A STUDY OF STUDENT PREFERENCE FOR THE

TECHNICAL HIGH SCHOOL

ON A BASIS OF MECHANICAL APTITUDE

By

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CHAPTER I

INTRODUCTION

A technical high school in the best modern sense of the term may be said to be characterized by (1) the academic subjects of the traditional high school--English, mathematics, science, history, civics, and economics, with foreign languages usually omitted; (2) a variety of shops representing as large a range of industries as practicable in any given local situation; (3) equipment representative of the best modern industrial practices; (4) subject-matter courses designed to supplement the hand-work in the shops; (5) the production of marketable "projects" made, so far as possible, by modern factory methods of production; (6) the careful study, through special assignments, lectures, excursions, etc., of modern industries and their various problems; (7) well trained, college educated teachers; (8) a general curricular organization calculated to fulfil the entrance requirements of an engineering college.

The technical high school, in connection with which this study was made, also has vocational courses which emphasize shop work, eliminate much of the academic work, and aim, in a period of three years, to equip a boy to begin work in some specific trade.

Graduates of these courses are not qualified to enter standard engineering colleges without making up the omitted academic credits. Hence, we have the two main classifications used throughout this study: "Technical" or four-year students, and "Vocational" or three-year students. Only about one-third of the student body, however, is ordinarily made up of vocational students.

The aims of the modern technical high school according to Mays in his book The Problem of Industrial Education are:

> 1. To provide training in the common skills needed in the use of the hand tools necessary for the upkeep of the house, including the repair of the machines, appliances, and equipment usually found in modern homes;
>
> 2. To provide training in the designing and construction of various articles which meet a personal or social need realized by the pupils, and which call for the solving of such technical and mechanical problems as will aid in the development of habits of analysis and constructive planning in dealing with mechanical and technical problems;
>
> 3. To provide opportunity for the exercise of the normal constructive mechanical tendencies of boys through the making of useful articles in an orderly manner, by approved, modern methods of mechanical work;
>
> 4. To teach the methods of production, transportation, and preparation of the raw materials and the processes of manufacture in the basic industries of America;
>
> 5. To develop appreciation of good design and construction in the commonly used products of manufacture to the end that the boys may become intelligent consumers of such things;

6. To develop an understanding of the methods of production; transmission and application of power, to the end that the boys may become intelligent consumers of such power, and that they may become able to deal intelligently with the mechanical and economic problems involved in this important factor of human life;

7. To afford opportunity for the discovery of general mechanical or specific trade aptitudes through work in shops representing the typical trades and industries;

8. To give technical training which prepares in part for the positions in industry of the "junior engineer" or "non-commissioned officer" grade, and for entrance to engineering colleges.[1]

As mechanical aptitude or ability on the part of students of technical high schools is a major consideration of this study, a further definition of terms seems timely at this point.

"Mechanical aptitude" may be defined as the natural capacity that a person shows for understanding mechanical relationships and for handling mechanical things. In examining 2,000 pupils in a public school in New York City, Stenquist found that the children ranged all the way from practically no information or aptitude in solving problems that require a reasoning in mechanical terms to an unusual ability and understanding of mechanical devices. Stenquist and other research workers in the field conclude that the reason

1. Arthur B. Mays. The Problem of Industrial Education. The Century Co., New York. 1927, pp. 198-200.

that one child knows a great deal and another almost nothing about the mechanical principles of the hundreds of devices, toys, and machines with which both are surrounded must be based in large measure on original nature--the native interests and aptitude of each individual child. The child who by nature is mechanically inclined tends to develop from his every day experience a mechanical reasoning ability that may, in some cases, reach almost uncanny proportions. Every toy, every machine, every workshop that he sees contributes to his general knowledge of this field because of his interest in them. But authorities in this field have come to believe that the boy who does not naturally attend to things mechanical, and to whom such may even be positively distasteful, will profit very little from even an extended training or contact in this field.

In the light of the foregoing, it is assumed that mechanical aptitude as a unique trait definitely exists and that those who possess it should do better than those who do not in a school that emphasizes mechanical work. To test this hypothesis, the following method of attack was used:

1. Standardized mechanical aptitude tests were given to all first-term students in a technical high

2. Curves were plotted, showing the relation between vocational, technical, and control groups.

3. Scatter diagrams were plotted between mechanical aptitude scores and classroom grades.

4. Coefficients of correlation were calculated between mechanical aptitude scores and class-room grades.

5. Corrections were made for broad categories.

6. Scatter diagrams were sectioned and other relations calculated.

Through interpretation of this material it was assumed that the two major questions of the study could be answered; namely: (1) Are students attracted toward the technical high school from the standpoint of possession of mechanical aptitude? (2) Is the degree of mechanical aptitude possessed by the student a basis of prediction of his success in such a school?

CHAPTER II

GENERAL DATA ON MEASUREMENT OF MECHANICAL APTITUDE

While the literature in the field of measurement of mechanical aptitude is not voluminous, some outstanding and comprehensive contributions have been made. John L. Stenquist presents "descriptions, results, and conclusions resulting from experiments with mechanical aptitude tests carried on over a period of four or five years" in his book Measurements of Mechanical Ability.[1] Stenquist devised, experimented with, revised, tested, and calculated statistics for two general kinds of materials for the purpose of measuring mechanical ability: (1) assembling tests, in which actual disassembled objects are put together; and (2) picture tests, calling for judgments as to what parts belong together, and including questions on mechanics and machines. He says:

> The idea of presenting a disassembled actual commercial article, such, for example, as a bicycle bell or mouse trap to be assembled, was first suggested by Professor E. L. Thorndike as a promising method of reaching certain capacities more or less untouched by the more common verbal pencil-and-paper tests. In order to make them practicable as group tests in schools only such models as can be given to whole groups of pupils have been included. To meet this requirement it has been nec-

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1. John L. Stenquist. Measurement of Mechanical Ability. Teachers' College, Columbia University, New York, 1923, p. 1.

essary that all models be relatively small, light and unbreakable, so that they can easily be carried about and used over and over, as well as that they be of such a nature that they can be readily disassembled or assembled--and can be quickly and positively scored.

While it would be desirable to include other operations besides assembling, this one activity was chosen as representative of many mechanical tasks and calls less for special trade skill than most mechanical operations. Thus, assembling is of a more general nature than, e.g., chiselling, chipping, filing, sawing, soldering, forging, etc., all of which require at least some trade training.

The picture tests, however, cover a much wider range of objects and operations, and include questions pertaining not only to simple and small objects but to large and complicated machines and processes.[2]

Stenquist, after showing that the correlation between mechanical ability and intelligence is low (ranging from +.2 to +.4) and correlation between picture tests and assembly test runs as high as +.68, summarizes as follows in his pamphlet <u>Mechanical Aptitude Tests</u>:

Since these tests measure a trait which might well be called "general mechanical intelligence," wherever possible, they should be given in parallel with tests of general abstract intelligence, such as the Otis Group Intelligence Scale, Haggerty Delta 2, and National Intelligence Tests. By giving tests of mechanical aptitude to pupils of grades 6, 7, 8, and 9 in particular, it is possible for the superintendent to discover first of all those who have markedly high or markedly low ability of this kind, which cannot be found out easily in any other way. Such pupils will appear as of all grades of abstract

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2. Ibid. p. 4

intelligence. In the case of 275 seventh and eighth grade boys in a New York City school, for example, it was found by most careful tests that of those who were below average in general abstract intelligence as measured by the average score in six tests (Otis advanced Examination; National Intelligence Test, A and B; Meyers Mental Measure; Haggerty Delta 2; and Thorndike Visual Vocabulary) 40 per cent were nevertheless above average in mechanical aptitude as measured by the combined results of four tests of mechanical aptitude (Stenquist Picture Tests I and II, and Stenquist Assembling Tests, Series I and Series II). On the other hand, of those pupils who were above average in general abstract intelligence 52 per cent were also above average in general mechanical aptitude. The correlation for these cases was r (Pearson)= .21 ±.04. This indicates that pupils of great promise in mechanical intelligence or aptitude are almost as likely to be found among those with low scores as among those with high scores in general abstract intelligence tests of the kind mentioned above. But it seems reasonable to assume that those with high scores in both these types of tests give most promise of success along lines of engineering, invention, science, etc. These individuals are most likely to become the Edisons and Mergenthalers of tomorrow. On the other hand, for those of high general mechanical aptitude but of low general abstract intelligence many opportunities are open. . . .

