DOCUMENT RESUME

ED 024 813 VT 007 365

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Predictive Testing for Entrance in Vocational-Technical Schools; A Study of the Predictive Value of a Pre-selected Battery of Standardized Tests as a Tool for the Selection of Entering Students in Certain Trade Programs Offered in the Vocational-Technical Schools of the State of Connecticut.

New York Univ., N.Y. Center for Field Research and School Services.

Spons Agency- Connecticut State Board of Education, Hartford.; New York State Education Dept., Albany.

Pub Date Aug 68

Note- 85p.

EDRS Price MF-$0.50 HC-$4.35

Descriptors- Achievement Tests, *Admission (School), Electricians, Machine Tool Operators, Performance Tests, *Predictiv E Ability (Testing), *Predictive Measurement, *Standardized Tests, Testing Programs, Test Selection, Vocational Education, *Vocational Schools

Identifiers- Connecticut

This study was organized for the purpose of determining the validity of any part or parts of a pre-selected battery of standardized tests as predictors of success in secondary school trade programs. The study was limited to the trade areas of machine shop and electrical wiring in 14 state vocational schools in Connecticut. A battery of pre-selected standardized tests was administered to approximately 200 entering pupils in Bullard-Havens Technical School. The tests were also administered to about 200 grade 12 pupils who were completing programs in trade machine shop and trade electrical shop in six pilot schools. Achievement tests were developed and administered to these same 12th grade pupils. As a result of this pilot study, the original standardized test battery was reduced from 30 variables (sub-tests) to 15 variables, thus decreasing the testing time from the original 21 hours to 14 hours on the reduced battery. Subsequen t research indicated that a reduced number of selected variables would yield almost as high a correlation as the original number of variables. A related document is ED 019 437. (CH)

VT 2313

Predictive Testing for Entrance in Vocational-Technical Schools

A study of the predictive value of a pre-selected battery of standardized tests as a tool for the selection of entering students in certain trade programs offered in the vocational-technical schools of the State of Connecticut

August 1968

John G. Miller, Director
New York University Study Team

New York University
Center for Field Research and School Services

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This research reported herein was performed pursuant to a subcontract with the New York State Education Department and The Connecticut State Board of Education. Subcontractors undertaking such projects under state sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official State Department of Education position or policy.

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Center for Field Research and School Services
Office of Off-Campus Courses

July 19, 1968

Dr. Herbert Righthand, Chief
Bureau of Vocational Services
State Office Building
Hartford, Connecticut

Dear Dr. Righthand:

In fulfillment of an agreement dated December 1, 1966, between the Connecticut State Board of Education and the Center for Field Research and School Services, I am pleased to submit 1,000 copies of a report entitled, Predictive Testing as a Method of Selection of Entering Students for Trade Programs in Public Secondary and Vocational Schools. This represents the culmination of what was originally New York State contract No. C19724 titled "The Selection of Students for Entrance into Trade Programs in Public Secondary Vocational Schools."

The Connecticut State Department of Education and New York State Education Department deserve commendation for establishing a cooperative relationship which made it possible to complete this significant study of student aptitudes in the complex area of vocational and technical education. Undoubtedly, the study findings will prove useful to many educational agencies and communities throughout the United States. The professional staffs involved were most cooperative in providing data, offering counsel, and facilitating the study in general. The spirit of good will which prevailed during the study augurs well for an effective follow through on its implications.

Obviously, all recommendations in this report are not equally viable. Final decisions, moreover, are always the prerogative of constituted authority rather than of a consulting team, regardless of the latter's expertise. This report will serve its purpose best if it is studied and discussed by all who are concerned with vocational and technical education in Connecticut and elsewhere. To this end, the Study Director and his team are prepared to assist with the presentation and interpretation of the report.

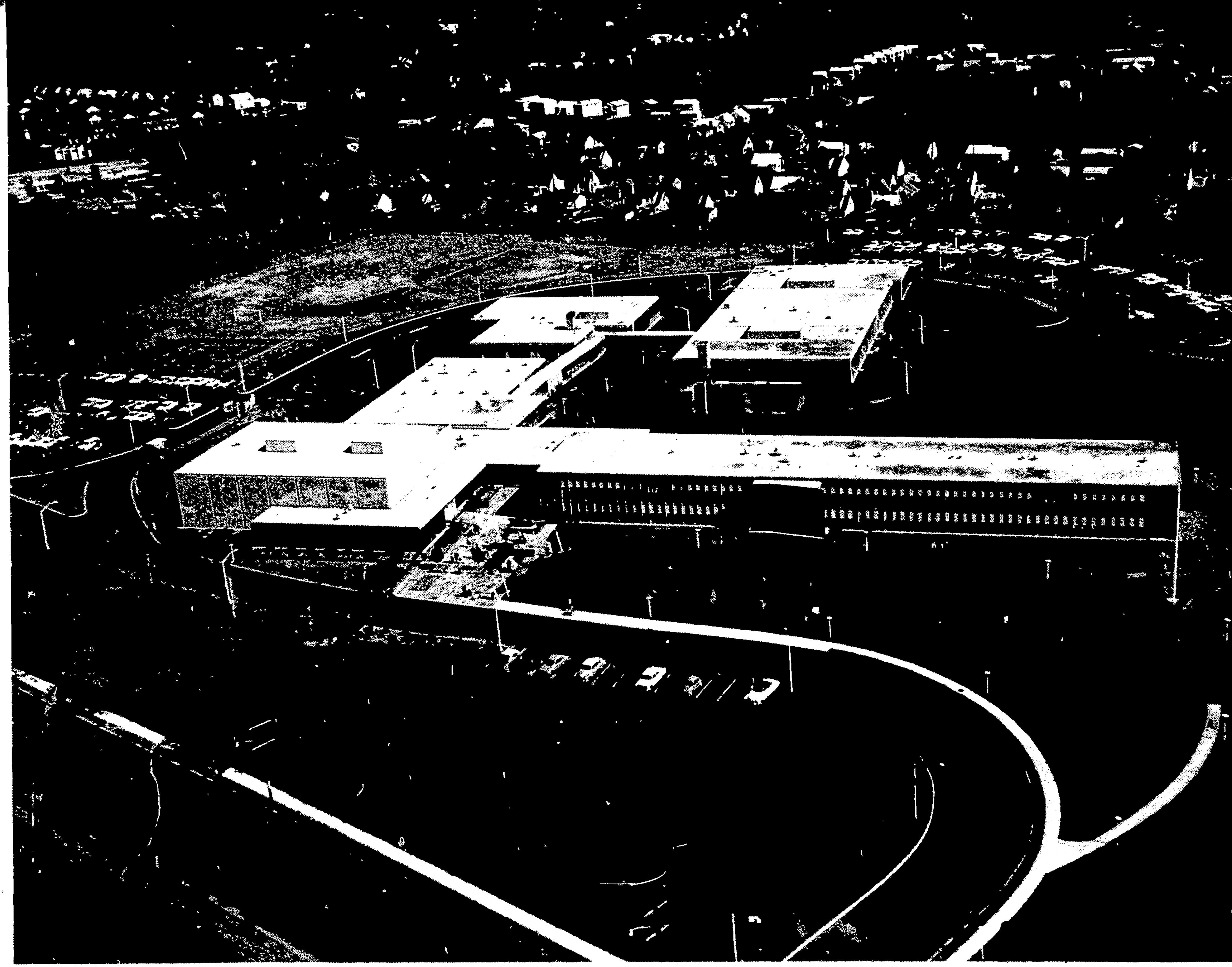
New York University and its Center for Field Research and School Services look forward to a continued association with the State of Connecticut in this important research endeavor.

Respectfully submitted,

Lou Kleinman

Lou Kleinman
Associate Dean

LK:md



ONE OF THE FOURTEEN REGIONAL VOCATIONAL/TECHNICAL SCHOOLS IN CONNECTICUT

SECTION I

BACKGROUND FOR STUDY

An important task in the administration of any program in vocational/technical education is that of pupil selection. The relative high cost of instruction in vocational/technical schools and the large investment of time and effort on the part of students and educators makes early identification and careful pupil selection an important key to the success of any terminal secondary program. Since teachers and administrators in all secondary school curriculum areas are contending for the pupil with high achievement potential and better-than-average intelligence scores, the pupils selected for vocational/technical curriculum areas are often those who are not able to meet the standards in secondary school programs designed to prepare students for college entrance. For this reason, those students with lower academic aptitudes often constitute the selection base for the skilled trade programs in secondary vocational schools. Because of the very nature of the trade curricula in a vocational/technical school, potential students often apply for entrance because of their lack of interest in books and abstract ideas and their early identification of the relevance of training in mechanical skills and the more practical aspects of numerical, verbal and scientific knowledge.

Many of the better secondary vocational/technical schools in this country rely on some form of predictive testing as an important part of their pupil selection procedure. Probably no two school systems use the same method of selection. Many schools rely upon some use of standardized achievement tests; intelligence tests; aptitude tests; occupational inventories; and attitude surveys. At the present time there has been little investigation concerning the predictive value of any battery of standardized tests for the selection of pupils in specific trade areas which are available to pupils making application for entrance into trade programs in secondary schools.

Vocational/Technical Education in Connecticut

The State program for vocational/technical education in Connecticut is organized in such a way that a study of this kind can be conducted with reasonable expectancy of success. The State Vocational Schools in Connecticut are all regional secondary schools operated by the State Department of Education. The principal objectives of these schools are the development of good citizenship, a reasonable degree of social competency, and the development of a marketable occupational skill. At the time the study began, there were fourteen vocational/technical schools located throughout the State, each having similar programs in the two curricula areas being covered by this study. Trade Electricity is taught in each of the schools. This curriculum includes fundamental training for an electrician. House wiring, repair and "trouble shooting" on motors, generators, wiring systems, switchboard installations, and the use of basic testing equipment for electronics constitute the three-year curriculum. Trade Machine Shop is also taught in all vocational/technical schools within the State. The machine shop curriculum offers instruction in the operation of basic machine shop equipment including the production machines commonly found in modern industry. In addition to the development of manipulative skills, the curriculum includes instruction in blueprint reading, sketching, related sciences and mathematics, in addition to general education courses. Each of the fourteen vocational/technical schools is a regional school serving the community in which it is located and also the surrounding communities. Many schools have specialty courses which are not offered in every vocational school, such as automobile body repair, aviation mechanics, baking, barbering, beauty culture, dental assistant, fashion design, food trades, occupational homemaking, industrial chemistry, industrial electronics, instrument making, practical nursing, painting and decorating, printing, plumbing and heating, screw machine operation, sheet metal, and tool and die making.

The major concern in determining the predictive value of a battery of tests is the individual pupil. It is the choice of his occupational career that is at stake. If the time he spends in the occupational program is not used to the best advantage because he lacks potential for entrance into the occupation for which he is training, his entire career may be jeopardized. A secondary concern is the consideration of the high cost of education. If selection techniques can be improved we should have fewer "drop-outs" and a higher percentage of placement among graduates in the occupation for which the training was designed. The fact that most vocational/technical programs are more expensive to operate than traditional academic programs makes the economic aspect of this study especially important.

The Study Defined

The original plans for this research project were first formulated in a meeting of staff members from the Bureau of Occupational Education Research of the State Education Department of the State of New York and the Department of Education, State of Connecticut. This meeting explored the development of a research proposal for Phase I which was then jointly sponsored by the State of Connecticut and the State of New York. Upon the completion of Phase I, the parameters of a second phase were defined and sponsored by the Connecticut State Board of Education.

Sponsoring Agency

Phase I of this study was financed by the Office of Education, Washington, D.C. through the New York State Education Department via the Bureau of

Occupational Education Research. Phase II has been financed jointly by the Office of Education and the Connecticut State Board of Education via the Bureau of Vocational Services of the State of Connecticut.

Objectives of the Study

The specific purpose of this study is to define more effective instruments in the form of a battery of predictive tests to be used for the selection of entering students in trade programs offered in the vocational/technical schools of the State of Connecticut. These predictive instruments will provide counselors with a more reliable tool for the identification of vocationally talented students who may be expected to prove successful in certain program areas common to vocational/technical schools. It was not the purpose of this study to establish cut-off scores after the predictive test battery has been identified.

The objectives of the study are further defined to include high school programs in Trade Machine Shop and Trade Electrical Shop. These two areas of the school program were selected because of their similarity of program and size in terms of pupil population for norming purposes. The fact that there is a high degree of similarity between programs in these two trade areas as they are taught in New York and Connecticut, strengthened the decision to start with the definition of predictive tools which would specifically apply to these trade areas.

If reasonable success is proven through the techniques used in studying predictive testing in these areas, a continuation of the study to cover other occupational areas will be investigated at a later date.

Organization of the Study

In order to effectively conduct the proposed research, the Director of the Study first organized a committee structure for implementing the various activities of the study team.

Executive Committee

An Executive Committee was the policy-making committee for the various aspects of the study. This Executive Committee nominated persons who served as members of the Advisory Committee and a Planning-Action Committee. It was the duty of the Executive Committee to resolve all questions regarding major problems encountered. Numerous meetings of the Executive Committee were held in Hartford during the period of the study. Periodic progress reports were submitted to the Chairman of the Executive Committee by the Director of the Study. The names of persons who served on the Executive Committee appear in the appendix (pg. A-1).

Advisory Committee

The Advisory Committee assisted the members of the N.Y.U. Study Team in the implementation of the study. This committee was oriented to the purposes and plans for conducting the study by a member of the Executive Committee during two of their regular monthly meetings. Members of this committee have been contacted individually for advice regarding test scheduling and for the collection of other necessary data. Serving on this committee were the directors of the fourteen vocational/technical schools throughout the State. A list of members appears in the appendix (pg. A-2).

Planning-Action Committee

The Planning-Action Committee included two teams of "Study Aids." One group was comprised of guidance counselors from each of the fourteen schools that participated in the study. A second group was composed of curriculum specialists in the areas of Trade Machine Shop and Trade Electrical Shop. Representatives from the Central Office of the State Department of Education served as members of this committee in an advisory capacity. The Planning-Action Committee worked directly with the N.Y.U. Study Team in the collection of data; the administration of the predictive battery of tests; the construction of the achievement instruments; and the scoring of the achievement instruments. In cases where members of the Planning-Action Committee were asked to perform services beyond their normal duties during the school day, they were reimbursed for their services by the Director of the Study. A list of members of this committee and the service area which they represent appears in the appendix (pg. A-2—A-4).

N.Y.U. Study Team

The N.Y.U. Study Team was composed of a Director of the Study and six consultants who had the major responsibility for conducting the study. Names of members of this team appear in the appendix (pg. A-1).

OUTLINE OF TESTING ACTIVITIES FOR PHASE I & II

Phase One

(March 30, 1966 through November 30, 1966)

Standardized Battery of Predictive Tests		Achievement Criteria in Machine & Electrical
	Spring 1966	
Administered tests to 12th grade machine & electrical students in six pilot schools.		Developed 12th grade achievement criteria (technical and performance).
Administered tests to all (Boys) in 9th grade at Bullard-Havens Technical School in Bridgeport: "Banked" the test results for future use.		Administered 12th grade achievement criteria to 12th grade machine & electrical students in six pilot schools.
	Fall 1966	
	Compared scores of 12th grade battery of predictive tests with scores of the same students on achievement criteria in the six pilot schools.	
	Defined a reduced battery of predictive tests as a result of analysis of correlation.	
Administered reduced battery of tests to all 9th grade boys in eleven schools and 10th grade boys in three schools. These scores were "Banked" for analysis with future achievement scores.		
	Final report on Phase I of the study published and delivered to contracting agencies.	

