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An analysis of objectives of industrial arts metalwork teaching in relation to general education aims

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AN ANALYSIS OF OBJECTIVES OF INDUSTRIAL ARTS METALWORK TEACHING IN RELATION TO GENERAL EDUCATION AIMS

Submitted by

Kenyon Scott Fletcher

(The Stout Institute, B.S., 1929)

(University of Minnesota, M.A., 1935)

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First Reader: Roy O. Billett

Professor of Education

Second Reader: Wesley N. Tiffney

Professor of Chemistry

Third Reader: William C. Kvaraceus

Professor of Education

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CHAPTER I

THE PROBLEM AND ITS BACKGROUND

1. Statement of the Problem

Purposes of this study.-- The purposes of this study are: (1) to analyze the topics included under the published objectives recognized by industrial arts leaders, for teaching industrial arts metalwork; (2) to determine the significance of the topics in a program of general education; (3) to determine where in the curriculum the topics should be emphasized; and (4) to draw from the findings implications for all areas of industrial arts work.

Obviously, the entire industrial arts field is too broad for an analysis of curriculum topics in all areas within the scope of a single dissertation. For that reason the subject was delimited in this study to metalworking only. That area of industrial arts was chosen because it is new enough in the usual curriculum to avoid some of the possible prejudices and traditions. At the same time it is taught frequently enough so that teachers and administrators are reasonably well informed concerning most of the topics.

Objectives are not static.-- This does not purport to be a status study. Rather, the attempt is made to develop ideals--what should be done in a valid program of studies which recognizes modern objectives of industrial arts teaching. Nevertheless, the lists of objectives developed and their relative importance in general education necessarily represent ideals of today and of today only. The content and method of industrial arts cannot be static, coming as they do from a constantly changing industrial environment:

> A generation ago it would have been a rather simple task to outline in detail the content and method of industrial arts . . . . Today the problem is fortunately more difficult for many reasons. For example, industry has become a major influence in daily living; hence industrial arts has more numerous and comprehensive functions to perform in interpreting this complex society. . . . The content of industrial arts expands almost daily with new inventions and discoveries, new materials and products, and new problems arising from the effects industry has upon society.1/

Questions to be answered.-- Industrial arts as a phase of general education will be discussed in the following pages. That there are misunderstandings concerning industrial arts as a phase of general education will also be discussed. These considerations give rise to the question: Are the specific and attainable goals of industrial arts metalwork at the same time suitable goals of general education? Also, are the general education goals of industrial arts metalwork suitable for emphasis in other curriculum areas as well as in industrial arts? To answer these questions is the purpose of this study.

2. Background of the Problem

Industrial arts is general education.-- From the first use of the term about fifty years ago,2/ industrial arts has been considered by its

1/Industrial Arts for Secondary Schools, Bulletin 331, Commonwealth of Pennsylvania, Department of Public Instruction, Harrisburg, Pennsylvania, 1939, p. 12.

2/Charles Alpheus Bennett, History of Manual and Industrial Education, 1870-1917, The Manual Arts Press, Peoria, Illinois, 1937, p. 453.

proponents as general education rather than as specialized vocational training.[1] In a significant statement issued by a group of prominent industrial arts educators, industrial arts is described as "a curriculum area rather than subject or course, being comparable in this respect to the language arts."[2]

"Industrial arts is no different than any other secondary school subject," says Seefeld.[3] "This assumption is based on the fact that we accept general education as the prime objective of our work along with other areas of learning . . . ."

Industrial arts and vocational-industrial education.-- No general education designation seems to be necessary in a discussion of such traditional areas of education as English, mathematics, or social studies. Courses in these fields seem to be accepted as general education without question, although it is likely that they often do not measure up to general education aims. Recent writers on industrial arts, however, frequently seem to sense the necessity to explain the differences between industrial arts and vocational-industrial education. The similarities and differences between the two fields apparently are difficult to discern. Yager uses the illuminating subject, "Twins, Although Not Identical," in an article designed to develop better understanding between workers in the two fields.[4]

1/Charles Alpheus Bennett, op. cit., p. 455.

