical insight. It is composed of eight units, each of which, when assembled, demonstrates a certain mechanical principle or combination of principles. Each unit, when properly assembled, can be operated in its own unique way.

"The first box is a practice exercise. Here it is. (Examiner presents box B-2 and demonstrates.) It is already assembled and operates this way. Observe that when I push this bar, the other bar moves.

"I will now take this assembly apart. Watch carefully, for you are to put it back together as it is now. (Disassembles the unit.) Now, there you are. Do you have any questions? (Examiner answers questions, if any.) All right, you assemble the parts as they were in the first place. (Examiner gives subject ample time to reassemble box B-2.)

"Now you have an idea of the way in which this test is worked. All of the other boxes are like this one in one respect: they operate from the outside of the box by either cranking or pushing, as in this problem, never by pulling, lifting, or moving sidewise, etc. Always either push or crank. The resulting action will always be a bar sliding in and out like this (operates box B-2).

"All of the other boxes differ from this one in one respect: the parts are unassembled. You are given the parts and the box. The problem is to assemble the parts correctly as quickly as you can.

"Remember, no tools are required to make any assembly; all parts fit together easily and the mechanism operates easily -- if you have to force anything, your assembly is incorrect.

"The remaining seven boxes will be presented one at a time. You may study the parts but you may not touch them. Your time required to assemble any box starts when you remove the cover to that box. Your score is the number of minutes you take to assemble all parts into the correct working action.

"Are there any questions? (Examiner answers questions, if any.)

"You may now start on box X."

A subject may study the parts and the box into which the parts are to be assembled for as long as he wishes. However, he is not permitted to touch any of the parts, nor to remove the lid from the box until he is ready to start. As the subject lifts the lid from the box, the examiner starts a stop watch. Time is called by the subject when he has completed the assembly and found that it operates smoothly. In the event the subject fails to complete the assembly within the allotted time, the examiner completes it for him.

Scoring method: The time required to assemble the seven boxes was used to determine each individual's score on this test. Cut off times listed below were assigned as time scores for individuals failing a specific box or exceeding the maximum time allowed for the solution to that box:

Box X	-	6 minutes
Box B-1	-	10 minutes
Box A-1	-	12 minutes
Box A-2	-	13 minutes
Box B-3	-	15 minutes
Box A-3	-	20 minutes
Box B-4	-	20 minutes

Time scores were converted to standard scores for each individual box. These values were combined over the seven boxes for each individual. The greatest positive value was assigned an arbitrary score of zero and this positive value was added to the negative value of the combined scores for each individual. This gives all positive scores with the individuals who had the shortest time scores having the greatest score on the arbitrary scale. These final values were multiplied by three and then rounded to the nearest whole number. Range of scores was from 0 to 93.

$$\text{Scoring formula: } 3 \left[\left(-\sum_{i=1}^7 z_i \right) + 17.524 \right]$$

where i = test item

Frequency chart: Class interval equals 5.

Score	From	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
	To	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84	89	94
Group I (N = 42)		1	0	2	1	5	1	5	4	4	10	2	2	1	4	0	0	0	0	0
Group II (N = 43)		0	0	0	0	0	0	0	1	1	4	4	11	2	5	5	1	0	6	3

TEST 17

COMPLEX COORDINATION

Source: Air University, School of Aviation Medicine, Randolph Field, Texas

Description: The apparatus used in this test was borrowed from the Air University, School of Aviation Medicine, Randolph Field, Texas. The equipment is L-shaped with the longer leg of the "L" lying on the floor. The shorter leg consists of a panel board on which are mounted the stimulus and response lights. The outside dimensions are approximately 6 feet in length by 4 feet in height by 30 inches in width. Mounted on the longer leg are a stick and rudder similar to that used in aircraft, and a chair. The chair is mounted on channel iron so that the distance from chair to rudder can be adjusted to fit the length of the subject's legs. When properly adjusted the chair is then locked in place. The subject sits on the chair with his feet on the rudder bar and one hand holding the stick. In this position he is facing the panel of stimulus lights. The stimulus jewels are red in color, and three bands of these jewels are used. The top band is curved with the center higher than the ends. The vertical band runs from the center of the top arc down to the third or bottom band of red jewels. Parallel to each of the bands described above is a band of