Phase Two

(December 1966 through August 1968)

Standardized Battery of Predictive Tests		Achievement Criteria in Machine & Electrical
	Spring 1967	
Administered reduced battery of tests to 12th grade machine & electrical in all fourteen schools.		Revised 12th grade achievement criteria (technical & performance). Administered revised achievement criteria to all 12th grade machine & electrical students in all fourteen schools.
	Fall 1967	
	Collected all permanent record data for students who were in 12th grade machine & electrical in spring 1967. Compared and analyzed scores of 12th grade reduced battery of predictive tests, permanent record data, and achievement criteria in all fourteen schools.	
	Spring 1968	
"Withdrew" scores of 9th grade boys at Bullard-Havens Tech which were "Banked" in spring 1966.		Developed 11th grade achievement criteria for machine & electrical.
"Withdrew" scores of 10th grade boys in three schools (Eli Whitney, H. H. Ellis, and J. M. Wright) which were "Banked" in fall 1966.		Administered 11th grade achievement criteria for machine & electrical to all fourteen schools.
	Compared scores of 11th grade achievement in machine & electrical with scores on battery of predictive tests which were taken in 1966 in four schools (Bullard-Havens, Eli Whitney, H. H. Ellis, and J. M. Wright).	

SECTION II

PHASE ONE OF THE STUDY

In order to conduct this research in predictive testing, over a prolonged period of time, various aspects of the total study were identified and classified into two distinct phases which cover a period of time beginning with March 1, 1966. Phase I of the study was completed November 30, 1966. Phase II began December 1, 1966 and has been completed with the delivery of this final report. Plans for a third phase of this research project are contingent upon the predictive value of the instruments selected and developed and also the availability of funding for further research in this field. The first phase of the study included a Pilot Study.

The Pilot Study

A pilot program of testing, both predictive and achievement, was a major part of the first phase of the study. This Pilot Study was conducted during the spring term 1966. The purpose of the Pilot Study was to try out testing procedures and to design and administer the achievement instrument in a limited number of schools.

The Executive Committee selected the pilot schools with several factors in mind. It was considered desirable to select schools with sufficient enrollments in twelfth grade Trade Machine Shop and twelfth grade Electrical Shop. A population of one hundred students for each subject was selected in order to provide a reasonable sample in each area. Schools were selected which had four-year programs consisting of pre-vocational shops in ninth grade and three-year trade classes. Because of the large ninth grade enrollment in Bullard-Havens Technical School in Bridgeport, this ninth grade group was used as the experimental group for the predictive tests in addition to the twelfth grade pupils in the trade areas covered by the study.

TABLE I

SCHOOLS USED FOR PILOT TESTING PROGRAM
AND APPROXIMATE ENROLLMENT

School Name	12th Grade Electricity	12th Grade Machine
Bullard-Havens Technical School	33	25
Warren F. Kaynor Technical School	17	26
Horace C. Wilcox Technical School	14	16
Windham Regional Technical School	16	16
Oliver Wolcott Technical School	16	18
J. M. Wright Technical School	13	15
Total	109	116

The total ninth grade enrollment for boys' trades in the Bullard-Havens Technical School was approximately two hundred.

12th Grade Achievement Criteria

During the spring of 1966, a consultant met with Planning-Action Committee members in two separate workshop groups. One group of five curriculum specialists worked on the development of the achievement instrument for twelfth grade Trade Machine Shop and the second group of five curriculum specialists worked on the development of the achievement instrument for twelfth grade Trade Electrical Shop. Each group met at least five times in a location convenient to the majority of the members. A representative from the Central Office of the Department of Education met with each group.

Each of the achievement instruments was developed in two basic parts: a section on "technical competence" and a second section involving the performance of a series of skills in the shop. The technical aspect of the achievement instrument was designed to be administered to a class during a single three-hour session. Students could make use of standard handbooks, code books or other reference materials in answering questions. The instruments involved both technical knowledge and computations. These instruments were comprehensive, covering the entire three-year course of study.

The following is a summary of the various parts of each of the achievement instruments:

Machine Shop

Part I (Theory)

Section A included technical questions basic to machine shop practice. Students were instructed to answer all the questions in this section. Questions were of the objective and also long-answer type involving computation and technical knowledge. A perfect score on Section A totaled thirty credits.

Section B provided a selection of questions. Essay, computation and short-answer type questions were used and the student was asked to choose questions which could give him a maximum total of twenty credits.

Part II (Practice)

This part of the instrument was a performance test making use of the shop equipment. It involved one job which included all of the basic operations on an engine lathe including an external and also an internal thread. This performance test also required some use of the drill press, the milling machine and the surface grinder. Ratings were made on a standard rating sheet based on:

Skill .... 20 credits
Time......................... 10 credits
Quality...................... 10 credits
Work habits................. 10 credits

The instructor's rating sheet suggested specific credit values of two, three and five credits for items listed under the above headings. A perfect score was indicated by a rating of fifty credits. Two instructors rated each performance job.

Trade Electricity

Part I (Theory)

Section A contained technical questions of the short-answer type. Students were instructed to answer all questions. Questions included both technical and computational information. A perfect score would total thirty credits.

Section B had a total of eight questions. The student was permitted to select four of the eight questions for a possible total score of twenty credits. This part of the test required more critical thinking both in technical content and also with respect to computation. A perfect score would be twenty credits.

Part II (Practice)

The performance test included three separate wiring jobs. Job #1 involved a pushbutton switch, a three-phase motor control and a motor using EMT conduit and flexible conduit. This job was rated with a score of fifty credits representing a perfect score. Job #2 included the wiring of a service entrance with an outside meter box and a sixty ampere main range and lighting panel distribution box. Fifty credits represented a perfect score. Job #3 was a wiring problem involving the control of two lights from three locations. Wiring was to be done using metal-clad cable and the installation was considered as "new work" type construction.

Each of the above jobs was rated as follows:

Skill .... 20 credits
Time...................... 10 credits
Quality.................... 10 credits
Work habits................ 10 credits

A rating sheet was provided for the instructors which subdivided the above rating areas into two, three and five units of credit. Two instructors rated each student.

The Predictive Test Battery

The first selection of the predictive test battery was made early in the original planning of the study before the N.Y.U. Study Team had been organized. The initial planners wished to bring together a comprehensive battery which would reflect: aptitude; general achievement; mental abilities; attitudes; and occupational interest. The following battery of commercial tests was considered to be most desirable for predictive purposes in the selection of students for vocational programs:

The Flanagan Aptitude Classification Test (FACT)

The Gordon Occupational Check List

The Stanford Achievement Test

The Primary Mental Abilities Test

The Gordon Survey of Interpersonal Values

The test forms and the answer sheets used were planned to provide for a minimum of administrative handling by the proctors in the schools where tests were given. Answer sheets were machine-scored for the three tests used. Pupil answers on the two check lists used were individually hand-scored at New York University.

The Stanford Achievement Test, Advanced Battery, (Partial)
Grades 7–9
(Harcourt, Brace and World, Inc.)

This test includes a test on paragraph meaning in which paragraphs are graduated in difficulty, a spelling test based on the 5000 words first used and a language test for the purpose of appraising language usage. The test also includes a test on arithmetic computations, a test on arithmetic concepts, including terms, values, relationships, and a test on arithmetic application as applied to life experiences. (Machine scored)

Primary Mental Abilities Test

Grades 9–12

(Science Research Associates)

This test investigated the five factors of intelligence most critical in schoolwork. These include verbal meaning, number facility, reasoning, perceptual speed and special relationships. (Machine scored)

The Flanagan Aptitude Classification Tests

(Science Research Associates)

These tests were developed to help schools identify students who are gifted in various vocational fields and to help students establish future educational and vocational plans. Scores are provided for nineteen job tasks and may be used to identify student aptitudes in thirty-seven occupational areas. (Machine scored)

The Gordon Occupational Check List

(Harcourt, Brace and World, Inc.)

This check list provided the student with a choice of characteristics of basic occupations which seemed to be desirable to him. It is fundamentally a preference form and administered under relaxed conditions.

After completion of the lists they were returned to New York University where they were individually scored.

The Survey of Interpersonal Values

(Science Research Associates)

This check list was designed to measure critical values involving the individual's relationships to other people or their relationships to him. These values are considered to be important in the individual's personal, social, marital, and occupational adjustment. The six values measured included:

Support — being treated with understanding, encouragement, kindness, and consideration.

Conformity — doing what is socially correct, following directions, doing what is acceptable and proper.

Recognition — being looked up to and admired, achieving recognition.

Independence — having the right to do whatever one wants to do in one's own way.

Benevolence — doing things for others, sharing, helping, being generous.

Leadership — being in charge of other people, having authority over others.

The form consists of thirty sets of three statements or triads calling for a choice of most and least important.

Completed forms were returned to New York University to be scored.

School Records

The records of pupils were used for the purpose of obtaining intelligence quotients, reading scores, arithmetic scores, aptitude scores (Differential Aptitude Tests), and school marks so that their value as predictive instruments might also be considered.

The scores obtained on other standardized tests administered by the schools were also tabulated for use in the comparative study of scores for predictive use in vocational guidance. The scores recorded were those obtained by schools as a result of intelligence, reading, arithmetic, and aptitude testing.

Teachers' marks in actual subject work were considered in the complete analysis of all data which may have predictive value.

Treatment of Data

Information from the six schools participating in the Pilot Study concerning the school subject marks or grades of twelfth grade pupils show that the majority of those pupils who had scored above the mean (58.79) on the achievement instrument, as a whole, were in the upper one-third of their trade group scholastically. This was also true in general for those pupils who scored above the mean on the technical competency (27.55) and above the mean (33.68) on the performance parts of the achievement instrument. It was interesting to note that although the intelligence quotient alone cannot generally be considered a predictor of success, those pupils who scored above the mean on each of the criteria, with few exceptions, had intelligence quotients of above 100 with the majority of these pupils having intelligence quotients of 110 to 120.

The use of the Survey of Interpersonal Values indicated a consistency on the part of a majority of those pupils tested, according to the Survey, in their desire to be treated with understanding, kindness, and consideration. This value is termed "support" in the Survey. They also indicated a desire to be independent of others and to be free to make their own decisions. The use of the form indicates that pupils in Trade Electrical Shop desire to conform, to be looked up to, and to be admired in addition to their desire for support and independence. Although there seemed to be little difference between the values held by successful pupils (above the mean on the achievement instrument) and unsuccessful pupils it seemed obvious that most pupils interested in the two vocational areas tested have a tendency to possess the values indicated. Responses on the Gordon Occupational Check List showed more interest in technical areas than in the other occupational areas included in this instrument. It is reasonable, however, to expect this response by pupils who had completed three years of vocational training.

The scores obtained by pupils in the sub-tests of the Primary Mental Abilities Test, the Stanford Achievement Test, and the Flanagan Aptitude Classification Test were correlated, using Pearson Product-Moment Coefficient of Correlation, with pupil performance as reflected by three criteria measures. These criteria consisted of the scores obtained by the individual pupils tested on the technical competence and the practical achievement tests developed for use in this study and the total combined scores on these two parts of the achievement instrument.

Data obtained by each of the six schools were first tabulated by schools and intercorrelations were computed between all sub-tests of the three standardized test forms. Separate tabulations by schools, however, were not used in the over-all interpretation of test results because an inspection of these results seemed to lack consistency between schools. This lack of consistency can probably be attributed to the small number of subjects in each sample and the tendency for a small number of scores in either direction in a sample of limited size to distort means, standard deviations, and correlations. The sub-test scores obtained as a result of testing both ninth and twelfth grade pupils in the six schools were then combined and analyzed to discover possible correlations of sub-tests with each other.

Finally the sub-test scores of twelfth grade pupils were correlated with each other and then with the three criteria measures. These final correlations were first computed for all pupils tested including those pupils who had missed either a part of the entire battery or a part of the achievement instrument. These correlations, however, seemed to have value only in establishing the relationship of each of the sub-tests with other sub-tests and in providing information which may be of value in the counseling of individual pupils. Correlations were then computed on data obtained from test results of only those twelfth grade pupils in electrical and machine shop courses who had completed all parts of the test battery and both parts of the performance and achievement tests. Preliminary findings as stated in this report have been based on the analysis of scores obtained by those 114 pupils who completed all tests. The means and standard deviations for this combined group are shown in Table II (page 19).

The statistical analysis of the scores obtained on the thirty sub-tests making up the three test forms showed little correlation (Pearson Product-Moment Coefficient of Correlation) between success in practical achievement (criterian measure II) on the performance part of the achievement instrument and scores on the various sub-tests. Correlations at the .05 level of significance were indicated only for certain sub-tests in relation to the technical competence part of the achievement instrument. When the scores obtained on the thirty variables by the electrical group alone (N = 42) and the machine group alone (N = 72) were compared with scores obtained on the three criteria (achievement instrument) it was found that there was little difference in the items which showed significant correlations for each separate group and those items which showed significant correlations for the combined groups. Further investigation will be necessary to determine the relative predictive values of each of the items or sub-tests.

Attempts were made to determine whether the predictive value of the various sub-tests would be increased by using multiple correlations. Because correlations between sub-tests were of a similar or larger magnitude than the correlations between sub-tests and the criteria measures, multiple correlations did not meaningfully increase.

TABLE II

MEANS AND STANDARD DEVIATIONS
(Phase One)
(Primary Mental Abilities, Stanford Achievement Test,
Flanagan Aptitude Classification Test)
COMBINED GROUP N = 114[a]

Variable	Test	Sub-Test (Title Abbreviated)	Mean	Standard Deviation
1	P.M.A.	Verbal Meaning	65.263	32.114
2		Number Facility	77.991	30.656
3		Reasoning	65.368	31.799
4		Perceptual Speed	77.614	27.537
5		Spacial Relations	76.763	29.921
6	Stanford	Paragraph	10.415	1.557
7		Spelling	9.245	1.912
8		Usage	8.774	1.628
9		Computations	10.281	2.071
10		Concepts	10.293	2.045
11		Applications	10.430	1.940
12	F.A.C.T.	Inspection	53.456	25.991
13		Mechanical	73.518	22.452
14		Tables	48.254	25.769
15		Reasoning	54.746	24.644
16		Vocabulary	46.368	22.436
17		Assembly	56.447	27.590
18		Judgment	52.465	25.697
19		Components	53.377	26.735
20		Planning	42.368	26.763
21		Arithmetic	56.640	28.344
22		Ingenuity	51.825	25.475
23		Scales	52.605	29.970
24		Expression	42.298	21.173
25		Precision	66.421	28.523
26		Alertness	25.921	7.215
27		Coordination	31.912	15.179
28		Patterns	15.711	9.549
29		Coding	97.833	27.750
30		Memory	15.316	12.416
31		(Criterion I Theory)	27.553	9.900
32		(Criterion II Practice)	33.675	10.883
33		(Criterion III Total)	58.789	21.080

[a]Variables 1–30: Predictor measures;
Variables 31–33: Criterior measures.

Intercorrelations of the thirty variables or sub-tests with the two parts of the achievement instrument and the combination of these scores to form a third criterion are shown in Table III (page 21).

The Reduced Test Battery

An examination of the results of the scores on the standardized tests as compared with the achievement scores indicates that each test has some degree of predictive value in examining potential for competence in the two trade areas covered by the study. Of the nineteen sub-tests included in the Flanagan test, only four showed correlations which seemed to be meaningful in terms of predictive value for the groups tested. A decision was made to use each of the original tests in the predictive testing program during the Fall of 1966. However, only the four sub-tests of the Flanagan test which showed significant correlations with the criterion measures were administered on a state-wide basis. The elimination of fifteen of the variables or sub-tests reduced the entire testing time required from twenty-one hours to less than fourteen hours.

During the fall testing (1966), it was suggested that the interest survey forms might be administered separately and not as a part of the test battery. In schools where this was done, the formal "testing time" was reduced; administration of the test battery was easier; and the interest survey forms were filled out under less tension than they would have been under testing conditions.