2/Industrial Arts: Its Interpretation in American Schools, Bulletin 1937, Number 34, United States Office of Education, Washington, D. C., p. 1.

3/Kermit A. Seefeld, "My Philosophy of Industrial Arts," The Industrial Arts Teacher (October, 1950), 10:1.

4/Sylvan A. Yager, "Twins, Although Not Identical," Industrial Arts and Vocational Education (March, 1952), p. 101.

Carefully worked out comparisons of aims and objectives of industrial arts and vocational-industrial education, groups served, time allotments and lengths of courses, content and nature of work, type of teacher, type of equipment required, relations with outside agencies, and federal and state aid have been published by state departments of education of Connecticut,[1] Illinois,[2] Missouri,[3] and Pennsylvania.[4] These discriminating statements are purported to help teachers and school administrators better understand the general education nature of industrial arts.

Pupils, too, sometimes fail to understand the distinctions between industrial arts and vocational-industrial education. For example, a committee investigating problems in the fields of vocational technical education and mechanic and industrial arts courses in the New York City schools discovered that "a number of students who are now in industrial arts classes desire vocational education and think they are receiving it."[5] The committee suggested changing the name of courses as a means of clarifying the situation.

1/A Handbook in Industrial Arts for Connecticut Secondary Schools, Part I, "Guiding Principles," State Department of Education, Hartford, Connecticut, 1945.

2/Industrial Arts in the Modern School: Its Function and Organization, Series A, Bulletin No. 94, March, 1949, Board for Vocational Education, Springfield, Illinois.

3/Industrial Arts Handbook, Bulletin 7B, Revised 1945, State Superintendent of Public Schools, Jefferson City, Missouri.

4/Industrial Arts, Bulletin 331, Commonwealth of Pennsylvania, Department of Public Instruction, Harrisburg, Pennsylvania, 1951.

5/Vocational Education and Mechanic and Industrial Arts Classes in Secondary Schools, The Board of Education, The City of New York, 1942, p. 84.

To explain the reasons for the apparent lack of clear-cut understanding of the nature and purpose of industrial arts is beyond the scope of this investigation. It is suggested, however, that such lack of understanding on the part of school administrators and specialists in the industrial arts field has been responsible for confusion regarding the goals of industrial arts and vocational-industrial education. It is suggested further that such lack of understanding has had an adverse effect on industrial arts curricula and instructional materials, probably because the materials in many instances have been designed to serve both industrial arts and vocational-industrial education instruction.

Industrial arts objectives.-- The industrial arts literature is replete with lists of objectives and values of instruction. One such list which has had great influence in the field was prepared by the American Vocational Association Committee on Standards of Attainment in Industrial Arts.[1] The Committee's preliminary report was published in 1929 and a progress report was published in 1931. The complete report was published in 1934 and in 1946 a revised report was published. The current report was published in 1948. In all, 27,200 copies of the report have been distributed. According to the committee, "It is probable that no other publication in the field of industrial arts has been used by so many teachers and administrators. Certainly, none has exerted equal significant influence upon the progress of industrial arts in public education in this country."[2]

The Committee on Standards of Attainment has been replaced by an

1/Improvement of Instruction in Industrial Arts, American Vocational Association, Washington, D. C., 1948.

2/Ibid., p. 7.

Industrial Arts Policy and Planning Committee whose most recent publication[1/] is a further revision of the original Standards of Attainment bulletin. The list of industrial arts objectives contained in this bulletin, as well as in the 1948 revision, is quoted here:

> 1. Interest in Industry.-- To develop in each pupil an active interest in industrial life and in the methods and problems of production and exchange.
>
> 2. Appreciation and Use.-- To develop in each pupil the appreciation of good design and workmanship, and the ability to select, care for, and use industrial products wisely.
>
> 3. Self-discipline and Initiative.-- To develop in each pupil the habits of self-reliance, self-discipline, and resourcefulness in meeting practical situations.
>
> 4. Cooperative Attitudes.-- To develop in each pupil a readiness to assist others and to join happily in group undertakings.
>
> 5. Health and Safety.-- To develop in each pupil desirable attitudes and practices with respect to health and safety.
>
> 6. Interest in Achievement.-- To develop in each pupil a feeling of pride in his ability to do useful things and to develop worthy leisure-time interests.
>
> 7. Orderly Performance.-- To develop in each pupil the habit of an orderly, complete, and efficient performance of any task.
>
> 8. Drawing and Design.-- To develop in each pupil an understanding of drawings, and the ability to express ideas by means of drawings.
>
> 9. Shop Skills and Knowledge.-- To develop in each pupil a measure of skill in the use of common tools and machines, and an understanding of the problems involved in common types of construction and repair.