green jewels. The position of the lighted lamp in these bands is controlled by the subject. Movement of the stick from side to side causes the position of the lighted green jewel to move either to the right or left of the center point. Movement away from or toward the subject causes a shift in the position of the vertical light. Movement of the rudder bar changes the position of the lower horizontal green light. With all controls in neutral position the green light appears in the center of each band of green jewels. The electronic device used with this apparatus is housed in the rear of the panel board. A frosted glass plate seen only from the rear indicates which of the forty possible stimulus settings is being presented to the subject. Switches are provided which control the power supply, the stimulus lights, and the resetting of the presentation cycle of the stimulus lights.

The subject in the test situation is to match the top red light by moving the stick sideways in the proper direction until the green light is in line with the red light. Then, holding the stick so that the lateral displacement obtained is constant, he is to move the stick forward or backward until the vertical red light is matched by the green light. With these lights matched, the bottom red light is matched by the bottom green light by moving the rudder bar in the proper direction. When all lights are matched and held for a period of .5 of a second the electrical circuit causes this configuration just matched to change to a new one. The subject continues matching the presented configurations making as many matchings as he can in the eight minutes allowed.

Administration: The test was administered in accordance with the directions obtained from the Air University, School of Aviation Medicine, Randolph Field, Texas. The directions used are as follows:

As the subject is taken into the testing room, the examiner turns on the stimulus lights and seats himself at the apparatus. All control movements by the examiner are made slowly enough for the subject to observe the illumination of each separate green light. The examiner says: "This is a coordination test used by the Army in selecting pilots. Your task will be to line up a green light with each of the three red lights. Moving the stick from side to side moves the top green light. Moving the stick away from or toward you moves the middle green light. Moving the rudder bar moves the bottom green light. (Examiner moves rudder bar as far as possible with right foot and then with left foot.)

"Move the stick sideways to match the top green light with the red light. Get it directly underneath. If it is off to one side like this (examiner moves green light off one light) it will not work. Then hold it in position to keep the top lights matched while you move it forward or backward to match the middle lights. Then hold the stick steady while you match the bottom lights with the rudder bar. (Examiner demonstrates each step while explaining.)

"Notice my heels are kept clear of the floor at all times. When all three lights are matched the three red lights go out and a new set appears. Go right ahead and match the new set of red lights without returning all controls to neutral. If a green light goes out completely, as is true in the top row at the present time (examiner moves stick laterally so as to make green light go out), move the control a little and the light will go on again. (Examiner brings control to right or left to cause light to reappear.) If you move any control as far as it will go there will be no green light. You must ease back a little to find the end green light. Do you have any questions?" Examiner turns off stimulus lights and stands up. If the subject asks about the prescribed order of matching, the examiner says: "Match the top light first, then hold the stick that far over to the side while you match the middle light. Then hold the stick steady while you match the bottom light with the rudder bar."

Examiner seats subject, adjusts seat if necessary, and says: "You may use either hand on the stick, but only one hand. Keep your heels off the floor. Try it yourself." Examiner turns on stimulus lights and allows subject two minutes practice. If coaching is necessary the examiner points to light to be matched and directs subject to move control in the direction necessary to match this light.

After the two minutes practice examiner stops the subject and resets the presentation cycle back to zero. He then says: "We are now ready to begin the test. Your score will be the number of matchings you can make in the time allowed. Work rapidly! Ready? Begin."

At the end of eight minutes subject is stopped and the number of matchings read from frosted glass dial at rear of apparatus.

Scoring method: The score used was the number of patterns correctly matched in the eight-minute trial. Range of scores was from 20 to 59.

Frequency chart: Class interval equals 2.

Score	From	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58
	To	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59
Group I (N = 42)		1	0	0	0	6	3	6	5	3	4	1	2	5	3	1	1	1	0	0	0
Group II (N = 43)		0	0	0	1	1	0	1	1	0	5	11	2	5	3	2	3	3	2	2	1

TEST 18

MINNESOTA ASSEMBLY TEST

Publisher: Marietta Apparatus Co.