Testing Entering Pupils

In the fall of 1966, the two interest forms and the reduced battery of tests were administered to entering ninth grade boys in eleven State Vocational/Technical Schools. Three of the schools, where entering students are admitted to the tenth grade, administered the test battery to all tenth grade boys. Data obtained as a result of this

TABLE III

INTERCORRELATION MATRIX OF THIRTY VARIABLES WITH THREE CRITERION MEASURES

COMBINED GROUP N = 114

Variable (Sub-Test)	Criterion I (Technical Competence)	Criterion II (Performance)	Criterion III (Total Achievement)
1	.065	.035	–.063
2	.149	.059	.003
3	.124	.071	.001
4	–.001	.032	–.087
5	.207*	.148	.083
6	.231**	.003	.101
7	.214*	–.148	–.020
8	.150	–.103	–.022
9	.286***	.055	.114
10	.377***	.090	.169
11	.312***	.121	.148
12	.105	.036	.038
13	.239**	.108	.127
14	.070	–.054	–.015
15	.342***	.112	.167
16	.093	–.096	–.079
17	.193*	.088	.130
18	.260***	–.005	.080
19	.183	–.013	.058
20	.031	.009	.003
21	.130	–.004	–.041
22	.129	–.112	–.043
23	.238**	.017	.063
24	.120	–.189	–.128
25	–.101	.081	–.044
26	–.059	.021	–.054
27	–.073	.083	.017
28	.007	–.016	–.061
29	–.060	.041	–.051
30	.069	–.170	–.211

Levels of Significance:

* P < .05

** P < .02

*** P < .01

comprehensive testing of entering students will be used for analysis in a future phase of the study.

Summary

Phase One of this research study began with the organization of a Study Team of professional consultants and the design of a committee structure for conducting the study. A major part of the first phase of the study was the Pilot Study involving six vocational/technical schools. A battery of preselected standardized tests was administered to about two hundred entering pupils and also to about two hundred twelfth grade pupils who were completing programs in Trade Machine Shop and Trade Electrical Shop. Achievement tests were constructed and administered to these same twelfth grade pupils. Scores of these twelfth grade pupils on the standardized battery were compared with the scores of the same pupils on the achievement tests. Some sub-tests of the original standardized battery showed little or no correlation when compared with achievement scores. A reouced battery of standardized tests was administered to all entering male pupils in the fourteen regional vocational/technical schools during the fall of 1966. Scores on these tests will be used in making comparisons and future refinements of the predictive test battery to be used in a future phase of the study.

SECTION III

PHASE TWO OF THE STUDY

The second phase of this predictive-testing research study began immediately upon the completion of Phase One in November, 1966. The period covered by this phase of the study includes one and one-half school years in which time additional information was gathered for the purpose of further refinement of the original battery of standardized tests. In addition, an instrument for measuring achievement of eleventh grade students in the areas of trade machine shop and electrical wiring was developed.

The Reduced Test Battery

In the spring term (1966-67), the reduced battery of predictive tests was administered to all twelfth grade machine and electrical students in each of the fourteen participating schools. This battery of standardized tests included: four of the original nineteen sub-tests of the Flanagan Aptitude Classification Tests (F.A.C.T.); the Gordon Occupational Check List; the Sanford Achievement Test; the Primary Mental Abilities Test; and the Gordon Survey of Interpersonal Values.

Revision of the Achievement Criteria

During the spring of 1967, members of the N.Y.U. Study Team revised the twelfth grade achievement tests for machine and electrical shops. The written (theory) tests were revised to include more objectivity in the test questions and scoring procedures. The machine shop practical (performance) test was unchanged with the exception of a revised scoring procedure which reflected more objectivity.

The original twelfth grade electrical performance test included three separate electrical jobs which were wired by students in wiring booths located in the electrical shops. Figure 1 (pg. 24) shows a student performing one of these jobs during the

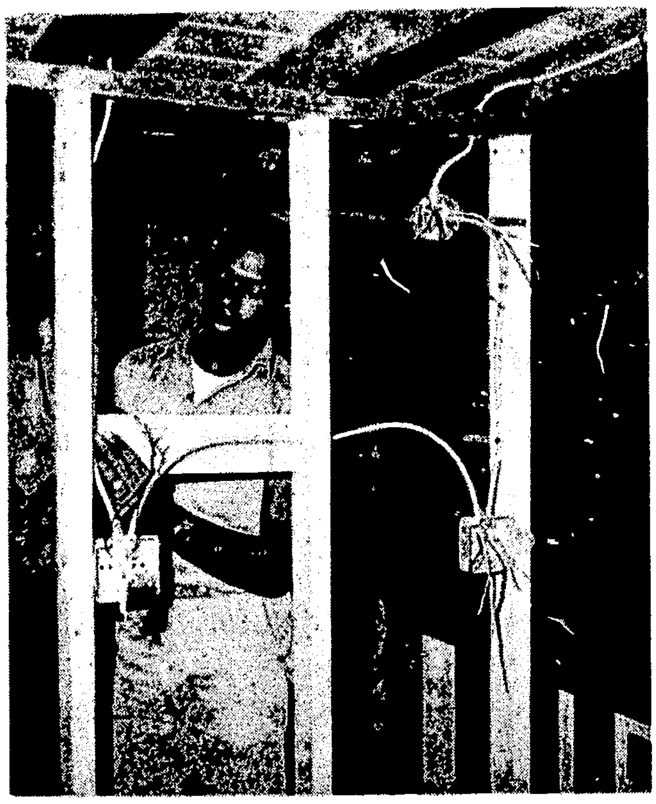


Fig. 1. Original Electrical Performance Test Administered in a Wiring Booth

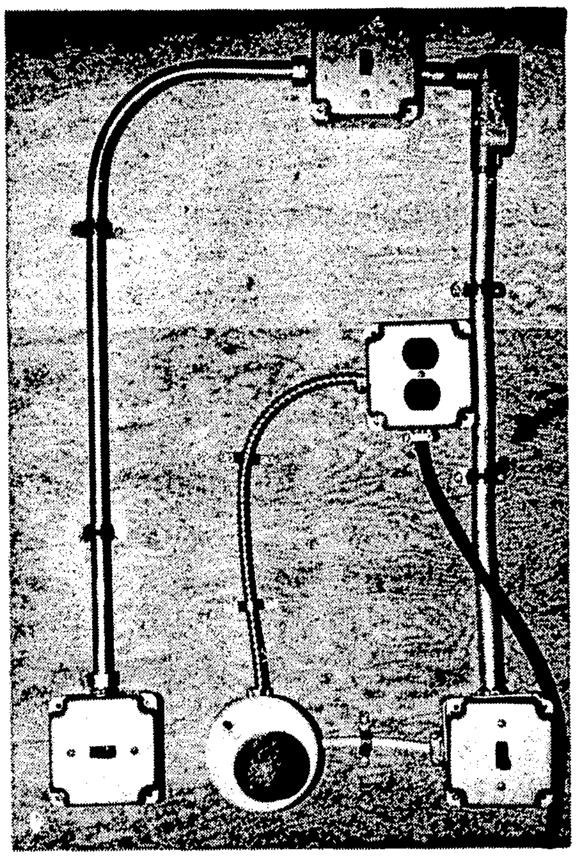


Fig. 2. Revised Electrical Performance Board

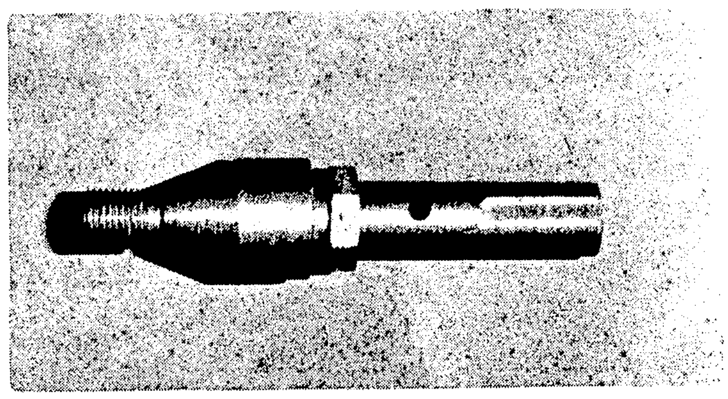


Fig. 3. Eleventh Grade Machine Shop Performance Test

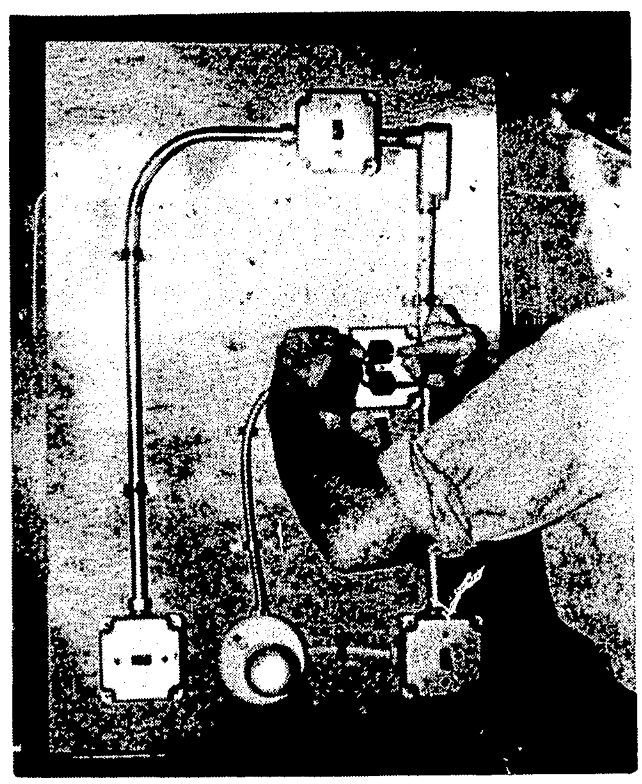


Fig. 5. A Step in Scoring Electrical Performance Test

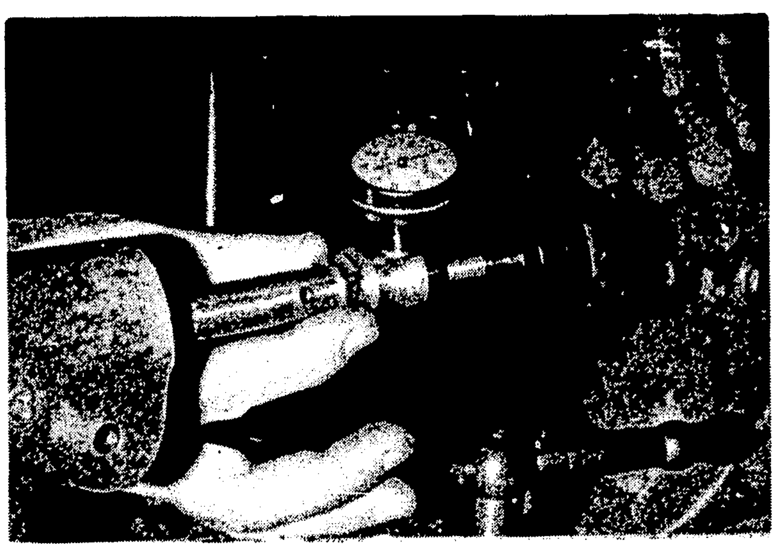


Fig. 4. A Step in Scoring Machine Shop Performance Test

Pilot Study (spring 1966). These jobs were scored by local teachers and dismantled immediately in order for other students to take the test. This testing procedure led to an element of subjectivity in scoring. There was also considerable variation in physical testing conditions in each of the pilot schools. A resulting discrepancy in the performance scores could affect the dependability of the data.

The revised twelfth-grade electrical performance test was developed by a group of consultants in order to correct the condition described above. This revised test made use of a test board measuring 1/2" x 2' x 4'. The wiring job included a combination of circuits with four-way and three-way switches controlling a lamp and a duplex grounding outlet (Fig. 2, p. 24). This job made use of a variety of electrical wiring supplies such as: flexible cable; armored cable; non-metallic-sheathed cable; thin-wall conduit; and rigid conduit. The advantage of this wiring test was the fact that it could be left intact thus permitting scoring of all tests by one electrical wiring specialist.

Uniformity of testing materials was accomplished by making a detailed supply list available to each school. Authorization was made to purchase supplies locally. The average cost of approximately $15.00 per student was financed with study funds.

Administering the Revised 12th Grade Criteria

Members of the N.Y.U. Study Team met with the machine shop and electrical teachers in two separate groups for the purpose of test orientation during the month of April, 1967. An orientation meeting was also conducted with counselors. A testing period was scheduled during the last two weeks in May and tests were delivered to each school by a member of the team.

At the end of the testing period (late in May), local teachers scored all tests (written and practical) using guidelines and keys which were supplied with the testing materials.

During the first week in June, all tests were collected by a representative from N.Y.U. This necessitated several trips with a pick-up truck due to the bulk in the electrical performance boards. Care had to be taken in handling the electrical performance boards in order to preserve the test boards in the same condition they were left by students participating. During the summer (1967) all tests were scored independently by specialists at N.Y.U. One person scored all machine performance tests, a second person scored all electrical performance jobs, and a third person scored written test papers. In some cases there was a noticeable discrepancy between original teachers' scores and scores by N.Y.U. specialists. Only scores from the second scoring were used in the data reported.

Scores of students on the fifteen sub-tests of the reduced standardized battery and the two parts of the achievement test (theory and practice) were tabulated and entered on IBM punch cards for computer treatment.

Collection of Student Records and Analysis

During the fall term (1967-68), school records of students who were registered in twelfth grade machine and electrical shop classes the previous spring (1967) were collected by school counselors. The data were analyzed by a member of the study team. An analysis of comparisons of school records with scores on predictive and achievement tests for this group is presented in Section V of this report.

Analysis of Twelfth Grade Scores

During the fall term (1967-68), a statistical analysis of twelfth grade predictive scores and twelfth grade achievement scores was made by the N.Y.U. Study Team. A report of this analysis is found in Section IV of this report.

Eleventh Grade Achievement Criteria

In order to sample the potential predictive value of the reduced battery of standardized tests, achievement instruments were developed for use with eleventh grade machine and electrical classes during the spring term (1967-68). At this point, comparisons could be made with certain student's scores on the predictive tests given in the spring (1965-66) and fall (1966-67). All ninth grade boys at Bullard-Havens Tech participated in the pilot testing program in the spring of 1966; all of the tenth grade boys at Ellis Tech, Whitney Tech, and Wright Tech were tested in the fall of 1966. A total of 85 of these students were completing the eleventh grade in machine and electrical classes in the spring of 1968.

Two series of workshops were conducted by study team members for the purpose of constructing eleventh grade achievement tests. A consultant from N.Y.U. conducted a series of workshops for the purpose of developing the electrical achievement test at Horace C. Wilcox Tech in Meriden. Six members of the Planning-Action Committee representing the electrical curriculum participated. A second workshop was conducted for the purpose of developing the eleventh grade machine shop achievement test at Albert I. Prince Tech in Hartford. Seven members of the Planning-Action Committee representing the machine shop curriculum participated in this three-session workshop.

Achievement tests were constructed to include material which was covered in the eleventh grade state curriculum for each subject area. Written (theory) and performance (practice) tests were developed in each subject (see appendix). Scoring keys were also developed. Figures 2 and 3 (page 24) show the eleventh grade electrical and machine practical tests.