In the light of these facts, as well as many other considerations, it is clearly important to discover the mechanical aptitude of every child.

This is the first step toward intelligent educational and vocational guidance, insofar as mechanical vocations are concerned. Such a procedure is surely far more rational than the method of merely recommending mechanical careers on the basis of failure in academic subjects, or making such recommendation for any child who, by some caprice, thinks he wants it.[3]

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3. John L. Stenquist, Mechanical Aptitudes Tests. World Book Company, New York, 1922, pp. 6-8.

In 1930 a thorough and exhaustive work entitled "Minnesota Mechanical Ability Tests--The Report of a Research Investigation Subsidized by the Committee on Human Migrations of the National Research Council and Conducted in the Department of Psychology of the University of Minnesota" was published. This study covers in great detail every conceivable ramification of the field of mechanical ability testing, including statements of hypotheses on which each research was conducted. The construction, validation, and use of the test material, together with thorough statistical data and original source data, is given throughout. The volume also covers such material as the criteria of mechanical ability, the prediction of mechanical ability, mechanical ability as a unique trait, the effects of environment on mechanical ability, the distribution of mechanical ability, etc. To give a further idea of the scope of this work, the following classification of tests used in it is presented:

I. STANDARD GROUP INTELLIGENCE TESTS

1. Army Alpha, Form 6 (Group Paper)

2. Otis Self-Administering Tests of Mental Ability, Higher Examination, Form A (Group Paper)

II. SIMPLE MOTOR TESTS

1. Tapping Test A (Group Paper)

2. Tapping Test B (Group Paper)

3. Tapping Test C (Individual Apparatus)

4. Steadiness of Motor Control (Individual Apparatus)

5. Accuracy of Movement or Tracing Board (Individual Apparatus)

6. Accuracy of Movement or Tracing Paper (Group Paper)

7. Aiming (Individual Paper)

8. Speed of Movement (Group Paper)

III. BALANCING TESTS

1. Body Balancing (Individual Apparatus)

2. Stick Balancing (Individual Apparatus)

IV. COMPLEX EYE-HAND COORDINATION TESTS

1. Link's Machine Operator's (Individual Apparatus)

2. Card Sorting (Individual Apparatus)

3. Card Assembly (Individual Apparatus)

4. Packing Blocks (Individual Apparatus)

V. ASSEMBLY TESTS INVOLVING MANIPULATION AND RESPONSES TO SPATIAL RELATIONS

1. Stenquist Assembly (Group Apparatus)

2. Paper Form Board (Group Paper)

3. Link's Spatial Relations (Individual Apparatus)

4. Cube Construction (Group Apparatus)

VI. TESTS OF MECHANICAL KNOWLEDGE

1. Stenquist Picture Tests I and II (Group Paper)

VII. MISCELLANEOUS TESTS

1. Slow Movement or Motor Inhibition (Individual Paper)

2. Digit-Symbol Substitution (Group Paper)

3. Letter Cancellation (Group Paper)

4. Number Cancellation (Group Paper)

5. Rhythm or Perception of Time (Group Apparatus)

In concluding the review of the "Minnesota Mechanical Abilities Tests" volume, the following statement which seems pertinent to this study is made:

> It must be recognized that what these tests measure is mechanical ability, not mechanical capacity; just as whatever is measured by intelligence tests is intellectual ability, and not intellectual capacity. Capacity is always an inference from measured ability. If for two individuals environment, training, and motivation are equal, it may be inferred that the person who makes the highest test score has the greater capacity.
>
> The fact that intelligence tests give far from perfect predictions of academic success indicates that even in this field, differences in interest and environment are operative to a greater degree than we ordinarily suppose. Tests measure more nearly what a person can do than what he will do. Colleges and universities do not expect their intelligence examinations to give perfect correlations with scholastic success. Coefficients of +.45 to +.50 are still considered good, and this is true after ten years' work in developing better techniques, both experimental and statistical, by which the tests themselves have been greatly improved. The fact that the predictive power of tests has not been increased in proportion to improvement in the measures employed suggests that intelligence is only one of the factors involved in academic success; that such matters as interest, temperament, incentive, outside work, social activities, and economic pressure are operative to an appreciable degree. In other words when motivation is maximal for all

members of the group, the correlation of tests and scholastic success becomes significantly higher.

Similarly it must be recognized that in measuring mechanical ability, only one of the factors necessary for success in mechanical work is being dealt with. One cannot expect, even on the assumption that it is possible to devise perfect tests of mechanical ability, that any instruments will predict with certainty whether or not a particular individual will succeed in a given line of work. One can only say that if he passes the tests in a satisfactory manner, he possesses one of the qualifications for success in the work in question, and that, in the main, individuals who show proficiency in the tests are more likely to succeed than those who do not. It may be said, too, that the better his ability as tested, the better his chances for success; and conversely, and with even more confidence, that individuals who do <u>not</u> succeed in the tests are <u>not</u> likely to succeed in the kind of work considered, since one of the elements necessary for that success is apparently lacking. It is a well-founded generalization in the field of vocational psychology that it is easier to predict failure than success.[4]

The test used in this study is the "Detroit Mechanical Aptitudes Test for Boys" by Harry J. Baker and Alex C. Crockett. The authors give the following general information and statistical data in regard to it:

The Detroit Mechanical Aptitudes Examination for Boys has been developed to measure general mechanical aptitude or ability by the group method and with as great accuracy and reliability as seems possible at the present time.

Mechanical aptitude may be expressed as the "knack" that a person shows for understanding

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4. Donald G. Paterson and Richard M. Elliott. <u>Minnesota Mechanical Abilities Tests</u>. Univ. of Minnesota Press. 1930, pp. 7, 8, 9.

mechanical relationships and for handling mechanical things. We have all noted differences between individuals in this regard with such expressions as "fingers are all thumbs," "drives, but doesn't know the motor is missing," etc. A much different type of person is to be found in the person who wishes to tinker with a clock, to build a model aeroplane, to tear down an old car, or to construct a new mechanical apparatus. While the home environment and other opportunities undoubtedly play some part in a boy's immediate ability to carry on mechanical operations, native differences in mechanical aptitude are relatively fixed as are differences in general intelligence.

Test Construction and Validation

The items of the test were eventually selected to resemble as faithfully as possible the actual situations which a boy meets in the shops or outside the traditional classroom. A satisfactory group test must be easy to administer and to score, short enough to sustain interest and avoid fatigue, yet long enough to be a fairly thorough measure, and at the same time meeting the requirements as to reliability and validity.

Three types of material were eventually selected to fulfill these requirements: (1) tool knowledge or information; (2) a type of motor skill; and (3) visual acuity. Tool knowledge and information items were incorporated in the test in sub-parts 1, 4, and 7. These parts of the test are probably not influenced by experience as much as is commonly supposed. In fact, individual cases can be cited showing that boys with practically no experience in shop courses, but with good mechanical ability, are known to excell the performance of boys having much more experience but no aptitude, interest, or liking for mechanical performance. The use of results of experience as a measure is justified in the same manner that the measure of certain basic but ordinary experiences are valid measures of general intelligence.

Correlations were computed between the various pages of the test and with the total score minus each test in turn. It will be noted that all correlations are positive and fairly high. If these correlations were somewhat lower they might show

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5. Harry J. Ba ker and Alex C. Crockett. Detroit Mechanical Aptitude Examinations for Boys. Public School Publishing Co., Bloomington Ill., 1928, pp. 7, 8, 9.

that mechanical aptitude did not seem to have a general factor running through it, and if they were much higher, some pages might be considered as measuring identical traits.

The examination in printed form was repeated after an interval of two weeks on 193 pupils in the seventh and eighth grades and the coefficient of reliability between the two trials was 0.76 ± .02.