These industrial arts objectives have been used in many bulletins and courses of study. Other significant but somewhat different lists of

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1/A Guide to Improving Instruction in Industrial Arts, American Vocational Association, Washington, D. C., June, 1953.

industrial arts objectives have been published by Newkirk,[1] Sotzin,[2] Goodykoontz,[3] and the Oklahoma State Advisory Committee for Industrial Arts.[4]

Each of the statements of industrial arts objectives implies a close relationship to the objectives of general education. The American Vocational Association Committee says:[5]

> The objectives of industrial arts teachers are not essentially different from those of teachers in other subjects or areas. The place of industrial arts in the school curriculum is justified and assured because this field, with its distinctive physical setting and pupil activities, provides a highly effective means of reaching worthy ends. The legitimate purposes of academic subjects are the legitimate purposes of industrial arts subjects. The valid aims of general education are the valid aims of industrial arts work, because the latter is merely a phase of the former. Industrial arts should always be conceived and practiced as general education, for youth and for adults, in day and evening hours."

Although the valid aims of general education are the valid aims of industrial arts, industrial arts has specific aims which are very different from the specific aims of other general education aims. The Industrial Arts Policy and Planning Committee says:[6]

1/Louis V. Newkirk, The Industrial Arts Program, The Macmillan Company, New York, 1950.

2/Heber A. Sotzin, A Brief Resume of Industrial Arts, San Jose State College, San Jose, California, 1949, pp. 10-11.

3/Bess Goodykoontz, "Preface," Industrial Arts: Its Interpretation in American Schools, op. cit., p. v-vi.

4/Industrial Arts in Oklahoma, Bulletin No. 105, State Superintendent of Public Instruction, Oklahoma City, Oklahoma, 1951, p. 3.

5/Improvement of Instruction in Industrial Arts, op. cit., p. 50.

6/A Guide to Improving Instruction in Industrial Arts, op. cit., p. 13.

Industrial arts, as a part of general education, does not have a set of objectives which industrial arts alone supports but it does make unique contributions to objectives which are common to the entire school program. Industrial arts is basically a shop or laboratory subject area; it emphasizes the use of tangible media and the problem solved usually results in concrete things; it provides for extensive expressional opportunities; it provides experiences in which the learning takes place through the sense of feeling or touch in conjunction with the avenues of seeing and hearing; it is conducive to informal class organization patterns; it derives its content from the world of work.

Quite obviously some of these features are shared with the physical sciences, some with the social sciences, some with the arts. Hence, a statement of objectives associated with an industrial arts curriculum constitutes points of emphasis rather than jurisdictional boundaries.

How the objectives are implemented.-- In general, industrial arts objectives have been supported in the literature in two different ways: (1) through lists of "Things Pupils Should Learn To Do" and "Things Pupils Should Know"; and (2) through lists of suggested pupil activities, including projects.

The lists of "Things Pupils Should Learn To Do" and "Things Pupils Should Know" usually are derived through job analysis. Hornbake points out a serious objection to such implementation of industrial arts objectives when he says in part:[1/]

> The trade and job analysis procedure is indispensable for developing instructional materials where the purpose is to teach a person a trade or to have him perform successfully in a designated job or occupation. But when the purpose shifts to general education, with its numerous social-competence and individual growth objectives, the application of job analysis is open to question.