Early in May, 1968, orientation meetings were held with all teachers of machine and electrical shops to review the eleventh grade testing procedures. An orientation meeting was also held with the counselors who were responsible for the supervision of the testing program. All schools administered the achievement tests within a two-week period in May. Tests were scored by teachers on location and then collected by a representative of N.Y.U. Eleventh grade achievement tests were scored a second time by subject specialists at N.Y.U. and these scores were tabulated for written (theory); practical (performance); and combined (total). Figures 4 and 5 illustrate a stage in the scoring procedure for each of the eleventh grade performance tests.

Predictive scores from the first phase of this study which were "banked" were "withdrawn" for statistical treatment. A report of the analysis of this data is shown in Section V of this report.

SECTION IV

COMPARISON AND ANALYSIS OF PREDICTIVE SCORES WITH ACHIEVEMENT SCORES

(Twelfth Grade)

The data analyzed in this section was collected during the predictive testing of twelfth grade students of Machine Shop and Electrical Wiring in two separate groups during Phase II of the Study (school year 1966-67). These criteria in the Machine group and the Electricity group were compared with the scores on the fifteen sub-tests of the predictive criteria. Criteria I represents the Theory (written) achievement test; Criteria II represents the Practical (performance) achievement test; and Criteria III represents the Total (combined) scores of Criteria I and II.

Analyses of the data were performed separately for the Electricity and Machine groups. The analyses consisted of computations of means, standard deviations, Pearson Product Moment Coefficients of Correlations, and Multiple Correlations. While the mean is the average score of the group, the standard deviation describes how members of the group vary around the mean. Thus the smaller the standard deviation the more homogeneous the group. The Pearson Product Moment Coefficient of Correlation describes the degree of relationship between two variables. When the relationship is perfect, that is when knowledge of an individual's score on one variable enables perfect prediction of his score on the other variable, the Pearson is 1.00. The upper limit of Pearson is, therefore, 1.00. When two variables are not related at all, the Pearson is .00. Multiple correlation describes the degree of relationship between a number of predictor variables and the criterion variable. The interpretation of multiple correlation is essentially the same as the Pearson. Its upper limit is also 1.00. However, since more than one variable is used in predicting the criterion, the computation of multiple correlation also yields the relative contribution of each of the predictor variables. For example, one can determine a rank order of the potency of the predictor variables in predicting the criterion when these variables are combined.

Means and Standard Deviations

The means and standard deviations of the Electricity and Machine groups on all the predictor variables and the three criterion measures are reported in Table IV. It is interesting to note that the means of the Machine group on four of the five sub-tests of the Primary Mental Abilities (i.e., Verbal Meaning, Number Facility, Reasoning, and Perceptual Speed) are higher than the means of the Electricity group. Furthermore, the standard deviations of the Machine group on these four sub-tests are smaller than the standard deviations of the Electricity group indicating that the Machine group shows greater ability and is more homogeneous than the Electricity group. In the rest of the tests there is no marked difference between the groups. One cannot study the differences on the criterion measures since they are different for both groups.

Correlations Between the Predictor and Criterion Variables

The Pearson Product Moment Coefficients of Correlation between the fifteen predictor measures and the three criterion variables for the Electricity group and the Machine group are reported in Table V. One should note that all the correlations are low, that is, none of the predictors taken singly will enable one to make satisfactory predictions of the criterion variables. Nevertheless, in the Electricity group there are several variables that correlate significantly with the criterion measures. Seven predictor measures correlate significantly with Criterion I (Theory). These are: P.M.A.–Number Facility and Spatial Relations; Stanford–Usage, Computations, Concepts, Applications; and F.A.C.T.–Judgment. Three predictor measures correlate significantly with Criterion II

TABLE IV

MEANS AND STANDARD DEVIATIONS

(Twelfth Grade)

Primary Mental Abilities, Stanford Achievement Test, Flanagan Classification Test, Criterion I (Theory), Criterion II (Practice), Criterion III (Total)

			GROUP			
			Electricity		Machine	
Variable	Test	Sub-Test (Title Abbreviated)	Mean[a]	Standard Deviation	Mean	Standard Deviation
1	P.M.A.	Verbal Meaning	96.77	24.21	100.30	14.15
2		Number Facility	105.44	27.24	107.59	14.80
3		Reasoning	99.74	23.40	102.24	14.02
4		Perceptual Speed	104.26	24.52	109.21	17.66
5		Spatial Relations	105.46	16.03	105.38	13.69
6	Stanford	Paragraph	9.87	2.13	9.31	2.13
7		Spelling	8.75	2.22	8.27	2.31
8		Usage	8.34	1.85	8.21	1.96
9		Computations	10.06	2.47	9.77	2.21
10		Concepts	10.14	2.70	9.82	2.20
11		Applications	10.30	2.33	10.10	2.04
12	F.A.C.T.	Inspection	71.95	20.64	71.81	20.70
13		Reasoning	9.87	5.10	9.17	4.61
14		Judgment	15.33	3.57	15.01	4.52
15		Scales	16.52	21.29	17.96	25.19
16		Criterion I (Theory)	19.69	7.25	29.63	7.08
17		Criterion II (Practice)	37.84	7.32	17.57	10.17
18		Criterion III (Total)	57.43	11.66	47.92	12.15

[a]Since some subjects did not have scores on all the measures, the statistics in this table were computed with different numbers of subjects as follows: Electricity group — Variables 1—16, N = 109; Variables 17—18, N = 107. Machine group — Variables 1—16, N = 109; Variables 17—18, N = 84.

TABLE V

CORRELATIONS BETWEEN FIFTEEN PREDICTOR MEASURES AND THREE CRITERION MEASURES
(Twelfth Grade)

Variable (Sub-test)	Electricity[a] Criterion I (Theory)	Electricity[a] Criterion II (Practice)	Electricity[a] Criterion III (Total)	Machine Criterion I (Theory)	Machine Criterion II (Practice)	Machine Criterion III (Total)
1	09	–05	03	15	—09	–04
2	19*	04	14	19*	11	18
3	15	09	16	13	—06	–01
4	18	13	20*	00	—03	–09
5	20*	26**	31***	10	—02	–02
6	17	03	13	12	–02	–01
7	14	–17	–01	02	01	–04
8	20*	–07	09	10	–04	–03
9	22*	07	18	08	01	00
10	19*	06	15	22*	08	15
11	28**	23**	32***	18	12	18
12	05	09	11	02	—37*	–37**
13	03	11	08	–01	–11	–14
14	19*	21*	25**	16	13	18
15	13	08	15	—14	—16	–26*

[a]Since some subjects did not have scores on all measures, the correlations were computed with different number of subjects as follows: Electricity group – Criterion I, N = 110; Criterion II, and III, N = 107. Machine group – Criterion I, N = 109; Criterion II, and III, N = 84. Decimal points omitted.

*$p < .05$.

**$p < .02$.

***$p < .01$.

(Practice). These are: P.M.A.—Spatial Relations; Stanford—Applications; and F.A.C.T.—Judgment. The four measures that correlate significantly with Criterion III (Total) are: P.M.A.—Perceptual Speed, Spatial Relations; Stanford—Applications and F.A.C.T.—Judgment.

In the Machine group the correlations between the predictor measures and the criterion variables are even lower. In other words, there are even fewer variables that can be used to predict the criterion measures. Two variables correlate significantly with Criterion I (Theory). These are: P.M.A.—Number Facility, and Stanford—Concepts. Only the sub-test inspection from the F.A.C.T. battery correlates significantly with Criterion II (Practice). The two variables that correlate significantly with Criterion III (Total) are: F.A.C.T.—Inspection and Scales. Since the significant correlations with Criterion I and Criterion II are negative, it means that subjects who perform well on these sub-tests will tend to perform poorly on the criterion variables.

In summary, it is to be noted that all the correlations are rather low and only a few of the sub-tests reach significance levels.

Multiple Correlations—Electricity Group

Multiple correlations were computed to determine what combination of predictor measures will yield the highest correlation with each of the criterion measures. Nine variables correlate .40 with Criterion I (Theory) (significant at the .05 level). These variables, in order of importance are: Stanford—Applications; P.M.A.—Perceptual Speed; F.A.C.T.—Judgment and Reasoning; Stanford—Computations; P.M.A.—Verbal and Number; Stanford—Spelling; and F.A.C.T.—Scales. Students who do well on these tests will tend to do well on Criterion I (Theory). The rest of the variables add practically nothing to the prediction.

The multiple correlations between nine predictor measures and Criterion II (Practice) is .55 (significant at the .01 level). These are, in order of importance: P.M.A.—Spatial Relations; Stanford—Spelling; P.M.A.—Verbal Meaning; Stanford—Applications, Concepts, Computations, and Usage; and F.A.C.T.—Judgment and Reasoning. Students who perform well on these tests will tend to perform well on Criterion II (Practice).

The multiple correlations between eight predictor measures and Criterion III (Total) is .49 (significant at the .01 level). In order of importance, the variables are: Stanford—Applications; P.M.A.—Spatial Relations and Verbal Meaning; Stanford—Spelling; F.A.C.T.—Judgment; P.M.A.—Perceptual Speed; and P.M.A.—Reasoning.

Multiple Correlations—Machine Group

Six variables correlate .37 (significant at the .05 level) with Criterion I (Theory). The variables, in order of importance, are: Stanford—Concepts; F.A.C.T.—Scales; Stanford—Computations; P.M.A.—Number Facility; F.A.C.T.—Judgment; and P.M.A.—Perceptual Speed. Students who perform well on these tests will tend to perform well on Criterion I (Theory).

Six variables correlate .44 (significant at .01 level) with Criterion II (Practice). In order of importance, they are: F.A.C.T.—Inspection; Stanford—Usage; P.M.A.—Number Facility; F.A.C.T.—Judgment and Reasoning; and Stanford—Spelling.

Eight variables correlate .54 (significant at the .01 level) with Criterion III (Total). The variables, in order of importance, are: F.A.C.T.—Inspection, Judgment and Scales; P.M.A.—Number Facility; Stanford—Usage, Concepts, and Computations; and F.A.C.T.—Reasoning.

Summary

In attempting to predict any of the three criterion measures for either group, one can reduce considerably the number of predictor measures used. In fact, taking the first two or three measures listed under each multiple correlation above will yield almost as high a correlation as the one indicated by the total number of variables. One should, however, bear in mind that multiple correlations are very sensitive when using a small number of subjects, as is the case in the present investigation, and should therefore proceed with caution. In view of the small number of subjects, it is not unlikely that correlations with another sample will be quite different from the ones indicated in this sample reported.

Freshmen—Combined Group From All Schools

For the combined group of freshmen (N = 1552) who took the fifteen predictor measures only, the following analyses were performed: (1) Means and standard deviations of all variables, (2) factor analyses of all the variables.

The means and standard deviations of the fifteen predictor variables are reported in Table VI.

Factor Analysis

This method of analysis attempts to get at factors underlying the measures. It determines how the measures cluster together. These clusters are the factors. From the factors that emerge, one may be in a better position to note basic patterns of the tests.

Three factors emerged from the analysis. Except for two sub-tests of F.A.C.T.—Inspection and Reasoning, all sub-tests loaded significantly on the first factor. This means that thirteen sub-tests measure in common a general ability. On

TABLE VI

MEANS AND STANDARD DEVIATIONS

(Freshmen)

(Primary Mental Abilities, Stanford Achievement Test, Flanagan Classification Test)

FRESHMEN, N = 1552

Variable	Test	Sub-Test (Title Abbreviated)	Mean	Standard Deviation
1	P.M.A.	Verbal Meaning	96.86	15.83
2		Number Facility	102.67	16.25
3		Reasoning	100.48	15.96
4		Perceptual Speed	101.74	18.36
5		Spatial Relations	99.36	17.46
6	Stanford	Paragraph	8.45	6.69
7		Spelling	7.50	2.39
8		Usage	7.17	1.99
9		Computations	7.74	2.29
10		Concepts	8.40	2.32
11		Applications	8.25	2.26
12	F.A.C.T.	Inspection	73.03	39.54
13		Reasoning	7.35	5.45
14		Judgment	11.81	5.61
15		Scales	10.54	25.94

the second factor, only the five sub-tests of the Primary Mental Abilities loaded significantly. This means that in addition to what the Primary Mental Abilities Test shares with the other tests, it measures something which is different from what the others measure. The only sub-tests that loaded significantly on the third factor are those of the Flanagan Test. This, again, indicates that over and above the general ability that is tapped by the Flanagan Test in conjunction with the other measures it taps an ability unique to it.

In summary, it should be noted that, although the three batteries tap a general ability, the Primary Mental Abilities Test and the Flanagan Test each measure in addition some specific ability.

SECTION V

COMPARISON AND ANALYSIS OF PREDICTIVE SCORES WITH SCHOOL GRADES AND ACHIEVEMENT SCORES

(Eleventh Grade)

The information contained in this section is based upon scores of a group of ninth grade students who were tested with thirty sub-tests during the Pilot Study (Spring, 1966) and a group of tenth grade students from three schools who were tested with the reduced battery of fifteen sub-tests in the fall of 1966. This was the first opportunity in this study to compare achievement scores with predictive scores with an extended period of time intervening.

The analyses are presented in two parts: (1) analyses of school grades and criterion measures, and (2) analyses of test batteries and criterion measures.

When reading the present analyses one should bear in mind that the number of students is small, at times very small. One should therefore exercise extreme caution in the interpretations and conclusions drawn from the data.

School Grades and Criterion Measures

The purpose of this analysis is to determine the relationship between seven school subjects and each of the criterion measures.

Means and Standard Deviations

The means and standard deviations of the Electricity and Machine groups on the seven school subjects and criterion measures are reported in Table VII.

Correlations Between School Subjects and Criterion Measures

The Pearson Product Moment Coefficients of Correlations between the seven school subjects and the three criterion measures for the Electricity group and the Machine group are reported in Table VIII.

TABLE VII

MEANS AND STANDARD DEVIATIONS
(School Subjects)

Variable	Electricity Mean[a]	Electricity Standard Deviation	Machine Mean	Machine Standard Deviation
1 Shop	71.48	6.24	71.93	7.93
2 Theory	65.18	7.07	71.83	6.58
3 Blue Print	75.59	5.26	70.04	16.50
4 Math	69.00	10.64	69.22	6.20
5 Science	69.96	8.01	64.96	5.77
6 English	71.56	7.66	70.61	6.06
7 Social Studies	71.74	6.81	67.48	7.05
8 Criterion I (Theory)	29.33	6.88	28.76	6.79
9 Criterion II (Practice)	25.46	9.32	23.41	10.24
10 Criterion III (Total)	53.46	16.65	51.00	16.98

[a]Number of subjects in Electricity group — 27.
Number of subjects in Machine group — 23.

TABLE VIII

CORRELATIONS BETWEEN SEVEN SCHOOL SUBJECTS AND THREE CRITERION MEASURES

Variable	Electricity[a] Criterion I (Theory)	Electricity[a] Criterion II (Practice)	Electricity[a] Criterion III (Total)	Machine Criterion I (Theory)	Machine Criterion II (Practice)	Machine Criterion III (Total)
1 Shop	53****	37*	41**	19	54****	49***
2 Theory	57****	65****	62****	38*	61****	58****
3 Blue Print	36*	18	19	11	23	00
4 Math	24	59****	49****	19	10	16
5 Science	05	16	11	51***	–05	20
6 English	–09	16	17	24	–32	–27
7 Social Studies	09	12	12	25	09	26

[a]Number of subjects in Electricity group — 27.
Number of subjects in machine group — 23.
Decimal points omitted.
*p < .05.
**p < .025.
***p < .01.
****p < .005.

Bearing in mind the caution that has been urged in interpretations due to the small number of subjects, one may note that some of the correlations are relatively high and highly significant. From Table VIII it is clearly indicated that the subjects Shop and Theory are good predictors of the criterion measure for both Electricity and Machine groups, whereas Math and, to some extent, Blue Print are effective predictors for the Electricity group. Science is significantly related to Criterion I (Theory) in the Machine group only. The relations between all other subjects and the criterion measures are low and not significant. Due to the small number of subjects one may not perform a multiple correlation analysis in order to see how the school subjects relate to the criterion measures when taken in combinations. On the basis of the present evidence it would be advisable to collect similar data from a large number of subjects in order to be able to perform multiple correlation analyses.