Validity

Shop teachers' ratings for mechanical aptitudes were compared with the test scores in a technical high school on 50 cases with a correlation of 0.64 ± .06. The ratings by an apprentice supervisor in an industrial plant on 30 cases correlated 0.64 ± .07 with test scores. The difference between the average scores of seniors in an academic high school and a technical high school was more than three times the standard error, which indicates a real difference between these two groups as regards mechanical aptitude.[5]

The test itself has eight pages made up as follows: Pages 1, 4, and 7 are composed of tool knowledge and information items covering shop, tools, and machinery, and their common uses. Pages 2 and 5 measure a type of motor control and coordination which is considered by the authors to correlate with actual performance in the operation of mechanical devices. The students are tested on their ability to draw a line along a given path; to recognize bolts, nuts, screws, and washers; and to tabulate the corresponding numbers in columns provided for each at the bottom of the page. Pages 3, 6, and 8 are designed primarily to measure visual acuity. Judgments of differences in size, in in shape, and in direction and speed of motion are measured on these pages, the problem on page 8 being to determine the speed and direction of pulleys of various sizes which are belted together.

There is a time limit for each page and the test is so designed that, while no one is likely to complete successfully all items on the page, every one is almost certain to complete at least some items. Otherwise, an adequate measurement could not be obtained either for those who correctly complete all items or for those who complete none.

According to the authors, the original test material was tried out in mimeographed form on over three hundred cases, ranging from mentally subnormal pupils to the graduating class of the technical high school, and a significant range of scores resulted. All items which did not show a distinct difference between slow, average, and bright pupils on the basis of total score were eliminated in the printed edition.

These tests were given to 3,255 boys in a nation-wide testing program conducted in 1928, and letter ratings for scores according to chronolgical age (ranging from 12 to 16 years or over) were developed as follows:

E	D	C-	C	C-	B	A
8%	12%	18%	24%	18%	12%	8%

In this scale "A" is high, "E" is low, and the per cents follow the normal curve of distribution. As age is a factor in the letter rating, a 16-year-old would have to make a much higher score than a 12-year-old to get a rating of "A", for example.

The authors' statistics show the test to have a reliability of .76 ± .02 and a validity of .64 ± .06 from which one is justified in assuming not only that the test is a good one, but also that it does measure mechanical ability at least to a moderately high degree. Inasmuch as this study shows that the students of the technical high school select themselves to a striking extent on a basis of what the test measures, we have by inference further evidence that the test measures mechanical ability, or at least mechanical interest (and the two are strongly correlated according to Stenquist and the authors of this test), for the boys, in the main, go to the school that interests them, and, as the school's offering is mechanical, the interest which impells them to enter there is also mechanical. Hence, it follows that if the test measures mechanical interest it is permissible to assume that it also measures aspects of mechanical aptitude.

CHAPTER III

TEST RESULTS ANALYZED

Tables Number I, II, and III show a tabulation of the results derived from giving Detroit Mechanical Aptitude Tests to the first term or entering group in a technical high school. Table Number I (Vocational Students) includes 93 cases and represents the mechanical aptitude standing of all first-term students taking a vocational or three-year course. The numbers

TABLE I

MECHANICAL APTITUDE RATINGS DERIVED FROM TEST SCORES--VOCATIONAL STUDENTS--93 CASES

		Mechanical Aptitude Ratings						
		E	D	C-	C	C+	B	A
Age	14	0	0	1	8	5	5	2
	15	0	2	4	6	11	0	2
	16 or more	2	5	8	15	8	7	2
	Totals	2	7	13	29	24	12	6
	Per cents	2.15	7.5	14.0	31.2	25.8	12.6	6.45
	Normal Per cents	8.0	12.0	18.0	24.0	18.0	12.0	8.0

such as 0-72; 73-85; 86-79, etc. (shown only in Table II, but applicable equally to Tables I and III also) located under E, D, and C respectively for age 12, for example, represent the test score range for each letter rating at a given age. At the bottom of each table are given the percent of the total number of cases falling under each letter rating of mechanical aptitude. Below that are the percents representative of the normal distribution for each letter rating. Notice that in Table I (Vocational Students) while the percentage of E, D, and C-, or very low standing, is below normal in each case, and the percentage of higher, or C, C+, and B scores is above normal, the percentage of A or highest rating is below normal, showing that while the group as a whole is above average in mechanical aptitude, it is deficient in its number of outstanding possessors of mechanical aptitude.

Table Number II (Technical Students, comprising 182 cases, also shows a superior mechanical group, but it excells both the vocational and the normal percent in the upper or "A" rating as well as in most other ratings--a group appreciably superior in mechanical aptitude to the vocational group.

TABLE II

MECHANICAL APTITUDE RATINGS
DERIVED FROM TEST SCORES--TECHNICAL STUDENTS--182 CASES

Age	Mechanical Aptitude Ratings						
	E	D	C-	C	C+	B	A
12	0-72 0	73-85 0	86-97 0	98-112 0	113-124 0	125-137 0	138-305 1
13	0-79 0	80-93 0	94-101 0	102-122 1	123-135 5	136-149 5	150-305 6
14	0-85 1	86-100 1	101-114 7	115-131 13	132-145 22	146-160 21	161-305 10
15	0-90 0	91-106 6	107-121 7	122-139 13	140-154 19	155-170 7	171-305 3
16 or more	0-94 0	95-111 3	112-127 3	128-146 7	147-162 7	163-179 6	180-305 3
Totals	1	9	17	38	53	41	23
Per cents	.55	4.95	9.34	20.88	29.12	22.5	12.63
Normal Per cent	8.0	12.0	18.0	24.0	18.0	12.0	8.0

TABLE III

MECHANICAL APTITUDE RATINGS DERIVED FROM TEST SCORES

--VOCATIONAL AND TECHNICAL STUDENTS COMBINED--275 CASES

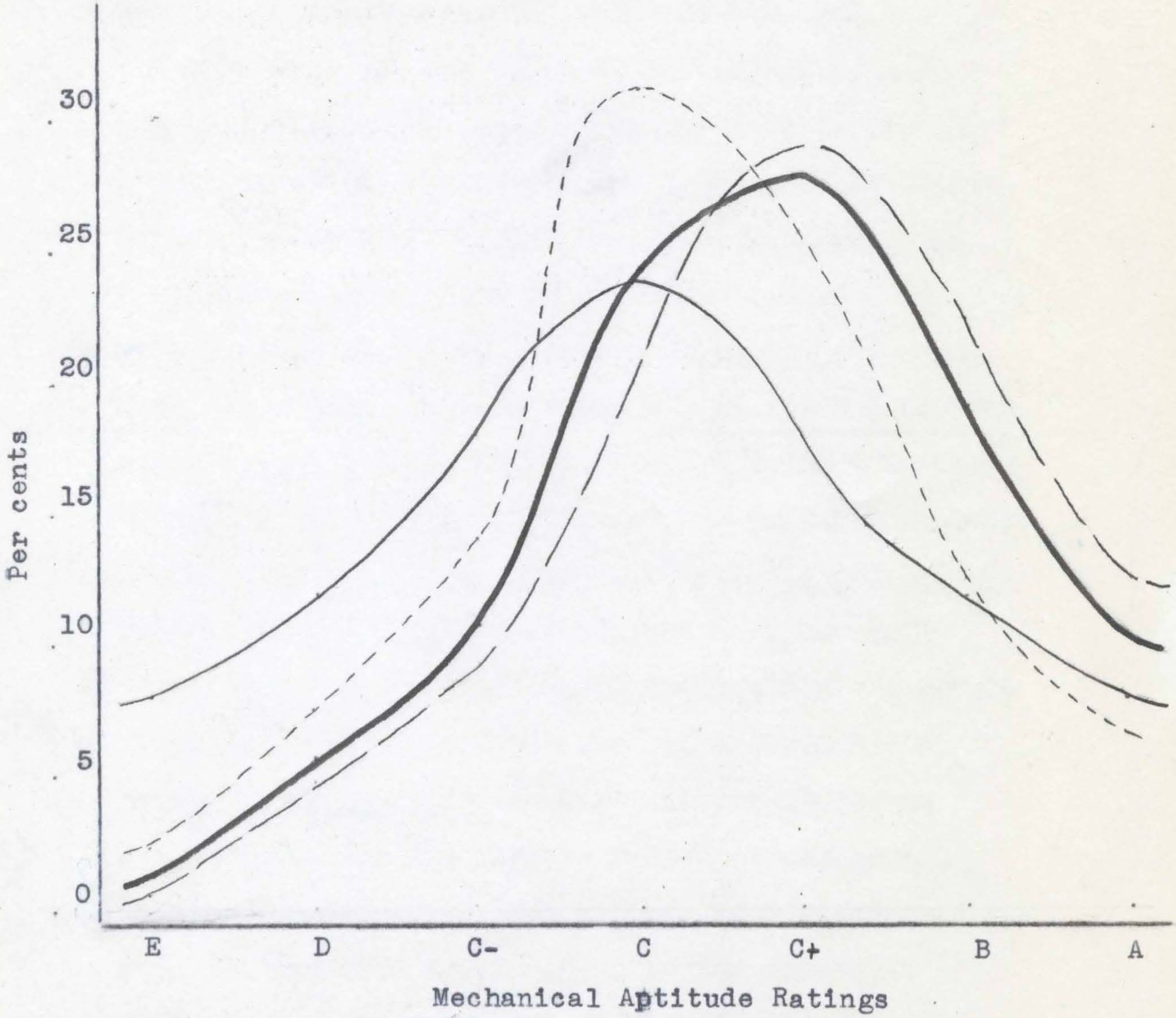
		Mechanical Aptitude Ratings						
		E	D	C-	C	C+	B	A
Age	12	0	0	0	0	0	0	1
	13	0	0	0	1	5	5	6
	14	1	1	8	21	27	26	12
	15	0	7	11	23	30	7	5
	16 or more	2	8	11	22	15	15	5
	Totals	3	16	30	67	77	53	29
	Per cent	1.09	5.81	10.9	24.36	28.0	19.27	10.58
	Normal Per cent	8.0	12.0	18.0	24.0	18.0	12.0	8.0