Wilber also objects to job analysis as a means of deriving industrial arts goals. In discussing the job analysis techniques, which were

1/R. Lee Hornbake, "The Price of Tradition," The Industrial Arts Teacher (December, 1951), 11:4.

developed in training workers during World War I and which were taken over by industrial arts teachers following the war, he says:[1]

> The ineffectiveness of such devices [job analysis] in relation to the attainment of industrial arts objectives has now been fairly well established, especially in teaching students to solve their own problems. Yet, it is interesting to note the extent to which the use of such techniques and devices still persists in many industrial arts classrooms.

While job analysis seems to be losing favor as an industrial arts curriculum-planning device, analysis of objectives appears to be gaining acceptance. The Industrial Arts Policy and Planning Committee suggests that objectives should be analyzed into (1) student behavior which characterizes the objective, (2) activities for effecting the desired behavior, and (3) evaluation data.[2]

Suggested pupil activities are usually stated in general terms. For example, this suggestion is given for attaining the objective "Interest in Industry":[3] ". . . . Attempt in varied ways to increase the mechanical and industrial vocabularies of pupils." Again, to attain the objective "Cooperative Attitudes," this activity is suggested:[4] ". . . . Instruct about the causes of discharge and separation from industrial jobs, about factory safety programs, time study services, training arrangements, and personnel management activities."

Such general suggestions do not readily fit into a standardized

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1/Gordon O. Wilber, "Industrial Arts and the Pedagogical Lag," School Shop (September, 1952), 12:10.

2/A Guide to Improving Instruction in Industrial Arts, op. cit., p. 13 ff.

3/Improvement of Instruction in Industrial Arts, op. cit., p. 53.

4/Ibid.

pattern for teaching and testing according to traditional methods; nor is it the intention that industrial arts teaching should be standardized. It is quite possible, nevertheless, that teachers are more likely to use specific suggestions than they are to use generalities.

Industrial arts objectives and teaching materials.-- It is reasonable to assume that the writers of textbooks and tests and the designers of all kinds of instructional equipment for industrial arts would follow the lead of the published and widely accepted objectives of industrial arts. If any of the objectives are inappropriate or lack adequate specificity, the instructional materials likely would have the same deficiencies.

3. Review of Related Literature

Research in the field of industrial arts metalwork.-- The research literature gives little evidence of previous investigations specifically concerned with the objective determination of industrial arts metalwork goals and their relative importance in general education. There have been a number of studies, however, concerned with the content of industrial arts metalwork in terms of operations and related information.

Activities of the American Vocational Association Committee.-- The most important study of the above-mentioned kind is the one made by the American Vocational Association Committee on Standards of Attainment in Industrial Arts Teaching. Since its appointment in 1928, this Committee has continuously studied pertinent literature and has enlisted the cooperation of several thousand teachers and supervisors in all parts of the United States. In a report of the Committee which was published in 1948 1/

1/Ibid.

is the general conclusion that "industrial arts teachers desire to make worthy changes in their pupils, changes which may be roughly classified as doing, knowing, and being improvements." The bulletin contains long lists of things that may be done and of informational items for eighteen different industrial arts subjects or fields. For metalwork, the numbers of items shown in Table 1 were listed.

Other industrial arts metalwork studies.-- Industrial arts metalwork operations and related information in ten different areas (art metal, bench metalwork, forging, foundry, jewelry, machine shop, sheet metal, spinning, arc welding, and gas welding) were studied by Russell[1/] to determine their importance in teacher education. Juries of outstanding teachers of metalwork, industrial arts supervisors, and teacher trainers in industrial arts metalwork participated in the study. Russell found that there was good agreement between the three juries. He also found that the over-all objectives being stressed by the teachers had little relation to the operations or items of information included in secondary school courses.

Trade analysis was used by Benson[2/] to determine what information should be included in a resource unit for industrial arts machine shop. Suggestions for pupil activities in the areas or manipulative work, technical information, guidance, and general information were developed.

An analysis of projects in terms of the objectives of industrial arts and of general education was made by Willings.[3/] Through the jury technique

1/Ellsworth M. Russell,"An Analysis of Areas, Units, Operations and Related Information of Industrial Arts Metalwork for Teacher Education," Unpublished Doctor's Dissertation, Pennsylvania State College, 1950.

2/Willard A. Benson, "A Resource Unit for Machine Shop," Unpublished Master's Thesis, The Stout Institute, 1949.