Test Batteries and Criterion Measures

Fifteen Sub-tests and Three Criterion Measures

In Table IX are reported the means and standard deviations of fifteen sub-tests (5 from Primary Mental Abilities; 6 from Stanford; 4 from Flanagan) and the three criterion measures for the Electricity and Machine groups.

Correlations Between the Predictor and Criterion Variables

The Pearson Product Moment Coefficients of Correlations between the fifteen predictor measures and the three criterion variables for the Electricity group and the Machine group are reported in Table X. One should note that the predictors are generally more effective for the Electricity group. Furthermore, the Primary Mental Abilities sub-tests and some of the Stanford sub-tests are the most effective in the Electricity group. With the exception of one sub-test, and only in relation to

TABLE IX

MEANS AND STANDARD DEVIATIONS
(Fifteen Sub-Tests — Eleventh Grade)

			Group			
			Electricity		Machine	
Variable	Test	Sub-Test (Title Abbreviated)	Mean[a]	Standard Deviation	Mean	Standard Deviation
1	P.M.A.	Verbal Meaning	77.09	32.37	78.23	37.11
2		Number Facility	86.51	30.11	93.54	30.32
3		Reasoning	80.23	37.45	90.11	27.17
4		Perceptual Speed	82.21	32.54	89.40	31.45
5		Spatial Relations	80.05	34.70	84.80	35.02
6	Stanford	Paragraph	8.59	2.26	9.09	1.95
7		Spelling	8.42	2.68	8.89	2.22
8		Usage	7.48	2.09	7.99	1.78
9		Computations	8.79	1.95	9.12	1.90
10		Concepts	9.10	2.09	9.30	2.15
11		Applications	9.08	1.88	8.46	2.77
12	F.A.C.T.	Inspection	70.93	28.77	72.11	27.11
13		Reasoning	21.02	22.99	19.54	24.32
14		Judgment	26.12	20.02	22.71	19.03
15		Scales	25.93	20.56	29.11	26.87
16		Criterion I (Theory)	27.72	7.03	29.36	7.46
17		Criterion II (Practice)	24.11	8.39	25.47	10.16
18		Criterion III (Total)	50.99	15.03	53.94	16.86

[a]Electricity Group N = 43;
Machine Group N = 35.

Criterion I (Theory), the Flanagan sub-tests are the least effective. More specifically: seven sub-tests correlate at various levels of significance with Criterion I (Theory). These are: P.M.A.—Verbal Meaning, Number Facility, Reasoning, Perceptual Speed, Spatial Relations; Stanford—Concepts; Flanagan—Judgment. Nine predictor variables correlate significantly with Criterion II (Practice). These are: P.M.A.—Verbal Meaning, Number

TABLE X

CORRELATIONS BETWEEN FIFTEEN PREDICTOR MEASURES AND THREE CRITERION MEASURES

(Eleventh Grade)

	Group					
	Electricity[a]			Machine		
Variable (Sub-test)	Criterion I (Theory)	Criterion II (Practice)	Criterion III (Total)	Criterion I (Theory)	Criterion II (Practice)	Criterion III (Total)
1	32**	29*	25	24	–10	02
2	29*	39****	33**	26	–10	03
3	28*	36***	29*	28*	–07	08
4	49****	42****	43****	15	–04	–01
5	40****	42****	37***	24	–08	03
6	12	25	15	52****	–13	07
7	16	26	24	19	–21	–11
8	21	32**	26	29*	–21	–13
9	24	33**	32**	31*	–24	–07
10	30**	42****	36***	38**	–10	05
11	21	58****	49****	26	–06	03
12	07	23	15	18	23	23
13	–25	–08	–12	23	36**	32*
14	–37***	–08	–19	32*	29*	31*
15	–03	11	07	43****	31*	37**

[a]Electricity Group N = 43; Machine Group N = 35. Decimal points omitted.

*P ‹ .05;

**P ‹ .025;

***P ‹ .01;

****P ‹ .005.

Measures are the same as those identified in Table IX.

Facility, Reasoning, Perceptual Speed, Spatial Relations; Stanford—Usage, Computations, Concepts, Applications. Seven predictor variables correlate significantly with Criterion III (Total). These are: P.M.A.—Number Facility, Reasoning, Perceptual Speed, Spatial Relation; Stanford—Computations, Concepts, Applications.

As noted above, the predictors are much less effective for the Machine group. However, unlike the Electricity group, the Flanagan sub-tests seem to be more consistently effective than the others for the Machine group. Seven predictors are significantly correlated with Criterion I (Theory). These are: P.M.A.—Reasoning; Stanford—Paragraph, Usage, Computations, Concepts; Flanagan—Judgment, Scales. Three predictors are correlated significantly with Criterion II (Practice). These are: Flanagan—Reasoning, Judgment, Scales. Three predictors correlate significantly with Criterion III (Total). These are: Flanagan—Reasoning, Judgment, Scales.

In summary it may be noted that the P.M.A. and Stanford sub-tests may be most useful, in varying degrees, for the Electricity groups. On the other hand, the subtests of Reasoning, Judgment, and Scales from the Flanagan sub-tests seem to be the most useful for the Machine group.

The small number of subjects precludes the possibility of studying the relations between combinations of predictors and the criterion measures via multiple correlations.

Thirty Sub-Tests and Three Criterion Measures

Thirty sub-tests from the P.M.A., Stanford and Flanagan were used in predicting the three criterion measures. In the present analysis the number of subjects is even smaller than in the previous ones. The results are presented even though they mean little because of the small number of subjects.

In Table XI are reported the means and standard deviations of the thirty predictors and the three criterion measures for the Electricity and the Machine groups.

Correlations Between the Predictor and Criterion Variables

The correlations between the thirty predictors and the three criterion measures are reported in Table XII for the Electricity and Machine groups. Due to the very small number of subjects it is indeed difficult to make any generalizations. The significant correlations are indicated in the table. Generally speaking, the predictors seem to be least effective in relation to Criterion I (Theory) for the Electricity group. But again one must bear in mind the size of the groups. An addition of several subjects may change the correlations drastically.

TABLE XI

MEANS AND STANDARD DEVIATIONS

(Thirty Sub-Tests – Eleventh Grade)

			Group			
			Electricity		Machine	
Variable	Test		Mean[a]	Standard Deviation	Mean	Standard Deviation
1	P.M.A.	Verbal Meaning	39.75	19.51	40.25	28.36
2		Number Facility	54.56	24.03	63.17	29.25
3		Reasoning	38.38	27.55	60.75	26.30
4		Perceptual Speed	45.62	21.61	56.08	28.09
5		Spatial Relations	41.12	24.02	53.00	29.93
6	Stanford	Paragraph	7.88	2.13	8.40	2.15
7		Spelling	6.76	1.88	8.59	1.91
8		Usage	6.81	1.77	7.30	1.77
9		Computations	7.98	1.61	8.47	1.78
10		Concepts	8.21	2.09	8.68	2.09
11		Applications	8.06	1.93	8.61	2.19
12	F.A.C.T.	Inspection	62.56	21.51	61.75	25.40
13		Mechanical	64.06	22.94	62.92	24.28
14		Tables	60.94	29.79	63.92	27.87
15		Reasoning	43.44	24.73	43.75	28.59
16		Vocabulary	53.69	24.90	43.17	24.16
17		Assembly	53.62	30.64	63.83	24.50
18		Judgment	45.00	22.08	39.42	24.43
19		Components	54.25	35.25	62.00	32.06
20		Planning	60.50	27.02	57.25	27.81
21		Arithmetic	60.06	36.15	53.50	35.10
22		Ingenuity	46.12	23.08	44.33	29.29
23		Scales	41.25	24.51	53.58	30.73
24		Expression	19.94	18.28	29.75	23.29
25		Precision	70.38	23.78	72.83	17.65
26		Alertness	24.56	4.50	23.83	3.69
27		Coordination	35.38	8.73	36.75	6.43
28		Patterns	11.94	7.47	16.83	7.44
29		Coding	102.31	17.23	99.08	19.33
30		Memory	13.94	6.89	14.92	7.10
31		Criterion I (Theory)	25.00	6.39	30.17	8.43
32		Criterion II (Practice)	21.84	5.81	29.42	8.76
33		Criterion III (Total)	46.84	10.57	59.58	15.10

[a]Electricity Group N = 16;

Machine Group N = 12.

TABLE XII

CORRELATIONS BETWEEN FIFTEEN PREDICTOR MEASURES AND THREE CRITERION MEASURES

(Eleventh Grade)

	Group					
	Electricity[a]			Machine		
Variable (Sub-test)	Criterion I (Theory)	Criterion II (Practice)	Criterion III (Total)	Criterion I (Theory)	Criterion II (Practice)	Criterion III (Total)
1	35	54**	51**	77****	51*	73****
2	–04	40	20	76****	47	70***
3	–01	52**	28	82****	37	67***
4	40	45*	49*	54*	58**	64**
5	22	58***	45*	79****	54*	76***
6	–23	49*	13	60**	48	62**
7	47*	80****	72****	49	28	44
8	–12	48*	19	67***	49	66**
9	–07	61***	38	46	46	52*
10	–07	52**	24	59**	47	60*
11	–14	41	15	84****	52*	77****
12	–08	–08	00	05	–14	–06
13	36	62****	56**	37	39	43
14	11	44*	31	84****	31	65**
15	–11	13	01	29	52*	47
16	26	25	30	26	49	43
17	–02	19	09	52*	75****	73****
18	–41	27	–09	31	39	40
19	10	41	29	73****	51*	71****
20	–33	40	02	39	07	26
21	17	–01	10	–23	–11	–19
22	01	33	19	74****	50*	71****
23	11	30	23	61**	38	56*
24	–01	41	22	67***	60**	72****
25	25	01	16	22	13	20
26	27	05	19	17	16	18
27	–13	–06	–12	13	39	30
28	54**	48*	59***	75****	65**	80****
29	–08	05	–02	12	–12	00
30	–01	42	22	11	–16	–03

[a]Electricity Group N = 16; Machine Group N = 12. Decimal points omitted.

*$p < .05$;
**$p < .025$;
***$p < .01$;
****$p < .005$.

Measures are the same as those identified in Table XI.

SECTION VI

SUMMARY AND RECOMMENDATIONS

This research has been conducted in two distinct phases over a period of two years and six months. Phase I (March 1966 through December 1966) was the result of a joint effort of the New York State Education Department and the Connecticut State Board of Education. Phase II (December 1966 through August 1968) was sponsored by the Connecticut State Board of Education. Both phases of the study were funded in part through the United States Office of Education.

The study was organized for the purpose of determining the validity of any part or parts of a pre-selected battery of standardized tests as predictors of success in secondary-school trade programs. The study was limited to the trade areas of machine shop and electrical wiring in the fourteen State vocational schools in Connecticut.

Phase One

A battery of pre-selected standardized tests was administered to approximately two hundred entering pupils in Bullard-Havens Technical School. The tests were also administered to about two hundred twelfth grade pupils who were completing programs in Trade Machine Shop and Trade Electrical Shop in six pilot schools. Achievement tests were developed and administered to these same twelfth grade pupils.

As a result of this pilot study, the original standardized test battery was reduced from thirty variables (sub-tests) to fifteen variables thus decreasing the testing time from the original 21 hours to 14 hours on the reduced battery.

This reduced battery was administered to all male pupils entering each of the fourteen State vocational schools in the fall of 1966. Among these schools, eleven had entering classes at grade nine and three schools had entering classes at the tenth-grade level. The results of this testing program were "banked" for future use in this research.

Phase Two

The reduced battery of standardized tests was administered to twelfth grade machine and electrical students in each of the fourteen State schools during the spring of 1967. The twelfth grade achievement criteria were revised and administered to all twelfth grade machine and electrical students.

An analysis was made by comparing scores of twelfth grade predictive variables (fifteen) and achievement scores on theory, practice, and total (combined theory and practice). The analysis indicated that a reduced number of selected variables would yield almost as high a correlation as the total number of variables. Caution was taken in arriving at a definitive conclusion at this point because of two factors: (1) Comparisons made with twelfth grade scores concurrently on predictive and achievement tests do not provide sufficient time for achievement development; (2) The sample was small. It is not unlikely that correlations with another sample could produce quite different results.

During the spring of 1968, the achievement criteria were again refined and administered to all eleventh-grade machine and electrical pupils in the fourteen State vocational schools. Among these eleventh grade pupils was a sample group from three schools which had been tested when they were in the tenth grade in the fall of 1966. Although this sample was too small to produce statistically significant data, an analysis was made of this sample since it was the first opportunity to make comparisons of predictive scores with achievement scores with a two year period of achievement development between testing periods.

Recommendations

It has been recognized that definitive conclusions regarding the predictive value of the pre-selected test battery could not be made in a short period of time. The earliest possible date at which significant achievement scores of twelfth grade students who have been exposed to the predictive criteria either in the 9th or 10th grade will be June 1970.

The statistical analysis reported in Sections IV and V of this report cannot be considered as conclusive because of the small number of subjects involved. It is therefore reccommended that no further reduction of the predictive test battery be made until entering student scores on the fifteen variables are compared with the achievement criteria of all twelfth graders.

The following procedures are recommended for future phases of this longitudinal study:

1968–69

1. Administer the achievement criteria to twelfth grade machine and electrical pupils in Bullard-Havens, Eli Whitney, H. H. Ellis and J. M. Wright Technical High Schools. Scores on the fifteen variables of the predictive measures are available for comparisons from the former testing period in Spring and Fall 1966.

2. Store this achievement test information for use in an analysis of all 12th grade students to be made upon the completion of achievement testing program in June 1970.

Sufficient achievement testing supplies to cover most of the needs for the electrical test are available from previous testing programs. Use of these supplies would reduce the high cost of this aspect of the performance test.

1969–70

1. Administer achievement criteria to 12th grade machine and electrical pupils in the balance of the fourteen schools (ten schools).

2. Make an analysis of correlations of the predictive scores (fifteen variables) obtained upon school entrance with achievement scores in 12th grade for machine and electrical in all fourteen schools.

It is reasonable to assume that at this point sub-tests or parts of sub-tests can be identified which will show high correlation with achievement. Recommendations may then be made for a refined predictive testing program which will permit further reduction in the battery of fifteen sub-tests. This refined predictive battery may then be administered to all entering trade students in the fall of 1970.

APPENDIX

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Planning-Action Committee

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NEW YORK UNIVERSITY
Department of Vocational Education
Connecticut Vocational Study Phase II
Section One
11th Grade Machine Shop Test

Name: ______________________________ School: ______________________________
Last (print) First (print)

Date: ____/ /68____ Town: ______________________________

Examination time for Parts I and II - 2 hours: Class textbooks and/or the Machinists' Handbook may be used for reference in answering the questions or solving the problems.

PART I (50 Credits)

Instructions: In the space provided in the lefthand column, place the letter of the phrase, term, or word which best completes the sentence.