Table Number IV represents the same material graphically, one curve showing the normal distribution, based upon the general norms, one showing the distribution of the vocational group, one the technical group, and one a composite curve. Note that the vocational group is superior to the Technical group and that both vocational and technical groups are superior to the normal distribution as obtained in the nation-wide testing campaign.

It is now clear that the group is attracted toward the technical high school on a basis of whatever

TABLE IV

RELATION BETWEEN NORMAL DISTRIBUTION OF
MECHANICAL APTITUDE AND DISTRIBUTION IN THE
TECHNICAL HIGH SCHOOL



——————— Normal Distribution Based on 3, 255 Cases

- - - - - - - - - - Vocational Student Distribution Based on 93 Cases

— — — — Technical Student Distribution Based on 182 Cases

▬▬▬▬ Combined Vocational and Technical Student Distribution Based on 275 Cases this test measures, and by a simple calculation it is possible to determine the size of the average group from which it was selected. Referring again to Table III (Vocational and Technical) and taking the totals from rating "B" which is the most heavily weighted one, we have 53 cases. Dividing by .12, the percentage which would normally fall in the "B" group, we obtain the number 442. This is the number of unselected eighth-grade boy graduates from whom the self-selected group of 275 was obtained. By multiplying 442 by the per cent normally possessing each mechanical aptitude rating, such as .08 X 442=35 for "E"; .12 X 442 = 53 for "D"; .18 X 442 = 80 for "C"; etc., we have the horizonal row in Table Number V entitled Normal Group. The next row, Technical High School, is the weighted distribution of the self-selected technical high school group which was determined in previous tables. The third row, entitled Number Eliminated, is the difference between the normal group and the technical high school group, showing the number of students who were eliminated from the original normal group by the automatic selection which took place at the technical high school. The Per cent Elimination shows the percentage of each rating group eliminated by the selective

Process.

TABLE V

ELIMINATION FROM THE NORMAL GROUP BY SELF-SELECTION ON A BASIS OF MECHANICAL APTITUDE IN A TECHNICAL HIGH SCHOOL

	E	D	C-	C	C-	B	A
Normal Group	35	53	80	106	80	53	35
Technical High Sch.	5	16	30	67	77	53	29
Number Elimin.	32	37	50	39	3	0	6
Per cent Elimin.	92.0	70.0	62.0	37.0	3.8	0.0	17.0

The feature of this table, of course, is the heavy percentage of eliminations from the low mechanical aptitude groups as measured by the tests --92 per cent in the "E" or lowest group, 70 per cent in the "D" or next lowest group, 62 per cent in the "C" group, and a total of 71 per cent of all levels below "C". However, the higher groups do not escape entirely and we have 3.8 per cent eliminated from the "C-" group and 17 per cent eliminated from the highest or "A" group--a total of 12 per cent eliminated from those above "C".

The significance of these findings is explained by a study of the setting of the school in which the survey was made and the factory which influence studets to go there. The school is located in the heart of a city of 300,000 population, which has six traditional high schools. Each traditional high school has a zone or area from which its students are drawn, and no student from one zone may attend a high school in any other zone. However, such is not the case with the technical high school. Residents of all zones are eligible to admission if they have graduated from the eighth grade, and actually they do come from all parts of the city and to a lesser extent, of course, from the surrounding country, also.

The question occurs: How do the pupils in the eighth grade learn about this school and what it has to offer? The answer is two-fold: The student body of the technical high school owns and operates a radio broadcasting station, located at the school, which broadcasts all basketball games played in the school gymnasium as well as all high school football games played in the city during the football season. Through this medium many prospective students have the existence of the school strongly impressed upon them. In addition to this, the school puts on each year, usually during the month of May, a three day (or rather three night) show, known as the "Tech Show." The show is advertised through items in the press and by posters, and all students are sent forth as salesmen to sell tickets. As a consequence, a large number of people attend the show during the three nights (about 14,000 in 1934). But the significant consideration is that amoung the spectators are the majority of the eighth grade boys of the city, inasmuch as the show is advertised to them in their respective schools, and they are all given free tickets of admission.

Here, then, is enough material to replace the entire student body, and usually more than 500 enter the school in the fall term and about 300 in the spring term. (The total student body usually numbers in the neighborhood of 2000) What is it about the show that influences students to enter this particular school? Why do some choose it while others choose the traditional high school instead? On the nights of the show all shops are in operation--the machinery is running, the foundry pours molten metal, the forges and trip hammer are in operation in the blacksmith shop, and in general the school equipment is being operated by students much as it is in the day time. In addition, much that is mysterious, or startling, or spectacular is displayed by students in the science and chemical laboratories and shops. Motion pictures are shown in the school auditorium, gymnasium exhibitions are given by students, and student club activities are exhibited. Student constructed projects such as the real aeroplane and the real house that were shown in 1934 are on display. It is not the intention here to intimate that the show is merely "bait" for prospective students--its primary purpose is to raise money for the student body,and most of the patrons are adults who have paid admission and naturally expect something out of the ordinary. In any event, the bulk of the eighth grade boys do see the show, and the results may be described somewhat as follows:

As they know that the school is a technical or mechanical school, most of those who have mechanical aptitude (and hence,interest) will tend to be drawn to the show. This is probably the first automatic selection, though no doubt many curiosity seekers, those who attend because it is free, etc., will be there. Then, as has been brought out earlier in this study, those who naturally possess mechanical aptitude take a keen interest in, and have much comprehension of, things mechanical. A first hand and thorough going experience with the wealth of mechanical and technical offerings that they find in the school influences most of those who are high in mechanical aptitude; they probably cannot resist the opportunity to make fuller contact with that which attracts them so much. Similarly, those who are wanting in mechanical interest (if they go to the show at all) are impressed with the feeling that it is not the place for them--it does not attract them and they feel that they have little or no capacity for it. This feeling apparently increases inversely with the possession of mechanical aptitude, for the per cent of elimination is found to be progressively greater in the lower mechanical aptitude ratings, culminating in a 92 per cent elimination in the "E" or lowest rating. Of course there would no doubt be exceptions in which other factors would motivate the choice. A questionnaire given to all entering freshmen in this school, asking them to state their reasons for choosing this particular school, brought forth a variety of answers; for example: "My parents wanted me to"; "My chum goes there"; "I want to learn a trade"; etc., but well over half the freshmen stated that they decided to enter on seeing the "Tech Show."