Description: Set 1 of the Minnesota Assembly Test was used in this study. This set contains the following common objects: (1) monkey wrench; (2) locknut; (3) hose clamp; (4) test tube holder; (5) links of chain; (6) air gauge valve; (7) bottle stopper; (8) bicycle bell; (9) plug and wire; (10) Corbin rim lock. These ten objects are placed disassembled in a box fitted with a hinged cover. All parts to one object are placed in one of the ten compartments provided in the box. The dimensions of the box are approximately 25 by 7 by 2.5 inches. The screw driver provided is the only tool necessary to make any of the assemblies. The items listed above are in an ascending order of difficulty and are placed in the box from left to right so that the subject working from left to right starts with the easiest item and works toward the more difficult items. The subject is to assemble each item as quickly and as correctly as he can.

Administration: The procedure used in administering the test follows the directions provided with the test. The subject was seated at a table and the closed box placed before him. The box was placed with the hinged side toward the subject. The examiner says: "In this box you will find some common mechanical things that have all been taken apart. In each compartment there are all the parts belonging to an object. You are to take the parts and put them together as you think they should be. When the box is opened in this position the cover forms a tray in which to work.

"You will be allowed a certain amount of time to work on each object. If you have not finished an object when time is called, leave it and go to the next one. Work on the items from left to right in the order they are placed in the box.

"Work as fast as you can but do not break the parts. When I say 'Go' open the box and work on the first object. Are there any questions? (Questions are answered by examiner before proceeding.) Ready! Go."

The time limits prescribed in the published directions were used but changed from seconds as given to hundredths of a minute.

Scoring method: The scoring is in accordance with the published directions. All ten items of the test were scored on the basis of ten points for a correct solution within the prescribed time limits and a part score given for uncompleted items based on the percentage of correct connections made to the total number of connections required. The chart below gives the time allowed for each item, the number of connections to be made, and the score given for each connection made correctly.

Item	Time	Number of Connections	Possible Scores
Monkey Wrench	.75 min.	2	0, 5, 10
Locknut	.83 min.	2	0, 5, 10
Hose Clamp	1.00 min.	3	0, 3, 6, 10
Test Tube Holder	1.67 min.	5	0, 2, 4, 6, 8, 10
Links of Chain	1.83 min.	5	0, 2, 4, 6, 8, 10
Air Gauge Valve	1.92 min.	3	0, 3, 6, 10
Bottle Stopper	2.08 min.	3	0, 3, 6, 10
Bicycle Bell	3.25 min.	4	0, 2, 5, 7, 10
Plug and Wire	3.50 min.	4	0, 2, 5, 7, 10
Corbin Rim Lock	4.17 min.	5	0, 2, 4, 6, 8, 10

The sum of the ten item scores was used as the individual's score on this test. An arbitrary scale with zero assigned to lowest value and running serially to greatest score was used. Range of scores on arbitrary scale was from 0 to 84.

Frequency chart: Class interval equals 5.

Score	From	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	To	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84
Group I (N = 42)		1	0	2	1	0	2	5	2	5	3	6	2	4	5	2	2	0
Group II (N = 43)		0	0	0	0	0	1	0	0	0	0	2	4	4	3	9	12	8

TEST 19

CRISSEY MECHANICAL ABILITY TEST

Author: Orlo L. Crissey
 Publisher: General Research and
 Development Company,
 Fenton, Michigan