________1. A cut-off tool requires ________.
a. clearance on both sides
b. clearance on the left side only
c. clearance on the right side only
d. no side clearance

________2. To sharpen a cut-off tool grind it on ________.
a. the top
b. the right side
c. the left side
d. the front

________3. The minimum radius which a band-saw blade can cut is determined by the ______.
a. thickness of the blade
b. thickness of the work
c. type of material being cut
d. width of the blade

________4. The pitch of a band-saw blade refers to the ______.
a. angle of the blade to the work
b. number of teeth per inch
c. radius of the smallest circle it will cut
d. pattern of the blade set

________5. The speed at which a band-saw travels is expressed in ______.
a. revolutions per minute
b. inches per second
c. feet per hour
d. feet per minute

__________ 6. For general work on a band-saw, the minimum number of teeth in contact with the work should be ______.
a. four times the pitch
b. at least two
c. as few as possible
d. left to operator's judgment

__________ 7. The tracking position of the blade on the wheels of a band-saw is controlled by _______ .
a. the blade guides
b. tilting the upper wheel
c. tilting the driving wheel
d. the rubber liner on the wheels

__________ 8. Toolmakers' buttons are made of ______.
a. aluminum
b. tool steel
c. machine steel
d. brass

__________ 9. A semi-circular key used to fasten machine parts is known as a _______.
a. Woodruff key
b. Pratt and Whitney key
c. Kennedy key
d. Brown and Sharpe key

__________ 10. Draw filing leaves a good finish because ______.
a. the teeth are cutting backwards and don't gouge
b. of the large shear-angle of the teeth
c. not much pressure is used
d. none of these

__________ 11. A file card is ______ .
a. a card for identifying files
b. a brush used to clean files
c. used by the crib-attendant to keep records
d. none of these

__________ 12. The safe edge on a file ______ .
a. is a safety precaution
b. does not have teeth
c. is used to file close to a line
d. is on all single-cut files

__________ 13. The term "second cut" refers to _______ .
a. the sequence in which a file is used
b. files that have been reclaimed by cutting new teeth on them
c. coarseness of teeth
d. a second set of teeth at an angle to the first set

________ 14. The term "bastard files" refers to a file's ______.
a. shape
b. useability
c. coarsness of teeth
d. sequence of use

________ 15. A mill file is always ______.
a. double cut
b. single cut
c. second cut
d. bastard cut

________ 16. The tap drill for a 1/4-20 tap would be nearest to the decimal equivalent ______.
a. .183
b. .201
c. .213
d. .226

________ 17. When tapping a through hole it is only necessary to use the ______.
a. plug tap
b. bottoming tap
c. straight tap
d. taper tap

________ 18. The class of fit for threads recommended for general work is ______.
a. No. 1
b. No. 2
c. No. 3
d. No. 4

________ 19. An American National Form thread has an included angle of ______.
a. 60°
b. 55°
c. 29°
d. 82°

________ 20. The lead screw on a modern lathe usually has ______.
a. a national form thread
b. a square thread
c. a sharp "V" thread
d. an Acme thread

________ 21. For general work in machine shop, the recommended number of teeth per inch for a hand hacksaw blade is ______.
a. 14
b. 18
c. 24
d. 32

________ 22. A "bell-mouth" condition which developed while boring a 2" hole was probably caused by ______.
a. a rigid setup
b. a fine feed
c. an offset boring head
d. a boring bar that was too light

_________ 23. The vernier scale on a micrometer is located on the ________.
a. thimble
b. hub
c. spindle
d. anvil

_________ 24. A thread micrometer is used to measure the ________.
a. minor diameter
b. major diameter
c. pitch
d. pitch diameter

_________ 25. Gauge or size blocks are used ________.
a. to position work on a milling machine
b. as parallel bars for shaper
c. for making or checking precision measurements
d. to hold round bars when drilling

_________ 26. Before counterboring holes in cast iron ________.
a. use a center punch
b. remove the scale
c. use a countersink
d. oil the blades

_________ 27. Spot facing on a drill press ________ .
a. enlarges the hole
b. trues the inside of the hole
c. smoothes the top surface around the hole
d. smoothes a conical surface around the hole

_________ 28. When measuring a twist drill with a micrometer, measure across the ______ .
a. web
b. twist
c. margin
d. flutes

_________ 29. When drilling cast iron it is common practice to use_________
a. no cutting compound
b. lard oil
c. cutting oil
d. kerosene

_________ 30. Twist drills for general work are usually sharpened with an included angle of _____.
a. 59°
b. 60°
c. 118°
d. 72°

_________ 31. When milling a gear tooth the operation is called ________.
a. form milling
b. gang milling
c. parallel milling
d. angular milling

_______32. When two surfaces are milled at the same time, using two side milling cutters, the operation is known as ________.
a. side milling
b. end milling
c. straddle milling
d. slab milling

_______33. Knurling is usually used to ________ .
a. prepare stock for threading
b. provide an oil retaining surface
c. remove scale from stock
d. create a special gripping surface

_______34. In machine shop practice, a chuck that automatically centers the work when the chuck is tightened is known as a/an ________ .
a. independent chuck
b. four-jaw chuck
c. centering chuck
d. universal chuck

_______35. To check the angle of a threading tool for cutting sharp "V" threads, use a ________ .
a. thread gage
b. height gage
c. center gage
d. center head

_______36. Screw threads should be true in reference to lead and concentricity, if they are ________ .
a. cut by a die
b. chased by hand
c. cut by a tap
d. cut by a single point threading tool

_______37. When cutting a left-hand thread on a lathe, the carriage should travel toward the ________.
a. tailstock
b. headstock
c. center line of the lathe
d. center line of the work

_______38. When thread cutting, the use of the chasing dial ________ .
a. saves time
b. prevents chatter
c. cleans the thread
d. checks thread depth

_______39. Of the following, which one is not part of a collet chuck assembly________ .
a. draw-in bar
b. knock-out bar
c. nose nut
d. adapter

_________40. To give a cutting speed of 35 ft. per minute, a 3/4" drill should travel about ________.
a. 186 rpm.
b. 70 rpm.
c. 280 rpm.
d. 350 rpm.

_________41. The three most commonly accepted taper standards are ________.
a. Morse, Brown, Sharpe
b. Jarno, Starrett, Morse
c. Brown & Sharpe, Morse, Jarno
d. none of these

_________42. The Morse taper standard is most commonly found on ________.
a. end mills
b. milling machine arbors
c. drills and reamers
d. stagger-tooth mills

_________43. Tapers are usually designated in ________.
a. degrees per foot
b. inches per foot
c. inches per inch
d. feet per foot

_________44. The standard taper housed in a lathe tailstock spindle is usually________.
a. Pratt and Whitney
b. Brown and Sharpe
c. Leblond
d. Morse

_________45. When checking a taper with a micrometer, increasing the distance between points of measurements results in ____________.
a. less accuracy
b. easier reading
c. more accuracy
d. nothing different

_________46. To convert taper-per-foot to taper-per-inch __________.
a. multiply by 12
b. subtract 12
c. divide by 12
d. multiply by 12 and divide by 2

_________47. In the formula: offset = $\frac{T \times L}{2}$, the letter "L" stands for _________.
a. the length of the taper
b. the length of the stock
c. the large end of the taper
d. the length tailstock is set over

_____ 48. In the formula: offset = $\frac{T \times L}{2}$, the "T" must be given by _____.

a. feet per inch
b. inches per foot
c. inches per degree
d. inches per inch

_____ 49. If two diameters on a taper differ by .300 in 4 inches of length, the taper per inch is _____.

a. 1.200
b. .750
c. .075
d. .0075

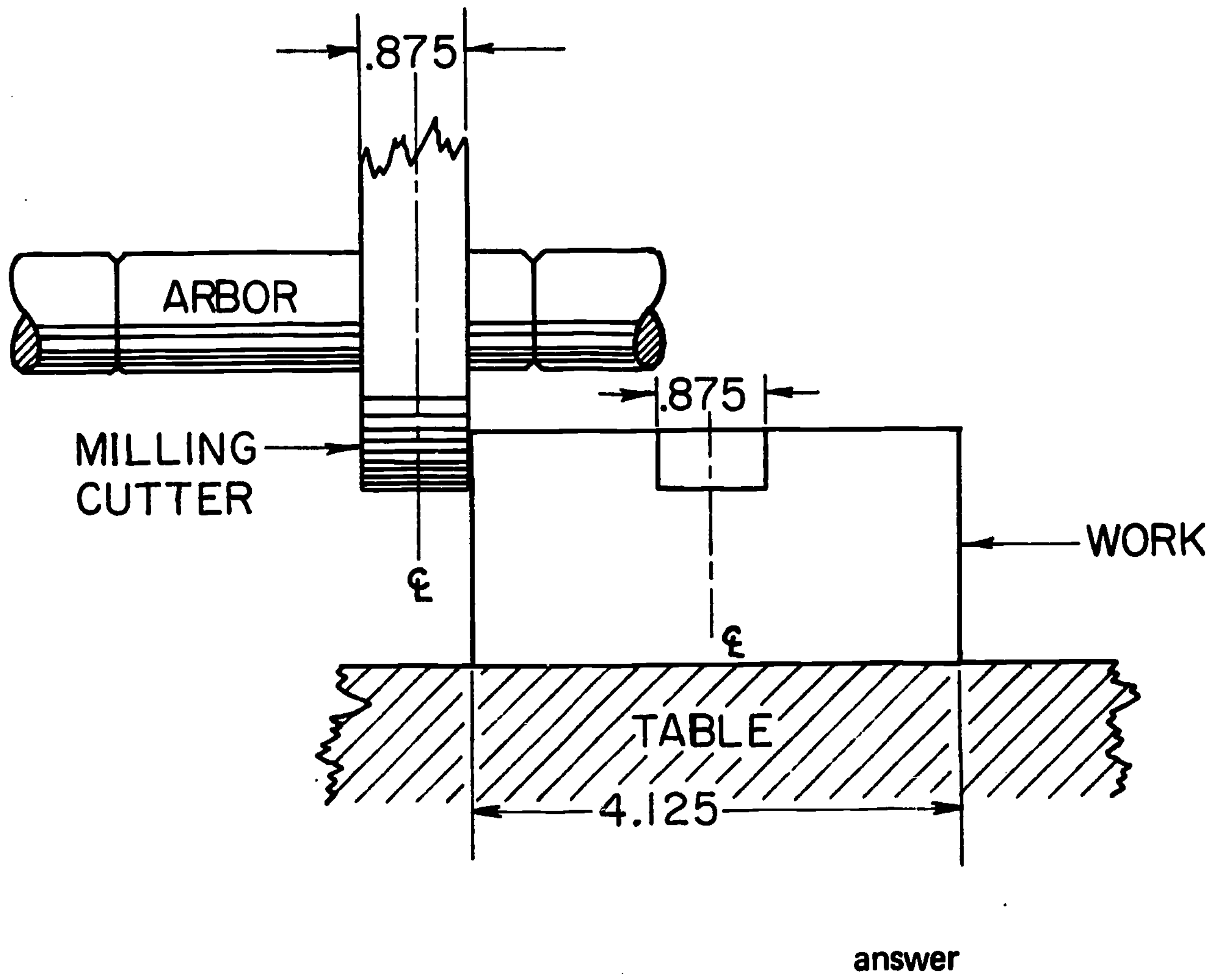
_____ 50. When turning a taper, the cutting tool must be set _____.

a. 3 degrees above center
b. on center
c. 3 degrees below center
d. at the same degree as the taper

PART II (50 points)

Answer any ten questions from this section. Show all calculations in the space provided.

51. In the diagram below, the side of the milling cutter is just "touching" the side of the work. Determine the distance the work should be moved to locate the center line of the cutter directly over the center line of the work. Give the answer in a decimal. (5)



answer _____

52. (a) It is necessary to machine an angle of 82 ^{o}on the end of a rod as shown in diagram 52A. At what angle should the compound rest be set if it is graduated in degrees as indicated in diagram 52B? (3)

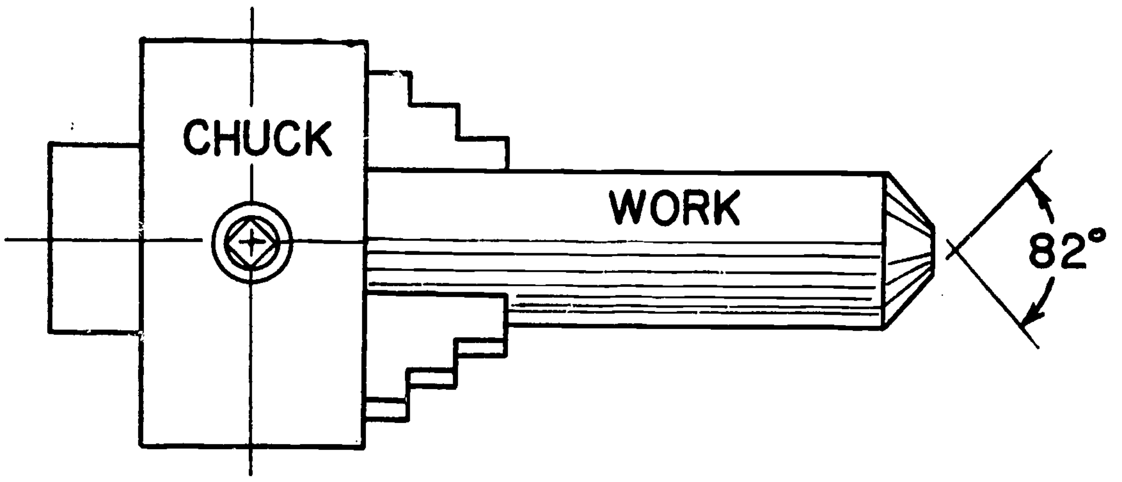


Diagram 52A

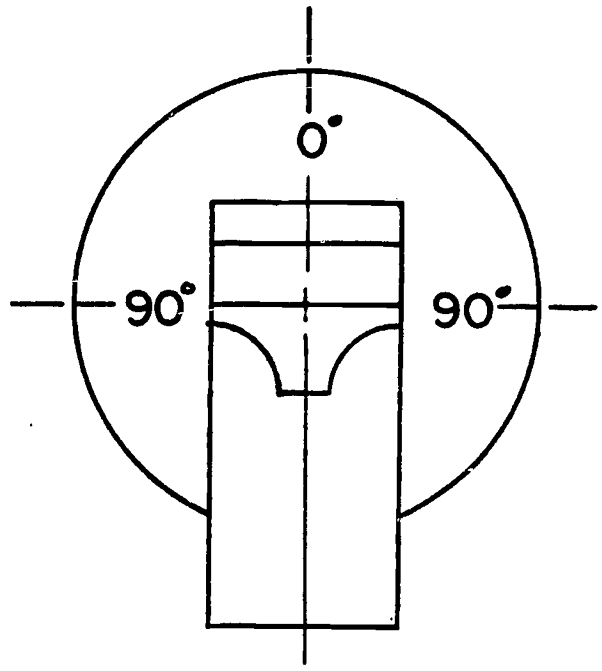


Diagram 52B

(b) Referring to diagram 52A, what angle does the tapered surface make with then center line of the work? (2)

answer (a) ________
answer (b)________

53. (a) In the space provided below, describe in two or three words what each of the symbols in the following expression represent: 3/4 - 1ONC -2 (1)

3/4 ________________________ NC ________________________
10 ________________________ 2 ________________________

(b) From the same expression (3/4-1ONC-2), compute the following in thousandths: (4)

________________________ single depth
________________________ pitch diameter
________________________ width of flats
________________________ minor diameter

54. (a) A 3" milling cutter rotates at 106 rpm. The table feed is 6" per minute. Compute the cutting speed. (3)

(b) Find the "feed per tooth" if the cutter has 16 teeth. (2)

answer (a) __________
answer (b) __________

55. An index head has a crank-to-spindle ratio of 40:1. Using simple indexing, calculate the indexing necessary to mill 6 equally-spaced flutes on a reamer. (5)

The following plates are available:

Plate # 1: 15, 16, 17, 18, 19, 20

Plate # 2: 21, 23, 27, 29, 31, 33

Plate # 3: 37, 39, 41, 43, 47, 49

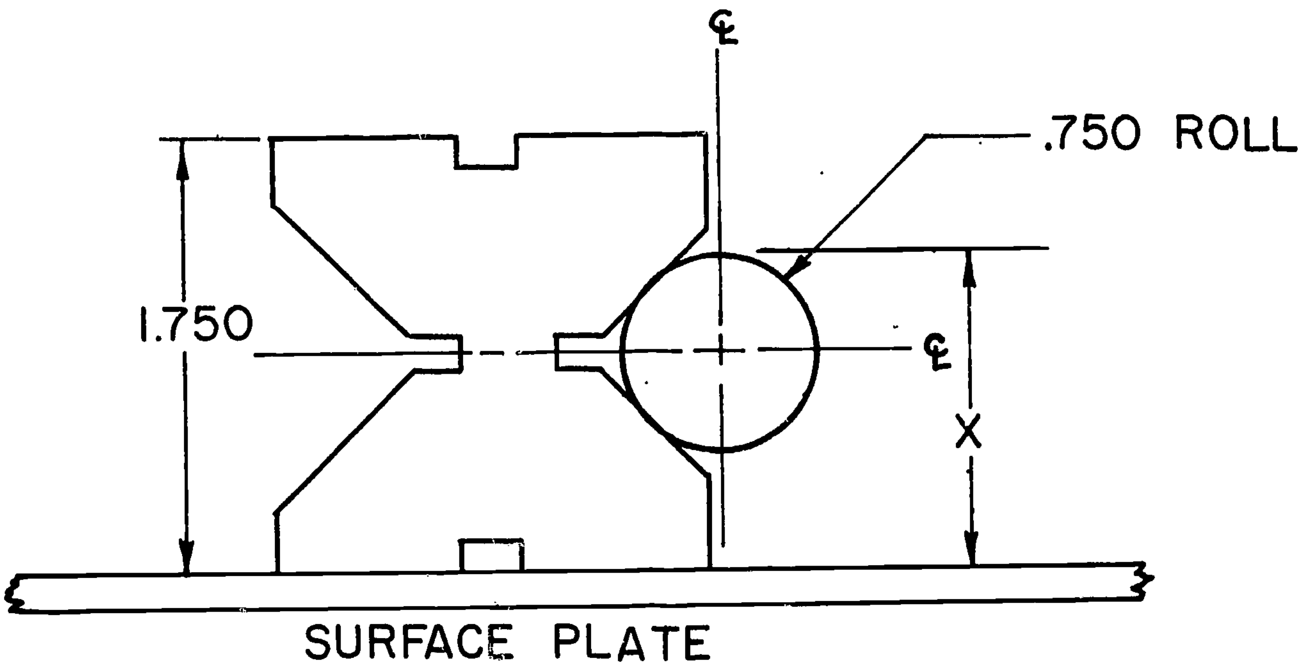
answer: ________ turns of the crank
and ________ holes in the
__________ hole circle.

56. A sine-bar height setting of 3.6787" is required. Select any suitable combination of the gage blocks listed below which will result in the required setting. Use a diagram and label the size of the blocks. (5)

1.000	.128
2.000	.140
4.000	.147
.1007	.150
.1008	.300
.1009	

answer ____________

57. A "V" block and a 3/4" are arranged on a surface plate as shown below. Calculate the distance marked X. (5)



answer ____________

58. Using an index head with a 40:1 ratio, calculate the indexing necessary to mill slots on a cylinder with centers 18^{o} apart. (5)

Plates available:	Plate 1:	15, 16, 17, 18, 19, 20
	Plate 2:	21, 23, 27, 29, 31, 33
	Plate 3:	37, 39, 41, 43, 47, 49

answer: ________ turns of the crank

and ________ holes in the

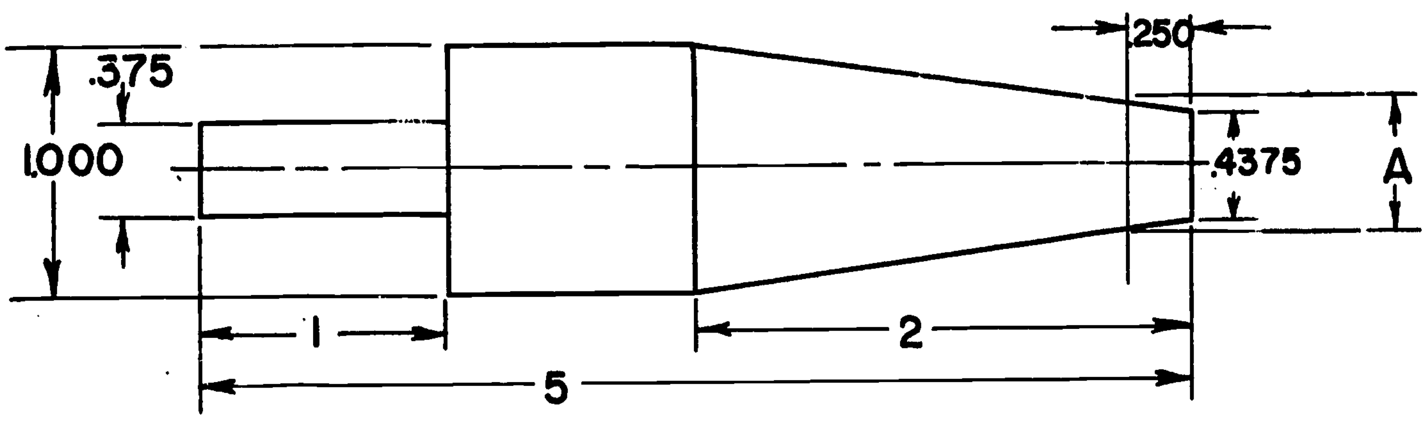
________ hole plate

59. Referring to the diagram below:

a. Compute the taper per inch. (2)

b. Assuming that the taper per inch is .076", find the diameter marked "A". (3)

Give answers in a decimal.



answer (a) ________

answer (b) ________

60. (a) Referring to the diagram in question number 59 and using the formula:

$$\text{offset} = \frac{T \times L}{2}$$

calculate the amount of tailstock offset for a job with a taper per inch of .062". (3)

(b) Given a taper per foot of .720", compute the taper per inch. (2)

Give answers in a decimal.

answer (a) ____________

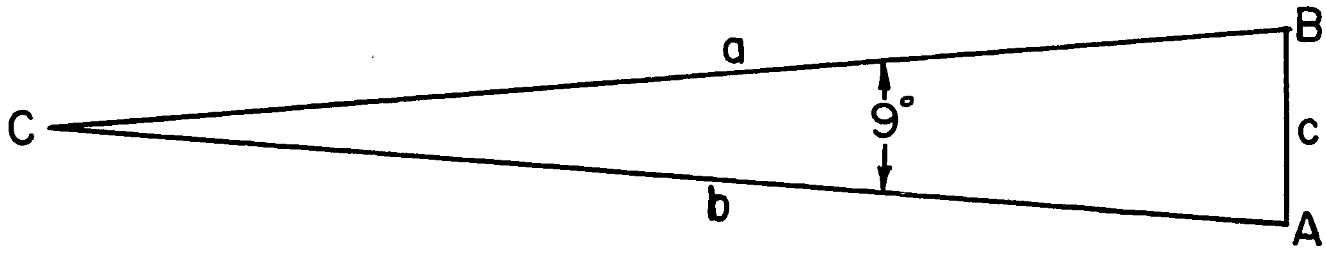
answer (b) ____________

61. Determine, by computation, the largest square that can be milled from a piece of round stock 2" in diameter. (5)

Give the answer in a decimal.

answer ______________

62. In the diagram of the wedge below: side (a) equals side (b) and angle A equals angle B. Find the number of degrees in angle A. (5)



answer ____________

NEW YORK UNIVERSITY
Department of Vocational Education
Connecticut Vocational Study Phase II
Section One
11th Grade Electrical Test

Name: ______________________________ School: ______________________
Last (print) First (print)

Date ______/____/68 Town: ______________________

Examination time for Parts I and II - 2 hours: Class textbooks and the National Electrical Code may be used for reference in answering the questions and solving the problems.

PART I (50 Credits)

Instructions: In the space provided in the lefthand column, place the letter of the phrase, term, or word which best completes the sentence.

_______1. The widespread distribution of electric power is made possible by the proper use of ________.
a. low voltage generators.
b. high resistance conductors
c. transformer action
d. inductive reactance

_______2. The primary coil of the transformer is always ________.
a. the high voltage coil
b. the low voltage coil
c. the coil that supplies voltage to the load
d. the coil that receives power from the supply line

_______3. The term "in phase" means ________.
a. the current leads the voltage
b. the current lags the voltage
c. current and voltage reach their peaks simultaneously
d. the current is maximum when the voltage is zero

_______4. The reason some direct current motors have interpoles is to ________.
a. reduce the motor's size
b. increase the speed
c. decrease cost
d. aid commutation

_______5. A rheostat is used in the field circuit of a D-C shunt generator in order to ______.
a. increase generator speed
b. decrease generator speed
c. increase the torque
d. raise or lower generator voltage

__________ 6. A transformer is used to __________ .
a. change direct to alternating current
b. raise or lower alternating voltage
c. raise or lower frequency in an A-C circuit
d. control the flow of alternating current

__________ 7. Moving a length of wire through the field of a magnet __________ .
a. increases the strength of the field
b. decreases the strength of the field
c. reverses the direction of the field
d. generates a voltage in the wire

__________ 8. Counter-electromotive force is generated __________ .
a. in the armature of a d-c motor
b. across an external load
c. in the field of a d-c motor
d. in the armature laminations

__________ 9. The shunt field of a d-c motor is wound with __________ .
a. the same size wire as the armature
b. a larger diameter wire than the armature
c. a smaller diameter wire than the armature
d. the same diameter wire as the series field

__________ 10. The rotation of a D-C compound motor may be reversed by interchanging __________ .
a. line leads
b. armature leads
c. armature and interpole leads
d. armature and series field leads

__________ 11. To reverse the direction of a split-phase motor, __________ .
a. reverse the line leads
b. shift the brush position
c. reverse both the starting and running windings
d. reverse either the starting or running winding

__________ 12. To reverse the direction of a three-phase induction motor, __________ .
a. turn rotor 180 degrees
b. reverse the running winding
c. reverse any two leads to the stator
d. turn the stator 180 degrees

__________ 13. To reverse the direction of a shaded pole motor, __________ .
a. reverse the line leads
b. reverse the polarity of the coils
c. reverse the stator, end for end
d. reverse the motor bearings

__________ 14. The core of an armature is laminated to __________ .
a. make it easy to assemble
b. reduce eddy currents
c. save on cost of material
d. stop humming from A-C

__________ 15. An ammeter should always be connected __________ .
a. in parallel with the line
b. across the line
c. in series with a voltmeter
d. in series with a resistance or load

__________ 16. The color of the neutral wire must always be __________ .
a. green
b. black
c. white or gray
d. white or red

__________ 17. Difference in potential means __________.
a. circuit resistance
b. the difference in emf between two points
c. the difference in current from one point to another
d. rated voltage

__________ 18. The equation used to calculate the resistance of a circuit is __________.

a. $R=\frac{E}{I}$ b. $R=\frac{I}{E}$ c. $R=\frac{P}{E}$ d. $R_I = R_1 \times R_2$

__________ 19. A 0-150 volt range voltmeter, with a sensitivity of 10,000 ohms per volt will have an internal resistance of __________.
a. 10,000 ohms
b. 150,000 ohms
c. 1,500,000 ohms
d. 1,500 ohms

__________ 20. Ten resistors connected in parallel, each having a value of 1 ohm, will have a combined resistance of __________.
a. 10 ohms
b. 1 ohm
c. 0.01 ohm
d. 0.1 ohm

__________ 21. Ten 1 ohm resistors connected in series will have a total resistance of __________.
a. 10 ohms
b. 1 ohm
c. 0.01 ohm
d. 0.1 ohm

__________ 22. Power is measured in __________ .
a. volts
b. ohms
c. watts
d. amperes

__________ 23. A permanent magnet may lose its magnetism if __________ .
a. located in a temperature below freezing
b. it is placed in a shielded box
c. dropped, hammered or heated
d. coated with paint

__________ 24. The rated voltage of a flashlight dry cell is __________.
a. 1 1/2 VAC
b. 2 VDC
c. 1 1/2 VDC
d. 6 VDC

__________ 25. The common frequency of alternating current for household use is __________ .
a. 60 cycles per second
b. 120 cycles per second
c. 60 cycles per minute
d. 120 cycles per minute

__________ 26. To obtain direct current from a generator, we use __________ .
a. slip rings
b. a commutator
c. stator windings
d. a rotor

__________ 27. Tools should always be __________ .
a. left on benches
b. carried in the pants pocket
c. put away when not in use
d. left on machines

__________ 28. When drilling sheet metal on a drill press, __________ .
a. hold material with your left hand
b. material should be hand held above a piece of scrap lumber
c. secure the material with a clamp
d. use an auger bit

__________ 29. When cleaning, oiling, adjusting or repairing a machine, __________ .
a. make sure it is completely stopped
b. make sure the power switch is locked in an "off" position
c. replace the guards immediately after finishing
d. all of these

__________ 30. Before operating a machine, __________ .
a. remove or tuck in your necktie
b. roll up your sleeves
c. remove rings, watches and other jewelry
d. all of these

__________ 31. When using a step ladder, open fully and __________ .
a. proceed to climb
b. set both spreaders before climbing
c. set one spreader before climbing
d. avoid any broken rungs

________ 32. Alternating-current systems which supply interior wiring at 150 volts to ground or less shall be grounded, is a rule described in the National Electrical Code 1965 under article # ________.
a. 336-5
b. 250-5
c. 410-25
d. 513-2

________ 33. 'Insulating bushings are used on Type MC Cable', is a rule to be found in the National Electrical Code 1965 under article # ________.
a. 334-10
b. 374.1
c. 501-16
d. 513-9

________ 34. 'The minimum size of "Greenfield" which may be used to supply a fixture is 1/2"', is a rule in compliance with the National Electrical Code 1952 under article # ________ .
a. 250-3
b. 280-21
c. 318-1
d. 350-3

________ 35. 'Plug fuses of 10 amperes rating shall have a hexagonal opening in the cap', is a rule to be found in the National Electrical Code 1965 under article # ________ .
a. 90-7
b. 240-20
c. 310-2
d. 501-8

________ 36. Type TW conductor is "thermoplastic and moisture resistant", is a description given in the National Electrical Code 1965 under article # ________ .
a. 310-2
b. 346-10
c. 370-7
d. 384-12

________ 37. 'Wireways may not contain more than 30 conductors', is a rule found in the National Electrical Code 1965 under article # ________ .
a. 262-5
b. 302-3
c. 362-5
d. 502-1

________ 38. The name D'Arsonval is related to a type of ________.
a. heat sink
b. generator
c. meter movement
d. heating element

__________39. If, when a compass is placed above a horizontal conductor carrying D-C, the north pole of the needle points away from the observer, the direction of the current flow is ____
a. right to left
b. reversing its direction
c. left to right
d. none of these

__________40. The strength of an electromagnet depends on ________.
a. the voltage and the wire size
b. the current and the wire size
c. the voltage and the number of turns
d. the current and the number of turns

__________41. Brushes are required on a D-C motor to __________.
a. provide a sliding contact
b. change the direction of current in the armature
c. clean the commutator
d. support the commutator

__________42. To operate properly, electrical devices in a parallel circuit must have the same rating with respect to __________.
a. voltage
b. current
c. resistance
d. wattage

__________43. Five lamps of equal resistance are connected in series to a 125-volt D-C supply. The current in the main line is 5 amperes. The current through a single lamp is __________.
a. 5 amperes
b. 25 amperes
c. 1 ampere
d. 20 amperes

__________44. In a D-C generator the direction of the E.M.F. induced in the armature depends on the __________.
a. number of lines of force
b. speed of the armature
c. action of the commutator
d. magnetic polarity of the field poles

__________45. The function of the glass envelope of an incandescent lamp is to __________.
a. protect the filament from mechanical damage
b. delay oxidation of the filament
c. focus the light
d. dissipate heat

__________46. One kilowatt is equal to __________.
a. 10 watts
b. 100 watts
c. 1,000 watts
d. 1,000,000 watts

__________47. The functioning part of a thermostat is a __________ .
a. bimetallic strip
b. steam valve
c. transformer
d. mercury switch

__________48. One milliampere equals _________.
a. 0.0001 amp.
b. 0.001 amp.
c. 1,000 amp.
d. 1,000,000 amp.

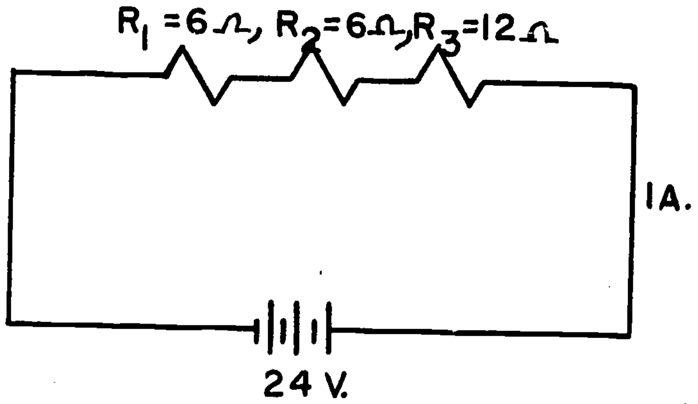
__________49. The particle of an atom which is positively charged is _________.
a. the electron
b. the neutron
c. the molecule
d. the proton

__________50. The material most frequently used as an electric heating element is ________ .
a. titanium
b. nichrome
c. alnico
d. carbon

PART II (50 Credits)

Instructions: Solve all problems, and place the answers in the space provided at the right. Show the method of solution.