3/Billy J. Willings, "Appropriate Sheet Metal Projects for a Unit Course in Industrial Arts Sheet Metal," Unpublished Master's Thesis, Agricultural and Mechanical College of Texas, 1950.

Table 1. Industrial Arts Metalwork Subjects or Fields and Number of Items To Be Learned a/

Industrial Arts Metalwork Subject or Field	Number of Things Pupils Should Learn To Do	Number of Things Pupils Should Know
(1)	(2)	(3)
Art metal work..................	43	17
General metalwork..............	57	22
Sheet metal work...............	70	22
Machine shop work:		37
Hand or bench work...........	57	
Machine work:		
All machines...............	5	
Engine lathe...............	53	
Drill press................	20	
Shaper.....................	22	
Planer.....................	17	
Milling machine............	34	
Grinder....................	4	
Power hack saw.............	8	
Forging........................	49	17
Foundry work...................	43	17

a/Improvement of Instruction in Industrial Arts, op. cit., pp. 24-25, 30-39.

he found that the design of the project is of great importance in meeting the objectives set up. He also found that practice work was not necessary for making the selected projects.

An analysis of textbooks was made by Luehring[1] to develop a questionnaire which was sent to teachers in an effort to determine the content of a general metalwork course as a part of an industrial arts general shop. An examination of textbooks in relation to industrial arts metalwork content was made by Lane[2] in an effort to determine the use of text and reference materials. He found that these materials had a significant effect on pupil marks.

Certain aspects of metalwork have been the subject of a number of investigations. Riccelli,[3] Van Arsdale,[4] and Martin[5] examined the literature on oxy-acetylene welding as related to industrial arts teaching. Coleman[6] and Van Liew[7] investigated wrought iron work.

1/Arthur H. Luehring, "General Metalwork for the Junior High School," Unpublished Master's Thesis, Indiana State Teachers College, 1934.

2/Irving Eugene Lane, "A Study of Text and Reference Material Used for Industrial Arts Metalworking in the Secondary Schools of California," Unpublished Master's Thesis, Oregon State College, 1942.

3/John J. Riccelli, "A Proposed Resource Unit for Oxy-Acetylene Welding in the Senior High School Industrial Arts Program for the State of Wisconsin," Unpublished Master's Thesis, The Stout Institute, 1947.

4/Gordon Duncan Van Arsdale, "Welding as a Medium of Instruction for Industrial Arts," Unpublished Master's Thesis, Oregon State College, 1947.

5/Anthony J. Martin, "Oxy-Acetylene Welding as Content Study for Industrial Arts," Unpublished Master's Thesis, Ohio State University, 1949.

6/Ralph Monroe Coleman, "To Determine a Satisfactory Course of Study in Ornamental Iron Work for Senior High Schools in Terms of Pupil Interests, Home Needs, Good Design, and by Analysis of the Field," Unpublished Master's Thesis, North Texas State College, 1939.

7/Wayne Van Liew,"Wrought Iron as a Unit in the General Metal Shop of a Junior High School," Oklahoma Agricultural and Mechanical College," Unpublished Master's Thesis, 1950.

Metallurgical information was considered for appropriateness in industrial arts metalwork by Lynn,[1/] Miller,[2/] Wald,[3/] and Duffey.[4/]

The content of industrial arts metalwork itself was analyzed by Wilson[5/] to determine the science principles involved.

A number of status studies have been made. For example, Brierley[6/] made a survey of metalwork teachers in forty-one states to develop content for a local course of study in general metalwork. To discover the type and number of machine shop operations taught in industrial arts. Knoss[7/] surveyed the practices in thirty-four Minnesota high schools. Hockey[8/] used a questionnaire to determine on what grade levels general metalwork operations and information are taught.

<u>Studies in other fields</u>.-- Several investigations in fields other than industrial arts are mentioned here (1) to support the idea of lists of concepts and skills as a worthy research outcome; and (2) to show that the research techniques used in the present study are appropriate for

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1/John M. Lynn, "A Content Study of Aluminum for Industrial Arts Classes," Unpublished Master's Thesis, Ohio State University, 1936.