Description: The test equipment consists of a cast metal framework supporting four vertical pistons, each with a different type of cam action. The linkage between the pistons and the cam shaft can be changed by the subject so that the maximum height to which any piston rises and the time that it reaches its maximum height in relation to the angular position of the cam shaft can be adjusted to comply with the test requirements. A hand-operated drive wheel is connected to the cam shaft by two spur gears. The test apparatus is set before the subject with the drive wheel to his right. In the description of the placement of various parts and their purpose the equipment

is considered to be so placed. Rigidly fastened to the left end of the cam shaft is an indicator wheel on whose rim are marked four lines each 90 degrees apart and lettered A, B, C, or D. The letters appear in alphabetical order when the drive wheel is turned clockwise. The four pistons are numbered 1, 2, 3, and 4 from left to right. When the equipment is correctly adjusted, piston 1 reaches its greatest height when the line marked A on the indicator wheel is opposite an index fastened to the frame. Pistons 2, 3, and 4 reach their maximum heights when B, C, and D respectively are opposite this same index. The pistons all rise to approximately the same height above the top surface of the supporting framework. The height is set by the use of a gauge. This gauge is T-shaped with the horizontal arm of the "T" of two thicknesses lengthwise. The distance from the base of the "T" to the underside of the horizontal arm is less on one-half of its width than on the other, the difference in height being $1/32$ of an inch. The gauge is set on top of the framework with one arm over the piston. When the piston is at the correct height it should touch the part of the gauge which is the smaller height above the base of the gauge but must not touch the part of the arm that is a greater distance above the base. This method makes it possible to set the maximum height to which each piston rises the same within tolerance limits of $1/32$ of an inch. The physical dimensions of the apparatus are approximately 4 inches wide by 11 inches long by 6 inches in height.

Administration: The apparatus with all pistons properly adjusted is set before the subject with the drive wheel to his right. The examiner demonstrates each step as he gives the following instructions: "As you turn this wheel notice that the four pistons move up and down. This is a gauge to measure the height to which the piston rises at the top of its stroke. Notice that piston 1 (examiner demonstrates on piston 1) almost touches that part of the gauge which is a greater height above the top of the frame and does touch that part of the gauge which is the smaller height above the top of the frame. All pistons are set in this way between the limits determined by the gauge at the top of their stroke." The examiner turns the drive wheel several times to demonstrate the explanation.

The examiner then moves the equipment to a point where the subject cannot observe him and changes the piston settings as follows: piston 1 is set so that turning the drive wheel results in practically no movement of the piston; cam set screw of piston 2 is loosened, fine adjustment is turned clockwise almost to limit, and lock nut is set tight; set screw on cam of piston 3 is loosened; set screw on cam of piston 4 is loosened and adjustment of cam follower set to minimum and tightened. The apparatus is then placed before the subject. The examiner indicates the various parts mentioned as he gives the following instructions: "When letter A on the indicator wheel is opposite the red pointer, piston 1 is to be at its maximum height above the top plate as determined by the gauge. As letters B, C, and D on the indicator wheel reach the red pointer, pistons 2, 3, and 4 respectively reach their maximum heights above the top plate which must be within the limits set by the gauge." The latch which locks the drive wheel is engaged with the equipment removed from the subject's view. The apparatus is then placed before the subject with the following final instructions: "Set the heights of all pistons as accurately and as quickly as possible. Do you have any questions? (If there are questions these are answered before proceeding.) Ready? Begin."

Scoring method: A maximum time of thirty minutes was allowed for the solution of the problem. Any individual who failed to solve the problem in this time was given a time score of thirty minutes. A distribution of time scores was made using a class interval of .35 of a minute. An arbitrary scale was used with zero assigned to the greatest time score and running serially by class interval to the shortest time score.

Frequency chart: Class interval equals 5.

Score	From	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	To	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79
Group I (N = 42)		9	0	2	2	4	3	0	2	3	4	7	4	1	1	0	0
Group II (N = 43)		0	0	0	0	0	1	0	0	2	3	2	5	9	7	11	3

TEST 20

DIAL FEED OPERATORS TEST

Author: H. C. Link

Publisher: C. H. Stoelting and Co.