51. (5 Points)



Find: a. R_T = __________

b. I_1 = __________

c. I_2 = __________

d. E_{D3} = __________

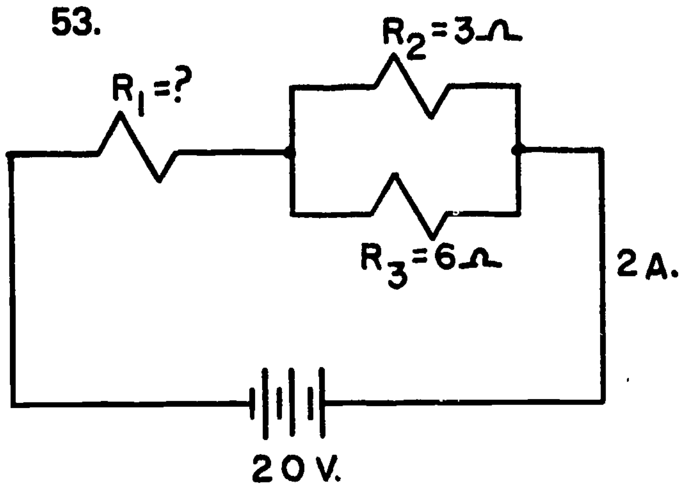
52. Three motors are connected in parallel. (5 Points)
I_1 = 3 amp, R_1 = 40 ohms, R_2 = 30 ohms, and I_3 = 1 amp.

Find: a. the total voltage __________

b. the total current __________

c. the total resistance __________

53. (5 Points)



Find:

a. E_1 = ______

b. R_1 = ______

c. E_2 = ______

d. I_3 = ______

54. Draw four circuit diagrams each including four resistors of 100 ohms each so that the total resistance shall be as follows: (5 Points)

a. 25 ohms

b. 100 ohms

c. 133.3 ohms

d. 75 ohms

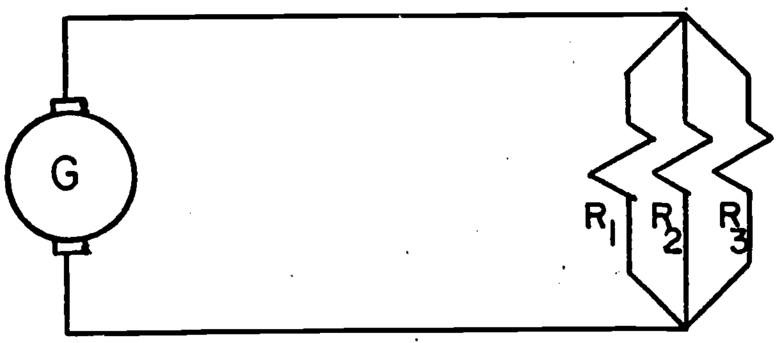
55. If a 100 ohm resistor has 2 amperes flowing through it. What power is dissipated in the resistor? (5 Points)

Answer: ____________

56. Given: $E = 100$ V.
$R_1 = 80$ ohms
$R_3 = 50$ ohms
$I_2 = 7.5$ amp.

Find: a. I_T = __________
b. I_1 = __________
c. I_3 = __________
d. R_2 = __________

(5 Points)

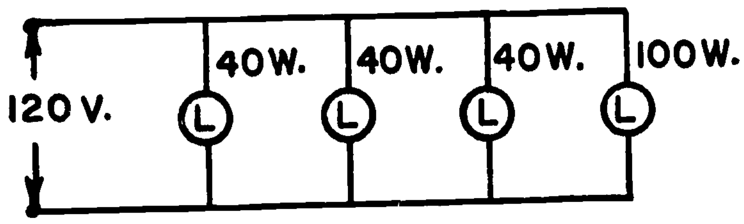


57. What is the D-C flowing through a 50-ohm electromagnet drawing 200 watts? (5 Points)

Answer: ____________

58.

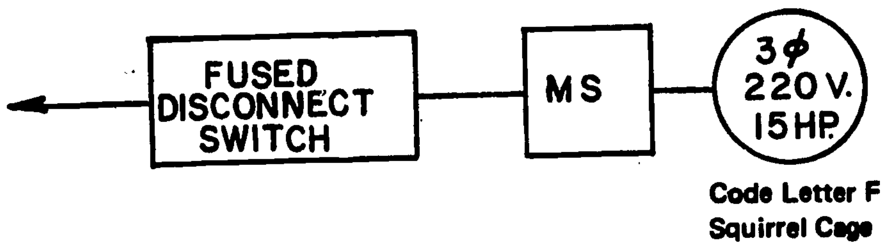
(5 Points)



Find: a. I for 40 W. Lamp = ____________

b. I for 100 W. Lamp = ____________

59.



Calculate: a. Size RH wire for branch circuit feeder ____________

b. Size conduit ____________

c. Maximum size fuse ____________

d. Overload protection (heaters) ____________

(10 Points)

NEW YORK UNIVERSITY
Department of Vocational Education
CONNECTICUT VOCATIONAL STUDY PHASE II
Section Two
11th Grade Electrical Performance Test

This performance test board is designed to include a variety of common wiring materials, procedures and problems in a unit for the purpose of measuring the manipulative achievement of a student.

Directions (Read carefully before starting the test.)

1. Four Hours will be allowed to complete the test.

2. Study the drawing and make a sketch of the electrical wiring details necessary to allow the lamp and duplex convenience outlet to be controlled from each of the three switch locations. Make your sketch in the space provided on page 2.

3. Locate and mount the components and then wire the job. Solder the splices in the lamp box. All other splices are to be made with solderless connectors.

4. A record of the time spent on the Performance Job will be kept by your instructor. If there is a necessary interuption, be sure to check "out" and "in" with your instructor.

5. Notify your instuctor when you have finished the job.

6. Using a felt marking pen which the instuctor will provide, print the initial letter of your first name, your last name and the name of the school below it in the upper right hand corner of the panel (see example on job layout.)

Date ____/____/68

Name ______________________
Last (print) First

School ______________________

Location ______________________

Note: Appropriate code and/or reference books may be used during the test period.

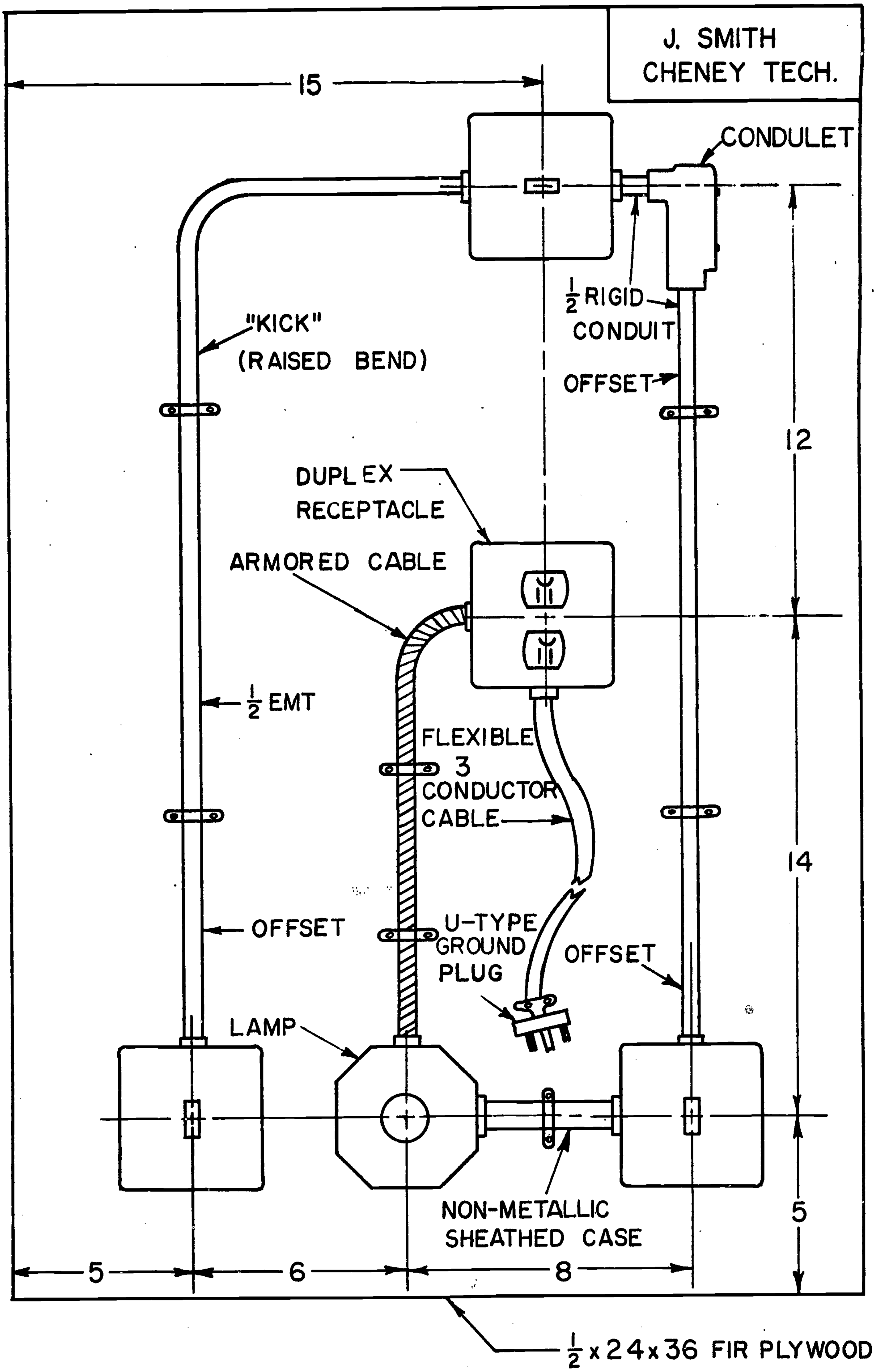
11th Grade Electrical Performance Test

Name: ____________________ , __________________________ School: ________________________

Last (print) First

WIRING SKETCH

11th GRADE ELECTRICAL PERFORMANCE JOB



NEW YORK UNIVERSITY

Department of Vocational Education

Connecticut Vocational Study Phase II

Section Two

11th Grade Machine Shop Performance Test

Name: ______________________________ School: ______________________________

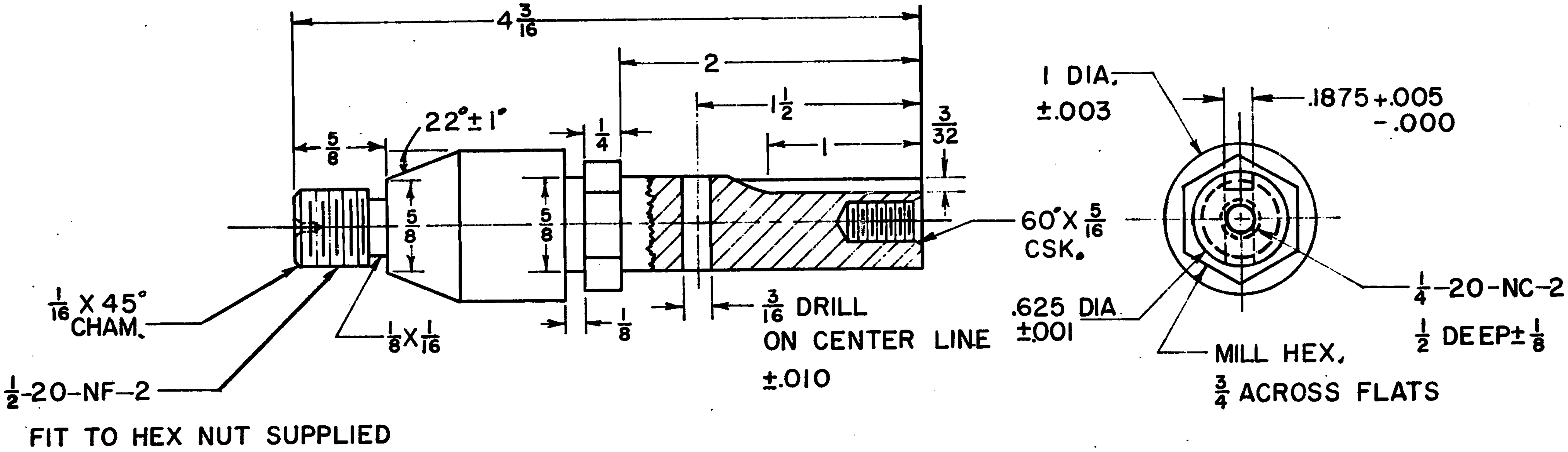
Last (print) First (print)

Date: ___/___/___ Town: ______________________________

TAPERED STUD

Directions:

1. Make one tapered stud as shown in the attached print. (Total credits 50 points)
2. Any tools and machines may be used.
3. A 1/2 NF "test nut" may be obtained from the instructor for gaging the thread.
4. Reference books may be used.
5. You will be allowed 4 hours to complete the job.
6. When you have completed the job, print your name and school on the tag and tie it through the hole in the screw.
7. Your job will be rated on skill, time, and accuracy.



ALL OUTSIDE DIAMETERS TIR ±.002

MATERIAL: #1018 CDS 1 1/8 X 4 5/16

± 1/64 ON ALL FRACTIONAL DIMENSIONS UNLESS OTHERWISE NOTED

BREAK ALL CORNERS 1/64 R

FAO - 63 ST

NEW YORK UNIVERSITY DEPARTMENT OF VOCATIONAL EDUCATION CONNECTICUT VOCATIONAL STUDY PHASE II	TAPERED STUD	11th GRADE TRADE MACHINE SHOP PERFORMANCE TEST SPECIMIN MAY, 1968