2/Harvey W. Miller, "A Study of Tin as Content for Industrial Arts," Unpublished Master's Thesis, Ohio State University, 1936.

3/Arthur B. Wald, "Copper as Content for Industrial Arts," Unpublished Master's Thesis, Ohio State University, 1937.

4/Robert M. Duffey, "Lead as Content for Industrial Arts," Unpublished Master's Thesis, Ohio State University, 1944.

5/Paul L. Wilson, "Science Involved in the Teaching of General Metal," Unpublished Master's Thesis, Colorado State College of Education, 1940.

6/R. G. Brierley, "A Course in General Metalworking for Birmingham, Michigan,"Unpublished Master's Thesis, The Stout Institute, 1942.

7/Forrest Fred Knoss,"Machine Shop Operations in Industrial Arts taught in High Schools in Minnesota," Unpublished Master's Thesis, Iowa State College, 1948.

8/Lawson E. Hockey, "Course Content in General Metal for Industrial Arts," Unpublished Master's Thesis, Iowa State College, 1941.

investigations of this kind.

In the field of science education, Wise[1] developed a list of principles that were most important for general education. To find what science principles should be included in the elementary curriculum, Leonelli[2] used two juries of seventeen science specialists and sixty-seven teachers, respectively. In a similar investigation, Miles[3] used a single jury of five specialists to determine the relative desirability of the concepts, previously developed by Wise,[4] for a high school physical science course. Miles used a three-point rating scale, asking his respondents to check the principles as <u>essential</u>, <u>desirable</u>, or <u>undesirable</u>.

Ross[5] developed a list of 720 concepts of occupational information through an analysis of twenty-four textbooks. The list was submitted to fifteen jurors who checked the concepts as <u>essential</u>, <u>desirable</u>, or <u>ineffectual</u> in general education, and the resultant rank order of concepts was determined by weighted mean or Z-scores. Ross concluded that all high school youth should master the twenty-eight concepts which were rated as

1/Harold E. Wise, "A Determination of the Relative Importance of Principles of Physical Science to General Education," Unpublished Doctor's Dissertation, University of Chicago, 1941.

2/Renato Edmund Leonelli, "The Selection and Grade Placement of Physical Science Principles in the Elementary School Curriculum," Unpublished Doctor's Dissertation, Boston University, 1952.

3/Vaden Willis Miles, <u>A Determination of the Principles and Experiments Desirable for a High School Course of Integrated Physical Science</u>, Doctor's Dissertation, University of Michigan, 1947 (Edwards Brothers, Ann Arbor, 1950).

4/Harold E. Wise, <u>op. cit</u>.

5/Maurice James Ross, "Concepts of Occupational Information in General Education for Secondary School Youth," Unpublished Doctor's Dissertation, Boston University, 1951.

essential and that they should be at least acquainted with the 659 concepts which were checked as desirable. Moreover, the essential and desirable items are bases for instruction of all youth sometime.

In the field of health education, Merrill[1/] searched thirty-six different health textbooks, fourteen safety textbooks, thirty-six issues of Hygeia, and tables of vital statistics to develop a list of 305 health concepts. This list was then submitted to two five-person juries (one member in each of five categories) to determine the suitability of the concepts to the needs and interests of elementary-school pupils. A five-point rating scale was used for the purpose of weighting the concepts for arrangement in rank order. The correlation between responses of the two juries was 0.89. Also, Merrill found general agreement as to content and method among the authors of teaching materials.

In a similar study at the secondary-school level, Staton[2/] examined ten textbooks and thirty-six issues of Hygeia in developing a list of 736 fundamental concepts for healthful living. With the assistance of two three-person juries, Staton classified the items as major or minor concepts and ranked them in order of suitability for secondary-school instruction. The coefficient of correlation between responses of the two juries was .66 on 251 major concepts and .63 on 279 minor concepts.

1/Charles Donald Merrill, "A Determination of Concepts of Healthful Living Which Are of Functional Value in Contributing to the General Education of Elementary School Pupils," Unpublished Doctor's Dissertation, Boston University, 1949.