Table I shows that not all of those with more than usual mechanical aptitude entered this school; 12 per cent of those above the "C" rating evidently went elsewhere. While no data were obtained from which reasons might be positively formulated, it seems logical to assume that of those who possess both high mechanical aptitude and high intelligence a certain per cent would prefer to go into some other field for which they felt themselves equally well fitted.

The fact that part of the eighth grade graduates do not go on to high school would also act as an eliminating factor in both groups.

CHAPTER IV

RELATIONSHIP BETWEEN TEST SCORES AND SCHOOL ACHIEVEMENTS

According to Symonds in his Measurement in Secondary Education:

> Practically all cities to-day admit pupils to high school on the basis of having satisfactorily finished the work of the previous school, whether it be the sixth grade of the elementary school, the eighth grade of the elementary school, or the ninth grade in the junior high school. The elementary school decides whom it considers ripe to advance to the next unit in the system. But the high school does not concern itself particularly with the problem of admission. Children coming from other school systems usually are admitted to high school on the basis of credentials which they bring showing their previous school progress. This apparent carelessness in scrutinizing candidates for admission to high school is due to the present-day tendency to democratize secondary education. "The doors of the high school should be open to all" should be a present-day slogan, and in the face of such public sentiment high school authorities do not care to challenge those who wish to enter high school. This attitude has a foundation in benevolent intentions, but like so many democratic notions, it operates somewhat blindly. The facts are that a large percentage (20%) of those who enter high school drops out before the second year, and a large number of those who drop out do so because they do not have the capacity to do the work. These facts indicate that the present policy is too liberal and even though we may admit that the high school should be open to all who wish to enter, schools could do more than they are now doing to insure that the pupils who come to them shall be directed toward activities in which they will be successful. . . .The problem then boils down to "How well can school marks in high school at the end of the first year be predicted from data available at the beginning of the year?" 1

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1. Percival M. Symonds. Measurement in Secondary Education. The Macmillan Co., N. Y., 1927, pp.390-392.

Symonds' answer to his question may be summarized briefly somewhat as follows:

When all the individual's elementary grades were averaged and all his high school grades were averaged, a correlation of -.71 was found. If only first-year high school grades were used the correlation might be higher, or lower, inasmuch as, in general, as the time between testing is increased the correlation decreases, but, on the other hand, a factor tending to offset this is the fact that the reliability of an average increases as the number of grades entering into it increases.

The correlation of elementary school marks and high school marks varies in experiments to date from -.49 to -.789, but the former figure was obtained in a high school which drew from many elementary schools with many standards, whereas the latter was obtained in a private school where there was less variation in standards.

Tests of elementary school subjects correlate less with school marks than do elementary school marks, probably because something that corresponds to effort or industry or favorable attitude toward school work tends to be incorporated into school marks and these factors tend to be more or less permanent.

Intelligence tests were found to be better than separate tests of elementary school subjects as predictors of high school success ("r" ranging from .413 to .645), but are not so good as elementary school marks. Ratings of character and ability qualities have been found to give high correlations. Teachers' estimates of intellectual ability correlated with school marks from .70 to .80, and character qualities correlated slightly less (in the Horace Mann Private School). However, superior teachers and closer acquaintance between teacher and pupil made possible by smaller classes no doubt tended to make for better results.

It was found that the same factors which are used to predict general success in high school may be used to predict general success in special subjects that in general any one factor such as an intelligence test or mark in the elementary school correlates less well with a mark in a special subject than with the general average of subjects; that to predict success in a special subject one would use data that have something in common with the particular subject being predicted; that age correlates rather consistently with high school success around -.30. The best predictions of high school success were obtained from elementary school marks, the next best from teacher ratings, and the next best from teacher ratings, and the poorest from the tests.

To return to the data obtained in the mechanical aptitude tests which are a part of this study, scatter diagrams were plotted showing the relation between mechanical aptitude scores and teacher grades in the various school subjects, and are shown in Tables VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, and XVI. The abscissa in the diagrams are mechanical aptitude ratings, which, as was previously stated, are A, B, C+, C, C-, D, and E;"A" being the highest and "E" the lowest. These ratings are adjusted to chronological age; i.e., the score which would give a 12-year-old an "A" rating might only give the 16-year-old a "C" rating. The ordinates are teacher grades, E, G, F, and U; E corresponding with a numerical grade of 90 to 100; G, 80 to 90; F, 70 to 80; U, below 70. No adjustment is made for age here--the quality of work which earned an "E" grade for a 12-year-old would earn the same grade for a 16-year-old. It should also be noted that the mechanical aptitude ratings compare the student with the general population, which obviously has a lower average mechanical aptitude standing, whereas teacher grades,presumably at least, compare the students with each other.

TABLE VI

RELATION BETWEEN MECHANICAL APTITUDE RATINGS AND TEACHER GRADES IN SHOP WORK--TECHNICAL STUDENTS

	Mechanical Aptitude Ratings							
	E	D	C-	C	C+	B	A	f
Teacher Grades E				1	4	6	3	14
G		2	5	11	17	13	11	59
F	1	6	9	20	31	23	7	97
U		1	3	4	6	1		15
f	1	9	17	36	58	43	21	185
r								.26

CHAPTER VII

RELATION

BETWEEN MECHANICAL APTITUDE RATINGS AND TEACHER GRADES IN MECHANICAL DRAWING--TECHNICAL STUDENTS

Teacher Grades	Mechanical Aptitude Ratings							
	E	D	C-	C	C-	B	A	f
E			1	5	5	10	7	28
G		2	7	13	18	12	7	59
F	1	4	7	16	26	17	8	79
U		3	2	4	3	4		16
f	1	9	17	38	52	43	22	182
r								.23

TABLE VIII

RELATION BETWEEN MECHANICAL APTITUDE RATINGS

AND TEACHER GRADES IN SCIENCE--TECHNICAL STUDENTS

Teacher Grades	Mechanical Aptitude Ratings							
	E	D	C-	C	C-	B	A	f
-E			1	2	8	3	7	21
G		4	4	10	17	18	6	59
F	1	2	4	18	20	14	6	65
U		2	7	6	5	8	1	29
f	1	8	16	36	50	43	20	174
r								.23

TABLE IX

RELATION BETWEEN MECHANICAL APTITUDE RATINGS
AND TEACHER GRADES IN MATHEMATICS--TECHNICAL STUDENTS

Teacher Grades	Mechanical Aptitude Ratings							
	E	D	C-	C	C+	B	A	f
E		3	1	12	10	7	9	42
G	1	1	5	18	17	16	7	65
F		4	7	8	17	13	4	53
U			4	1	7	6	1	19
f	1	8	17	39	51	42	21	179
r								.055

TABLE X

RELATION BETWEEN MECHANICAL APTITUDE RATINGS AND TEACHER GRADES IN ENGLISH--TECHNICAL STUDENTS

	Mechanical Aptitude Ratings							
	E	D	C-	C	C+	B	A	f
E			1	2	4	3	3	13
G	1	2	1	11	8	8	9	40
F		2	6	12	29	18	5	72
U		5	5	14	11	13	3	53
f	1	9	13	39	52	42	20	176
r								.16

TABLE XI

RELATION BETWEEN MECHANICAL APTITUDE RATINGS AND TEACHER GRADES IN SHOP WORK--VOCATIONAL STUDENTS

Teacher Grades	Mechanical Aptitude Ratings							
	E	D	C-	C	C+	B	A	f
E		1		2		2	2	7
G	1	1	1	12	7	7	2	31
F		8	16	15	18	7	3	67
U	1	1	5	8	6			21
f	2	11	22	37	31	16	7	126
r								.26

TABLE XII

RELATION BETWEEN MECHANICAL APTITUDE RATINGS AND

TEACHER GRADES IN MECHANICAL DRAWING--VOCATIONAL STUDENTS

Mechanical Aptitude Ratings

	E	D	C-	C	C+	B	A	f
E				2		4	1	7
G		2	2	11	11	3	3	32
F	1	4	7	11	10	4	2	39
U	1	1	4	4	4		1	15
f	2	7	13	28	25	11	7	93
r								.30