Description: The test equipment is roughly cylindrical in shape. The outside dimensions are approximately 18 inches in diameter by 8 inches in height. The top of the apparatus is a disc attached to the shaft of a spring-powered phonograph motor. Two diametrically opposed slots, one inch in width and concentric with the outer edge of the disc, are placed approximately one inch from the outer edge of the disc. The size opening of the slots can be adjusted from 0° to 60°. In this experiment the slots were used in their full open position. The disc rotates at a fixed speed of 35 RPM. The subject is to drop a steel ball bearing approximately 3/4 of an inch in diameter through the slot in the moving disc into a funnel located below the disc. If he successfully drops the bearing into the funnel, a shutter at the bottom of the funnel is depressed as the ball passes through, thus activating a Veeder counter. In this way the total number of balls dropped through the moving slot into the funnel during a fixed time interval is recorded.

Administration: The apparatus is set on a table at about waist height with the funnel through which the balls are to be dropped at the edge of the table next to the subject. The subject stands while doing this task. With the disc turning the examiner says: "I want you to drop a ball into the funnel like this. (Examiner drops four or five balls to demonstrate.) Use this hand (non-preferred hand of specific subject) to pick up balls and pass them to the other hand (specific subject's preferred hand) one at a time like this. (Examiner demonstrates with several balls.) If a ball fails to go through the slot in the disc or falls to the floor, pay no attention to it, but go right on using other balls from the reservoir. Try to drop as many balls through the funnel as you can in the time allowed. Now you try it." Subject practices for two minutes while examiner watches and makes occasional suggestions to correct bad practices.

At the end of the practice period the examiner winds the clock spring motor and records reading of counter and says: "This is the first trial. You are to drop as many balls as you can through the funnel in two minutes. Ready? Begin." At the end of two minutes apparatus is stopped and difference in counter reading recorded.

The examiner then says: "This is the second two minute trial. See if you can beat your first trial. Ready? Begin." At the end of two minutes the apparatus is stopped and the difference in dial reading recorded for this trial.

Scoring method: The greater number of balls dropped in two minutes was used as the subject's score. In order to reduce scores below 100 the smallest number of balls dropped by any subject was subtracted from the number dropped by each subject. Range of scores was then 0 to 86.

Frequency chart: Class interval equals 5.

Score	From	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
	To	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84	89
Group I (N = 42)		1	1	2	1	4	4	8	8	4	2	4	0	1	1	0	0	0	1
Group II (N = 43)		1	0	1	3	4	4	5	5	9	4	3	2	0	1	1	0	0	0

TEST 21

MULTIPLE CHOICE TEST

Author: R. M. Yerkes

Publisher: C. H. Stoelting and Co.

Description: This test consists of a varnished wooden box 16 inches long by 10 inches wide by 5 inches in height, the lid of which, when opened, stands vertically and serves as a screen to prevent the subject from seeing the examiner's keyboard. In the box (on the examiner's side of the open lid) are the inner ends of a row of twelve rectangular wooden levers and a twelve position switch. The twelve levers are under the control of the examiner, and he may place any or all of them in their extended or in their retracted positions. In their retracted positions the outer ends of the levers are flush with the subject's side of the box; in their extended positions they project several inches out through the side of the box toward the subject. They are numbered, on their inner ends, from 1 through 12, and when the switch is set on any given number the correspondingly numbered lever will sound a buzzer when the subject presses down on its outer end.

The task for the subject is to guess the principle underlying the examiner's choice of which lever is set to buzz. As the test was given in this experiment, there were five separate problems presented to the subject. In each problem a definite principle underlay the choice of the lever that buzzed (first lever from left, middle lever, etc.). On each trial of a problem the examiner would extend a group of levers and set one of the levers of this group to buzz in accordance with the principle of the problem. The subject on each trial was allowed to try all of the levers in order to find which one actuated the buzzer. Since in each trial the subject found out which lever actually controlled the buzzer he had enough information available to guess the principle that was determining the location of this lever, and the more trials he had, of course, the more information he obtained.

Five problems were used in the experiment. In problem I the principle was to always use the first lever at the subject's left. In problem II it was the first at the left and the first at the right, alternately. In problem III it was the third lever from the left. In problem IV it was the middle lever, and in problem V it was the n^{th} lever from the left where n was the number of the trial.