2/Wesley Morgan Staton, "A Determination of Fundamental Concepts of Healthful Living and Their Relative Importance for General Education at the Secondary School Level," Unpublished Doctor's Dissertation, Boston University, 1948.

A two-point rating scheme was used by Arnold[1/] in determining which of 288 items dealing with school administration are desirable or undesirable for teacher participation. The items were ranked in order of the per cent of the 102 graduate-student respondents which indicated the item was desirable.

4. Definitions of Terms Used in This Study

In order that all persons participating in this investigation might have a common understanding of certain important terms, descriptive definitions were prepared for their use. These were supplied to respondents in the form of questions and answers, as shown in Appendix A on page 185.

General education.-- Bergman[2/] defines general education as

> . . . . that broad, integrated, non-vocational and non-specialized part of a person's education which leads to personal growth and responsible citizenship by preparing him for satisfactory adjustment to the needs and problems of his environment, and for active participation in the many aspects of living.

Brandwein[3/] indicates that while general education is difficult to define,

> . . . . it can be clearly recognized if one looks at the process operationally. The process starts with the question, "Why are we giving this course?" continues with an investigation of the needs and interests of the students in terms of problems of living rather than in terms of subject matter, leads into experientation with consequent evaluation in terms of the objective of the course, and

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1/Dexter Otis Arnold, "Teacher Sharing in School Administration," Unpublished Doctor's Dissertation, Boston University, 1951.

2/George J. Bergman, "Definitions of General Education," Educational Administration and Supervision (December, 1947), 33:460.

3/Paul F. Brandwein, "The College Board's Science Tests," The Science Teacher (April, 1952), 19:3.

> develops into a dynamic relationship between teacher and student wherein both are engaged in getting significant information and experience in the solution of meaningful problems of living. The process never ends; it is its own motivation.

Statements such as these are difficult to use as a guide in determining the importance in general education of abilities, attitudes, and concepts treated in industrial arts metalwork teaching materials. Yet, as stated by Chamberlain and Buchler,[1]

> . . . . when one describes general education as "what every man should know," one conveys the impression of factory-like training, of deadly homogeneity, of mass packages of knowledge distributed to patiently waiting students. . . . We prefer to think not of "what every man should know," but of the experiences and methods that we have found to be conducive to literacy and to the urge for further understanding.

The items to be evaluated in this study as important or unimportant in general education, therefore, are potential <u>teacher's</u> objectives. They are <u>not</u> materials to be presented directly to students. They are specific <u>clues</u> to the kinds of experiences that should be provided students.

In view of the foregoing explanation, the following definition is used in this study:

> <u>General education consists of those abilities, attitudes, and concepts everyone should have an opportunity to learn, regardless of vocation, social or economic status, or other specialized considerations.</u>

<u>General metalwork</u>.-- Industrial arts, as a phase of general education, concerns itself with the materials, processes, and products of manufacture, and with the contributions of those engaged in industry.

> <u>General metalwork, or industrial arts metalwork, is that aspect of industrial arts which is concerned with metals, metalworking processes, metal products, and with the relations of the metalworking</u>

1/Lawrence H. Chamberlain and Justus Buchler, "Specialization of General Education," <u>School and Society</u> (May 3, 1952), 75:274-275.

industries to social and economic life.

Meaning of "importance in general education."-- Because items in the check list were to be classified as important or unimportant in general education, the following statement was given to respondents to help in their evaluation:

> The term importance refers to how important it is that everybody have a chance to acquire the particular knowledge or ability. It is not a question as to where it will be acquired. The items are to be thought of in terms of such questions as: How frequently is this useful? How many people will have use for it? Will it help people to have a better understanding of modern industry and our industrial society? Will it help people to become better citizens? Better consumers? Will it help a person perform common jobs as "man of the house"? Will it help a young person plan his future education? Will it provide a useful background for other learnings such as scientific, mathematical, and social?

Meaning of "emphasize."--

> Emphasize in industrial arts or in some other course means that learning experiences (laboratory, discussion, reading, and so forth) should be planned specifically for the purpose of bringing about the learning.