TABLE XIII

RELATION BETWEEN MECHANICAL APTITUDE RATINGS AND TEACHER GRADES IN MATHEMATICS--VOCATIONAL STUDENTS

Mechanical Aptitude Ratings

Teacher Grades	E	D	C-	C	C+	B	A	f
E				3	3	3	2	11
G	2	4	4	7	1	2	4	24
F		2	5	7	11	2		27
U			3	10	5	2		20
f	2	6	12	27	20	9	6	82
r								.13

TABLE XIV

RELATION BETWEEN MECHANICAL APTITUDE RATINGS AND SHOP WORK--TECHNICAL AND VOCATIONAL STUDENTS COMBINED

		Mechanical Aptitudes Ratings							
		E	D	C-	C	C+	B	A	f
Teacher Grades	E		1		3	4	8	5	21
	C	1	3	6	23	24	20	13	90
	F	1	14	25	35	49	30	10	164
	U	1	2	8	12	12	1		36
	f	3	20	39	73	89	59	28	311
	r								.28

TABLE XV

RELATION BETWEEN MECHANICAL APTITUDE RATINGS AND TEACHER GRADES IN MECHANICAL DRAWING--VOCATIONAL AND TECHNICAL STUDENTS COMBINED

Teacher Grades	Mechanical Aptitude Ratings							
	E	D	C-	C	C+	B	A	f
E			1	7	5	14	8	35
G		4	9	24	29	15	10	91
F	2	8	14	27	36	21	10	118
U	1	4	6	8	7	4	1	31
f	3	16	30	66	77	54	29	275
r								.27

TABLE XVI

RELATION BETWEEN MECHANICAL APTITUDE RATINGS AND TEACHER GRADES IN MATHEMATICS--VOCATIONAL AND TECHNICAL STUDENTS COMBINED

Mechanical Aptitude Ratings

Teacher Grades	E	D	C-	C	C+	B	A	f
E		3	1	15	13	10	11	53
G	3	5	9	25	18	18	11	89
F		6	12	15	28	15	4	80
U			7	11	12	8	1	39
f	3	14	29	66	71	51	27	261
P								.116

Scatter diagrams for the technical students, who are more nearly representative of our definition of a technical high school student than are those taking the vocational course, are shown first. Table VI shows the correlation between all first-term technical students in mechanical aptitude ratings and teacher grades in their shop work. Note that the frequency column for teacher grades shows a fairly well balanced distribution, except for a tendency to concentrate in the "P" or 70 to 80 section. The mechanical aptitude rating distribution roughly follows that shown in Tables I, II, and III. The coefficient of correlation between the two, however, is not high, being only .26. The per cent making "E" or "G" teacher grades who are above and below "C" in mechanical aptitude, and the percent making "P" or "U" teacher grades who are above and below "C" in mechanical aptitude are indicated on this scatter diagram, as well as on the succeeding ones. Table VII, a correlation between all first term technical students in their mechanical aptitude ratings and their teacher grades in mechanical drawing, displays a mechanical aptitude rating frequency similar to that in Table VI. Teacher grades also bunch up somewhat in the "P" section, but the percentage of "E" grades is higher. The coefficient of correlation is slightly lower, being .23. Table VIII, showing technical students correlated between mechanical aptitude and teacher grades in science is fairly well balanced in teacher grade distribution, but "r" is low, being equal to .23. Table IX correlates technical students in the same fashion in their work in mathematics. A more liberal policy in teacher grade distribution is obvious in the frequency column for grades, but "r" is very low (.055), and the calculations for "E" and "G", "P" and "U" grade groups above "C" show the first and only minus correlation obtained on any diagram. Table X shows the relation between English grades and mechanical aptitude ratings. Here we have a heavy concentration in the "U" or failure section in teacher grades, and "r" is lower than for shop or drawing, but higher than for mathematics, being .16.

The next three tables (namely, Tables XI, XII, and XIII) show the relation between the grades of vocational students and their mechanical aptitude. Each of these is characterized by a higher value for "r" than was obtained in the corresponding technical group table, and by an inferiority not only in mechanical aptitude ratings but also in teacher grades. Table XI shows vocational students in their shop grade correlation with mechanical aptitude, "r" being equal to .26, which is slightly higher than for the technical shop group; Table XII shows a similar correlation in mechanical drawing, with "r" equal to .30--the highest correlation obtained thus far; Table XIII completes the vocational students correlations, mathematics being the school subject. "r" is equal to .13, which is low, but it is higher than the correlation for technical students in mathematics.

No diagrams are shown for vocational students in English or science, as they do not take either of these subjects during their first term. It should perhaps be stated, however, that the subjects they do take are identical with those given the technical students, and most classes are made up of a mixture of the two groups.

In regard to coefficients of correlation in this study, it should be stated that correction for broad categories only raises the highest "r" an amount equal to .04.

Table XIV combines tables VI and XI, forming a composite of technical and vocational shop correlations, with "r" equal to .28. Table XV combines tables VII and XII, showing combined correlations of vocational and technical students in mechanical drawing. In this instance, "r" is equal to .27. Table XVI combines tables IX and XIII, showing combined correlations of vocational and technical students in mathematics. Here "r" equals .16.

Table XVIII summarizes and shows clearly the points illustrated by the scatter diagrams. Examination of this table reveals that in shop, mechanical drawing,and science there is in every case a greater percentage of high than of low teacher grades among those high in mechanical aptitude, though not by a large margin, the range being from practically no difference between the two (as in technical students --mechanical drawing) to nearly half again as great a per cent in the high grade (as in the case of vocational students--mechanical drawing and shop). For English and mathematics the percentage of "E" and "G" students and the percentage of "F" and "U" students among those high in mechanical aptitude are about equal, and for mathematics there is, among the technical students, a larger percentage receiving "F" and "U" grades in the group rating above "C" in mechanical aptitude.

The tabulation further reveals that among those who were low in mechanical aptitude,in every case but one(namely, vocational students--mathematics), the percentage receiving low teacher grades was significantly greater than the percentage receiving high teacher grades. In the case of vocational students taking shop and mechanical drawing, the percentage low in both teacher grades and mechanical aptitude ratings ranged from almost two to three times as high as the percentage rating high in teacher grades and low in mechanical aptitude. Even in English (among technical students) and mathematics (among vocational students) the percentage was almost twice as great.

Symonds in his study on predicting high school success from data available before high school is entered (see review at the beginning of this chapter) found that the correlation between the average of the individual's elementary school teacher grades and his high school teacher grades is as high as .79; the correlation between teacher estimates of intellectual ability and high school grades is as high as .70; and the correlation between intelligence tests and high school success ranges from .41 to .54. According to the authors of the Detroit Mechanical Aptitude Test, used in this study, a correlation of .64 was found in a technical high school when shop teachers' ratings for mechanical aptitude were compared with test scores.

TABLE XVII

SUMMARY OF RESULTS DERIVED FROM TABLES VI TO XVI INCLUSIVE

Student Grouping	E or G Grades above C in Mechanical Apt. Ratings	F or U Grades Above C in Mechanical Apt. Ratings	E or G Grades below C in Mechanical Apt. Ratings	F or U Grades below C in Mechanical Apt. Ratings	Value of "r"
Technical Students					
Shop	74.0	61.0	9.6	17.8	+.26
Mech.Drawing	63.0	61.0	11.0	18.0	.23
Science	73.7	57.5	11.0	17.0	.23
Mathematics	61.7	66.7	10.0	20.4	.055
English	66.0	64.0	9.4	14.6	.16
Vocational Students					
Shop	52.6	38.6	15.0	45.6	.26
Mech.Drawing	56.0	39.0	10.0	33.0	.30
Mathematics	43.0	42.5	28.8	21.0	.13
Composite Technical and Vocational Students					
Shop	66.6	51.0	9.9	25.2	.28
Mech.Drawing	64.0	53.0	11.0	23.0	.27
Mathematics	57.0	57.0	14.8	21.0	.116

In the light of these findings one would expect to find a fairly high coefficient of correlation between mechanical aptitude ratings and school success, particularly in mechanical subjects, in this study. Investigation of the "Value of 'r'" column in Table XVII, however, shows that such is not the case. "r" ranges from .23 to a high of only .30 in shop, drawing, and science; and from .055 to .16 in English and mathematics. Symonds found also that the best predictions of high school success were obtained from elementary school marks, the next best from teacher ratings, and the poorest from tests. Assuming that the Detroit Mechanical Aptitude Tests measures the abilities that predict success in shop work in a manner parallel with intelligence tests in predicting intellectual success, one might expect that mechanical aptitude ratings would correlate with success in mechanical subjects from about .40 to .55. As the composite shop correlation is only .28, and the composite mechanical drawing correlation is only .27, the tests as predictive instruments fall considerably short of such a goal. It may be said that whereas the tests obviously measure the qualities which attract the students toward, they do not measure for success in the school to an appreciable degree, according to the values found for "r".