In each problem a given sequence of settings for the trials was followed. For example, in problem I on the first trial the examiner extended levers 1 through 12 with 1 being the activated lever. On trial 2 levers 5 through 10 were extended, and 5 was the activated lever. And on trial 3

levers 10 and 11 were extended and so on through a series of ten trials. If at the end of the ten trials the subject had not solved the problem, the sequence was started over.

Administration: The test was administered in accordance with the following instructions:

Subject is seated at table with the multiple choice box before him. The examiner says: "This is called a multiple choice box or a problem box. You see on your side that there are the ends of a set of levers or keys that I can pull in or push out as suits me. (Examiner illustrates.) Also, on my side of the box, there is a switch by means of which I can set any one of the keys that is out so that it will sound a buzzer if you push down on it. For instance, I have one lever out now, and it is set to buzz if you push down on it. Try it and see.

"Now the test is given as a series of problems which you are to solve. I'll give you a practice problem first so that you can get the idea. This will be the first trial of the practice problem. (Examiner pushes out a group of keys and sets the one farthest to the subject's right as the buzzer.) You see I have pushed out a group of keys and one of those is set to buzz. And I chose that key in accordance with a certain rule that I have in mind. So it isn't a matter of chance which key I set to buzz; the rule determines the choice of key. And your problem is to guess what the rule is that I am using. Try the keys now and see which one it is that actually buzzes. Now we will try the second trial. Here's another set of keys, and one of those is set to buzz in accordance with the same rule as before. Which key is it? As soon as you think you know the rule tell me what it is. There is no penalty if you are wrong."

The examiner continues through successive trials of the practice problem until the subject guesses the correct rule and also until the examiner is satisfied that the subject understands the nature of the task.

The examiner then says: "All right, that was the practice problem. You told me the correct rule after ____ trials so your score would have been ____ trials for the problem. Your score for each problem will be the number of trials you take before you tell me the correct rule. You can take your time since time does not affect your score. Now we will try problem I. This problem is of the same sort as the practice problem but of course the rule will be different."

The examiner then presents problem I. If the subject does not solve it in twenty-five trials the examiner helps him with various hints. After solution of the first problem, examiner presents problem II, and so on. If the subject fails to solve both problems III and IV without hints, the examiner counts problem V as also failed and does not give it. In the cases when problem V is given and the subject fails to solve it before the end of the list of ten settings, the subject should be told that the examiner is working from a list of fixed settings and that they are now starting over on the list. If this were not done the nature of the rule is such that the problem would be very difficult, if not impossible.

Scoring method: The number of trials necessary for a subject to determine the underlying principle of each problem was his score for that problem. A maximum of 25 was allowed as the score for any one item. In the cases where the subject was not given the fifth problem due to having failed both the third and fourth, he was assigned a score of 25 on the fifth problem. The trial scores were converted to reversed standard scores for each problem, and these were combined over the five problems for each individual. The absolute value of the largest negative score so obtained was added to each of the other combined scores, thus converting them all to zero or positive scores. The final arbitrary score was found by multiplying by six, giving a range of scores from 0 to 95.

$$\text{Scoring formula: } 6 \left[\left(\sum_{i=1}^5 z_i \right) + 11.982 \right]$$

where i = test item

Frequency chart: Class interval equals 6.

Score	From	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	To	5	11	17	23	29	35	41	47	53	59	65	71	77	83	89	95
Group I (N = 42)		2	0	0	1	0	1	0	3	1	3	3	3	4	15	4	2
Group II (N = 43)		0	0	0	0	1	0	1	0	2	0	3	2	5	21	6	2

TESTS 22 and 23

ENGINE LATHE TEST

Author: Clark L. Hull

Publisher: C. H. Stoelting and Co.

Description: This test consists of a compound slide rest of the type ordinarily used on light engine lathes mounted on a wooden base. The slide rest is equipped with an extension arm holding a metal pointer and a pencil holder. The metal pointer rides on a bakelite plate in which are embedded six brass pins which determine the corners of a hexagon some three inches wide. With a weighted pencil in the pencil holder riding on a sheet of paper fixed to the block adjacent to the bakelite plate, a graphical record of the course of the pointer around the bakelite plate may be obtained. The subject, of course, moves the pointer in the two dimensions by operating the two cranks of the slide rest.

When the metal pointer touches any of the brass contacts a bell rings, and the subject's task is to run the pointer around the hexagon, ringing the bell at each corner before proceeding to the next.

Administration: The test was administered as follows:

The subject is shown the apparatus and told: "This is an ordinary slide rest taken from a lathe. You can move this metal pointer around the bakelite plate by using the two handles on the slide rest. (Examiner demonstrates.) Notice that each time you touch one of the brass contacts a bell rings. Your problem will be to run the pointer around this figure (examiner points) ringing the bell at each corner before you go on to the next. Now before you start and for some practice run the pointer from this top point over to this first one on the left and then back again."

After the subject finishes his practice the examiner sets the pointer directly on the first contact (the contact at the top of figure as the subject faces it) and says: "Your job is to run the pointer around this figure in this direction (examiner runs his finger around the figure in a counterclockwise direction) as quickly and directly as possible. You must ring the bell at each corner before going on to the next. We will take two scores on this test. We will take the time you require in going around, so go as fast as you can. And from the tracing that this pencil

makes we will score you on how directly you went from point to point -- that is, how straight your lines were. So go as fast and directly as you can. Are there any questions? Ready? Go!"

After the trial is finished the examiner resets the pointer at the top contact and says: "Now we have the second trial. You are to do the same as before. Ready? Go!" For the third and final trial these instructions are repeated.

Scoring methods: Two scores were obtained from this equipment.

(1) Median distance score: in moving the pointer to touch all six of the electrical contacts the subject made a tracing of his movements on a piece of paper. The subject was given three trials and the perimeter of the figure traced out on each trial was measured in centimeters by means of a map distance measuring instrument. The median of the three distances was used as the subject's score. A distribution of distances was made using a class interval of .5 of a centimeter. An arbitrary scale was set up placing zero at the greatest distance and running serially by class interval to the shortest distance. The range of scores was from 0 to 16.

(2) Median time score: the time required for each of the three trials was also measured. The median time of the three was used for the subject's score. A distribution of these times using class intervals of .05 of a minute was made. The greatest time was assigned a value of zero and a scale was established running serially by class interval to the shortest time. The range of scores was from 0 to 49.

MEDIAN DISTANCE SCORE - TEST 22

Frequency chart: Class interval equals 1.

Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Group I (N = 42)	1	0	0	0	1	2	2	1	2	2	6	5	7	2	6	5	0
Group II (N = 43)	0	0	0	0	0	0	0	0	0	0	1	2	4	2	19	6	9

MEDIAN TIME SCORE - TEST 23

Frequency chart: Class interval equals 4.

Score	From	0	4	8	12	16	20	24	28	32	36	40	44	48
	To	3	7	11	15	19	23	27	31	35	39	43	47	51
Group I (N = 42)		1	1	0	0	1	1	2	5	4	18	9	0	0
Group II (N = 43)		0	0	0	0	0	1	1	5	5	8	11	10	2

TESTS 24 and 25

CRAWFORD SMALL PARTS DEXTERITY TEST

Authors: John E. and Dorothea M. Crawford
Publisher: Psychological Corporation

Description: This test consists of a small square board (about twelve inches square) with three circular wells inset along the top of the board. The lower half of the board contains an inset metal

plate in which are two banks of thirty-six holes each. The left hand bank consists of small holes drilled a suitable size to take the pins used in the test, while the right hand bank consists of larger holes threaded to take the screws used in the test.

This apparatus is used for two tests. In the first the subject is required to use a pair of tweezers to take a pin from an upper well, insert it into the first pin hole, take a small metal collar from one of the upper wells and slip it over the protruding end of the pin, insert another pin into the next hole, and so on until the whole bank is filled. For the second test the subject is required to fill the right hand bank with the small screws. The subject takes a screw from the upper well - by hand - starts it in the first hole with his fingers, and runs it the rest of the way down with a small screwdriver.

Administration: These tests were administered in accordance with the manual obtainable from the publishers.