CHAPTER V

SUMMARY AND CONCLUSIONS

As was stated early in this study, two questions were to be answered: (1) Are students in a technical high school attracted toward the school on a basis of possession of mechanical aptitude? (2) Does the degree of mechanical aptitude possessed by the student form a basis of prediction of his success in such a school?

Question number I seems to have been answered very conclusively if we assume that the test used really measures mechanical aptitude. Tables Number I, II, III, and IV show a distinct selection on a basis of whatever the test measures, and all the scatter diagrams show a crowding or bunching in the higher mechanical aptitude ratings. As was calculated earlier in the study, the group of 275 to whom the tests were given was selected from a normal group of 442, and the elimination in the lower rating groups was as high as 92 per cent. Tables Number I, II, and IV show a greater ability for technical than for vocational students in mechanical aptitude, and the scatter diagrams show a consistent superiority of the technical students over the vocational students in all teacher grade distributions.

Question Number 2 is not so easily answered, nor can it be answered so clearly. The scatter diagrams, with mechanical aptitude ratings for abscissa and teacher grades for ordinates, show that the range for "r" is from .23 to .30 for shop, drawing, and science, and is appreciably lower for English and mathematics, being .055 to .16 for the last two subjects. To judge from these correlations the predictive value of the tests for succes in English or mathematics is negligible, and it is not very marked for shop, drawing, and science.

It would seem permissible, then, in the light of this study, to draw the following conclusions:

a. Students are attracted to a high degree toward the technical high school by virtue or possing mechanical aptitude.

b. Mechanical aptitude ratings correlate positively with school success, but not to a marked extent--especially in the case of those having high mechanical aptitude ratings.

c. The predictive value of the tests is greater for vocational students in predicting both success and failure.

d. Vocational students are inferior to technical students, both in mechanical aptitude and in school achievement.

e. The tests have a greater value in predicting failure among those with low ratings than in predicting success among those with high ratings.

f. While the test measures the qualities which influence students to decide to attend the technical high school, it does not measure for success in the school to a marked degree.

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APPENDIX

APPENDIX

			Mech.	Teacher Grades					
No.	Age	Test Score	Apt. Rating	Eng.	Math.	Science	Mech. Draw.	Shop	Shop
1	12	138	A	G	G	G	F	F	
2	13	167	A	G	E	G	E	G	
3	13	134	C+	G	E	G	E	G	
4	13	140	B	U	G	F	F	U	
5	13	174	A	F	F	G	E	G	
6	13	128	C+	U	G	F	F	F	
7	13	117	C	G	G	G	G	G	
8	13	128	C+	E	E	G	G	G	
9	13	145	B	F	G	F	F	F	
10	13	148	B	F	E	E	F	F	
11	13	167	A	G	E	G	F	F	
12	13	129	C+	G	G	G	G	F	
13	13	144	B	G	F	G	F	F	
14	13	123	C+	G	F	G	F	F	
15	13	162	A	G	E	G	G	F	
16	13	142	B	G	E	G	G	F	
17	13	186	A	E	E	E	G	G	
18	13	153	A	F	E	E	G	G	
19	14	104	C-	U	U	U	U	U	
20	14	147	B	U	U	U	F	F	
21	14	80	E	G	G	F	F	F	
22	14	157	B	U	U	U	F	F	
23	14	143	C+	G	G	G	F	F	
24	14	117	C	F	G	F	F	F	
25	14	133	C	U	E	U	F	F	
26	14	102	C-	U	U	U	F	U	
27	14	117	C	G	G	F	F	F	
28	14	157	B	E	E	G	G	G	
29	14	107	C-	F	G	U	G	F	
30	14	143	C+	F	G	G	F	F	
31	14	172	A	G	E	G	G		
32	14	149	B	E	E	E	G	G	
33	14	131	C	U	F	U	U	F	
34	14	137	C+	F	G	G	F	G	
35	14	135	C+	U	F	F	U	U	
36	14	152	B	F	G	G	G	G	
37	14	161	A	G	G	G	F	G	
38	14	116	C	F	G	F	G	F	
39	14	142	C+	F	F	F	F	F	
40	14	146	B	G	G	G	E	E	

No.	Test Age	Test Score	Mech. Apt. Rating	Teacher Grades Eng.	Math.	Science	Mech. Drw.	Shop	Shop
41	14	160	B	F	G	G	E	G	
42	14	138	C+	F	G	G	F	F	
43	14	144	C+	E	E	E	G	E	
44	14	175	A	E	E	E	E	E	
45	14	108	C-	E	E	E	G	G	
46	14	130	C	U	G	F	F	F	
47	14	135	C+	U	U	U	F	U	
48	14	145	C+	F	F	F	F	F	
49	14	131	C	G	E	F	G	F	
50	14	165	A	F	G	F	G	F	
51	14	142	C+	F	F	G	F	F	
52	14	157	B	F	F	F	F	G	
53	14	142	C+	F	G	G	F	F	
54	14	151	B	U	U	U	U	F	
55	14	143	C+	F	G	F	G	F	
56	14	98	D	G	E	G	G	G	
57	14	134	C+	F	F	F	F	G	
58	14	155	B	E	G	G	G	G	
59	14	191	A	U	G	F	F	F	
60	14	124	C	U	F	G	U	F	
61	14	157	B	F	F	F	F	F	
62	14	184	A	F	F	G	G	G	
63	14	114	C-	G	G	G	E	G	
64	14	135	C+	U	F	F	E	F	
65	14	135	C+	F	G	G	G	G	
66	14	160	B	F	F	U	U	F	
67	14	126	C	U	U	U	F	U	
68	14	151	B	G	G	F	F	F	
69	14	153	B	G	E	E	E	E	
70	14	134	C+	U	G	F	G	F	
71	14	146	B	U	U	U	E	F	
72	14	149	B	U	F	F	F	G	
73	14	116	C	E	E	E	G	G	
74	14	188	A		F	F	F	F	
75	14	149	B	G	G	F	G	F	
76	14	128	C	G	E	F	F	F	
77	14	174	B	F	G	U	G	F	
78	14	123	C	G	E	G	G	G	
79	14	132	C+	G	G	G	F	G	
80	14	132	C+	F	G	E	U	F	
81	14	151	B	F	G	F	F	G	
82	14	173	A	G	G	E	F	G	
83	14	107	C-	U	F	F	G	F	
84	14	150	B	U	F	G	G	F	
85	14	126	C	F	G	G	G	G	