Scoring methods:

TEST 24 - PINS AND COLLARS. The time taken by each individual was recorded in minutes and hundredths of a minute. A distribution of these time scores was made and an arbitrary scale was established with zero assigned to the greatest time score and running serially by class interval (a class interval of .05 of a minute) to the shortest time.

TEST 25 - DRIVING SCREWS. Again the subject was timed in minutes and hundredths of a minute and the distribution of these time scores was made. An arbitrary scale was established, with a value of zero assigned to the greatest time, and running serially by class interval (class interval equalled .10 of a minute) to the shortest time.

Frequency chart: Class interval equals 6.

TEST 24 - PINS AND COLLARS

Score	From	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96
	To	5	11	17	23	29	35	41	47	53	59	65	71	77	83	89	95	101
Group I (N = 42)		1	0	1	1	0	2	1	4	5	5	5	4	6	4	2	1	0
Group II (N = 43)		0	0	0	0	0	0	0	0	3	4	1	11	8	7	4	3	2

TEST 25 - DRIVING SCREWS

Score	From	0	6	12	18	24	30	36	42	48	54	60	66	72	78
	To	5	11	17	23	29	35	41	47	53	59	65	71	77	83
Group I (N = 42)		3	0	2	3	3	6	3	1	6	7	4	1	2	1
Group II (N = 43)		0	0	0	0	3	1	5	1	10	8	5	5	3	2

TESTS 26 - 32

TEMPERAMENT SCHEDULE

Author: L. L. Thurstone

Publisher: Science Research Associates

Description: The last seven scores in this study were obtained from a preliminary form of the Thurstone Temperament Schedule. This schedule consists of a short series of questions for each specific trait. The subject reads the instructions and then for each question circles the answer that fits him best: Y for yes, N for no, and ? for undecided.

Administration: The schedule is self-administering. The subject was given the schedule and told to read the instructions and asked to answer every question.

Scoring method: There are twenty questions for each of the seven temperamental traits covered by the schedule. Those questions where the ? is the response do not count in the scoring. For each trait some of the questions are phrased positively while others are negatively phrased. The scoring is facilitated by the spatial arrangement of the questions and the responses. The maximum score for each trait is 20.

Frequency chart: Class interval equals 1.

TEST 26 - MASCULINE

Score	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Group I														
(N = 42)	2	1	1	4	2	0	4	3	11	8	1	2	1	2
Group II														
(N = 43)	0	0	0	2	1	4	1	5	5	8	4	5	7	1

TEST 27 - ACTIVE

Score	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Group I																
(N = 42)	0	2	1	4	3	7	2	7	5	4	2	4	0	1	0	0
Group II																
(N = 43)	1	1	0	1	3	4	6	5	4	2	7	6	0	0	2	1

TEST 28 - IMPULSIVE

Score	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Group I																
(N = 42)	1	2	1	0	1	0	6	6	7	2	4	6	4	1	0	1
Group II																
(N = 43)	0	0	1	2	1	3	3	1	6	11	3	9	3	0	0	0

TEST 29 - DOMINANT

Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Group I																	
(N = 42)	2	1	2	3	4	5	4	6	2	5	1	3	2	0	1	0	1
Group II																	
(N = 43)	2	3	4	4	3	3	1	6	7	3	1	1	3	0	1	0	1

TEST 30 - STABLE

Score	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Group I															
(N = 42)	0	1	3	2	1	4	2	6	6	6	2	4	3	2	0
Group II															
(N = 43)	1	2	1	0	4	2	6	8	5	5	2	2	2	1	2

TEST 31 - SOCIABLE

Score	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Group I														
(N = 42)	1	1	4	6	6	7	4	6	2	1	3	0	0	1
Group II														
(N = 43)	2	6	6	5	5	9	4	3	1	2	0	0	0	0

TEST 32 - REFLECTIVE

Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Group I														
(N = 42)	1	2	4	6	8	5	4	2	5	2	1	2	0	0
Group II														
(N = 43)	1	2	2	3	6	7	5	6	3	2	4	1	0	1

UNCLASSIFIED

UNCLASSIFIED