No.	Age	Test Score	Mech. Apt. Rating	Eng.	Math.	Science	Mech. Draw.	Shop	Shop
				Teacher Grades					
86	14	138	C+	F	U	U	U	F	
87	14	151	B	U	F	G	U	F	
88	14	103	C-	U	F	U	G	U	
89	14	135	C+	F	E	E	F	G	
90	14	148	B	F	E	F	G	F	
91	14	187	A	G	G	E	E	G	
92	14	147	B	U	F	G	F	F	
93	14	125	C	U	G	G	U	F	
94	14	142	C+	E	E	G	E	G	
95	15	107	C-		U	U	U	U	
96	15	154	C+	F	U	G	G	F	
97	15	154	C+	U	F	G	F	F	
98	15	106	D	U	F	G	F	F	
99	15	117	C-	F	F	F	F	F	
100	15	135	C	F	G	G	F	F	
101	15	166	B	G	F	G	F	F	
102	15	110	C-	F	F	G	F	G	
103	15	141	C+	F	F	F	F	F	
104	15	134	C	F	G	F	F	U	
105	15	135	C	E	E	G	E	G	
106	15	146	C+	F	F	F	F	U	
107	15	152	C-	F	G	F	F	F	
108	15	105	D	F	E	G	F	F	
109	15	156	B	F	E	G	F	G	
110	15	162	C	F	G	F	E	F	
111	15	162	B	F	G	G	E	E	
112	15	134	C	U	F	F	F	F	
113	15	151	C+	G	E	E	G	G	
114	15	156	B	F	G	G	F	F	
115	15	187	A	U	G	F	F	G	
116	15	156	B	F	G	F	U	F	
117	15	136	C	G	E	F	E	G	
118	15	168	B	U	F	F	F	G	
119	15	145	C+	F		U		G	F
120	15	173	A	E	E	E	E	E	
121	15	139	C	F	G	F	E	G	
122	15	100	D	G	F	G	U	F	
123	15	129	C	G	E	F	G	E	
124	15	115	C-	F	G	G	F	F	
125	15	106	D	U	F	U	U	F	
126	15	153	C+	U	U	U	F	F	
127	15	154	C+	E	E	E	E	E	
128	15	113	C-	G	G	G	F	F	
129	15	123	C	F	G	F	F	F	
130	15	148	C+		F	U	F	U	
131	15	105	D	U	F	F	G	F	
132	15	143	C+	F	G	G	F	F	
133	15	143	C+	F	F	F	F	F	
134	15	176	A	G	E	E	E	E	
135	15	148	C+	F	E	E	G	F	

No.	Age	Test Score	Mech. Apt. Rating	Teacher Grades: Eng.	Math.	Science	Mech. Draw.	Shop	Shop
136	15	152	C	U	E	F	G	G	
137	15	123	C	U	F	F	U	F	
138	15	127	C	F	G	F	F	G	
139	15	136	C	F	G	U	G	F	
140	15	148	C+	G	G	F	G	G	
141	15	118	C-	F	F	U	F	F	
142	15	170	B	F	F	F	G	G	
143	15	133	C	F	F	U	F	F	
144	15	126	C	F	G	F	G	F	
145	15	126	C	G	E	G	G	E	
146	15	150	C+	U	F	F	F	U	
147	15	142	C+	U	U	F	F	G	
148	15	141	C+	F	F	F	G	F	
149	15	120	C-	U	G	F	F	F	
150	15	152	C+	F	G	G	F	G	
151	15	131	C		F	U	F	U	
152	15	147	C+	F	G	E	G	G	
153	16	131	C	G	E	G	G	G	
154	16	160	C+	G	E	E	E	G	
155	16	142	C	U	G	G	F	F	
156	16	154	C+	F	U	F	G	F	
157	16	124	C-	U	F	U	G	F	
158	16	107	D	F		F	F	F	
159	16	201	A	U	U	F	F	F	
160	16	189	A	F	F	U	G	G	
161	16	170	B	U	F	G	E	F	
162	16	146	C	G	E	G	E	G	
163	16	163	B	U	U	U	E	F	
164	16	170	B	F	G	F	F	G	
165	16	100	D	U	G	U	F	U	
166	16	169	B	F	U	U	G	F	
167	16	161	C+	U	U	F	G	U	
168	16	169	B	U	G	F	E	E	
169	17	178	B	G	F	G	E	E	
170	17	104	D	U	E	F	U	G	
171	17	156	C+	F	F	F	F	F	
172	17	141	C	F	G	F	G	G	
173	17	170	B	F		G	G	G	
174	17	131	C	U	F	E	F	G	
175	17	151	C+	F	F	F	G	F	
176	17	122	C-	F	F	F	G	F	
177	17	131	C	U	F	U	F	F	
178	17	143	C+	F	G	F	G	G	
179	17	126	C-	U	U		G	G	
180	18	166	B	G	G	G	E	E	
181	18	204	A			E	E		
182	18	148	C+	U	E	F	G	F	
183	19	157	C+		F		G	E	F

VOCATIONAL STUDENTS

No.	Age	Test Score	Mech. Apt. Rating	Eng.	Math.	Science	Mech. Draw.	Shop	Shop
				Teacher Grades					
1	14	162	A		G		U	E	
2	14	128	C		F		F	U	
3	14	139	C+		F		G	F	
4	14	137	C+		E		G	G	
5	14	139	C+		F		U	U	
6	14	137	C+		F		G	F	F
7	14	125	C		G		F	F	
8	14	120	C		E		F	G	G
9	14	101	C-		G		F	F	
10	14	121	C		U		F	F	
11	14	119	C-		G		F	F	
12	14	136	C+		E		G	G	
13	14	151	B		E		E	E	
14	14	162	A		G		G	E	
15	14	117	C	U	U		F	G	
16	14	152	B		E		G	G	G
17	14	115	C		F		G	U	
18	14	188	C		G		G	F	
19	14	173	A		E		G		
20	14	149	B		G		F	G	F
21	15	154	C+		F		F	F	
22	15	145	C+		G		G	F	G
23	15	125	C		G		F	G	F
24	15	105	D				F	F	
25	15	121	C-		F		F	F	F
26	15	136	C		U		G	F	F
27	15	152	B		E		F	F	
28	15	121	C-		F		U	U	U
29	15	144	C+				U	U	U
30	15	151	C		U		U	U	
31	15	138	C		E		E	F	F
32	15	129	C		E		G	G	F
33	15	175	A		G		F	F	F
34	15	103	D		G		U	F	F
35	15	218	A		E		G	G	
36	15	144	C+		F		U	U	
37	15	145	C+		F		F	F	
38	15	148	C+				G		
39	15	106	C-		F		F	G	F
40	15	121	C-		F		G	G	F
41	15	143	C+		U		G	F	
42	15	143	C+			U	G	F	G
43	15	151	C+		F		F	F	F
44	15	134	C		U		F	U	
45	15	143	C+		U		F	F	

No.	Age	Test Score	Mech. Apt. Rating	Teacher Grades Eng.	Math.	Science	Mech. Draw.	Shop	Shop
46	16	138	C		U		F	G	F
47	16	142	C+				F	F	
48	16	169	B		F		G	G	
49	16	157	C+		E		G	G	
50	16	146	C		F		F	G	
51	16	99	D		G		F	U	
52	16	118	C-	U			U	U	
53	16	91	E		G		F	G	
54	16	165	B		U		F	F	F
55	16	122	C-	F	G	F		U	
56	16	132	C		G		G	G	
57	16	161	C+				F	G	
58	16	116	C-		U		U	F	U
59	16	122	C-		F		F	F	F
60	16	116	C-		G		F	F	F
61	16	171	B		U		E	F	F
62	16	174	B	G			G	E	
63	16	140	C		U		F	F	
64	16	110	D		F		F	F	F
65	16	136	C		U		G	F	
66	16	164	B	F	F	F	F	G	
67	16	146	C		G		G	E	E
68	16	151	C+		U		F	F	F
69	16	161	C+		F		G	G	F
70	16	131	C		F		F	F	
71	16	162	C+		U		F	U	U
72	16	111	D		F		F	F	F
73	17	195	A			F	E	G	
74	17	181	A		G		F	G	
75	17	142	C		G		G	G	
76	17	159	C+		F		G	F	
77	17	134	C		F		G	F	
78	17	168	B			F	E	F	G
79	17	116	C-		U		F	F	F
80	17	176	B		G		E	G	
81	17	121	C-		U		U	F	
82	17	150	C+		F		U	F	
83	17	141	C				G	G	
84	17	121	C-		U		G	F	F
85	17	142	C		U		U	F	U
86	17	139	C		G		U	U	
87	17	111	D		G		G	E	
88	17	134	C		U		U	U	U
89	18	94	E		G		U	U	
90	18	102	D		G		G	F	G
91	18	141	C		F		E	G	
92	18	153	C+		F		F	F	