5. Summary

1. The purposes of this study are: (1) to analyze the topics included under the published objectives recognized by industrial arts leaders for teaching industrial arts metalwork; (2) to determine the significance of the topics in a program of general education; (3) to determine where in the curriculum the topics should be emphasized; and (4) to draw from the findings implications for all areas of industrial arts work.

2. Industrial arts is a phase of general education.

3. There is evidence that the general-education aspect of industrial arts is not clearly understood by people in the field.

4. The broad objectives for industrial arts are well established and generally accepted by industrial arts people.

5. Specific industrial arts goals seem to be derived by job analysis, a technique which has been questioned as a means of developing valid industrial arts curricula.

6. Pupil activities suggested for meeting objectives usually are non-definitive.

7. Industrial arts instructional materials tend to follow the published objectives and specific goals.

8. Most research on industrial arts metalwork has been in terms of operations and related knowledge rather than in terms of general education objectives.

9. Research in other educational fields supports the idea that lists of concepts and skills are a worthy outcome.

10. Research procedures used in investigations in the fields of science, health, guidance, and school administration indicate that the techniques used in this study are appropriate.

CHAPTER II

RESEARCH PROCEDURES AND TECHNIQUES

1. Analysis of the Problem

Determination of items.-- In previous curriculum studies in the field of industrial arts metalwork, the investigator usually has analyzed content in terms of "things people should learn to do" and of "things people should know." The resulting lists of topics do not seem to be in keeping with modern definitions of general education or of industrial arts, because the emphasis is on content rather than on changes in behavior of individuals. On the other hand, lists of suggested experiences usually are not sufficiently definitive to be of greatest help to teachers in directing the learning of pupils. In this study the curriculum items to be evaluated are considered as potential teacher's objectives and not as materials to be presented directly to pupils. The items are closely related to pupil experiences, however, because each item should suggest to teachers certain pupil experiences which might be arranged to help bring about desirable changes in the behavior of pupils. Some of the items are definitions; others are statements of principles; still others are concepts of various kinds. To teachers of industrial arts metalwork and curriculum planners in the industrial arts field each item will represent an ability, an attitude, or a concept the acquisition of which will affect the behavior of the learner.

Classification of items.-- The following classifications are used in this study to facilitate grouping items and handling data:

A. General Information
B. General Mechanical Knowledge
C. Metals and Metallurgy
D. Layout and Measuring
E. Hand Work
F. Machine Work
G. Assembly and Fabrication
H. Sheet Metal Work
I. Foundry Work
J. Forge Work
K. Welding
L. Pipe Work
M. Metal Finishing, Ornamentation, and Preservation

Establishing relative importance of items.-- One of the purposes of this study is to determine the significance of industrial arts metalwork curriculum materials in a program of general education. Three types of workers in the field of education are most likely to be concerned about this problem: (1) general educators, (2) industrial arts supervisors and teacher trainers, and (3) teachers of general metalwork. If certain teachers' goals are considered important in general education by a substantial majority of all three of these types of workers in education, those goals might well be considered as being of major significance. The goals which are considered important by the greatest number of general educators, industrial arts specialists, and general metalwork teachers might be considered as of greater importance than other goals which are considered important by fewer educators. Teacher's goals, then, may be arranged in rank order of importance in general education on the basis of reactions of appropriate workers in education.

To determine where in the curriculum industrial arts metalwork goals should be emphasized was another purpose of this study. The same three types of workers in education are concerned with this problem as are concerned with the importance of industrial arts metalwork goals. Those goals which are considered important in general education and which at the same time are suggested by a substantial majority of all three types of educators for emphasis in industrial arts courses are the ones which probably offer the greatest possibilities for serving general education purposes in industrial arts programs. Those goals which are considered important in general education and at the same time are suggested for emphasis in other courses as well as in industrial arts are goals which suggest the need for correlation and integration in curriculum planning. Those goals which are considered important in general education but which are suggested for emphasis in other courses more often than in industrial arts probably can be implemented more effectively in other courses.

Suggested procedures.-- In view of the nature of data needed in this study, the use of a check list with selected respondents seems appropriate. The selection of items for the check list, preparation of the instrument, the selection of respondents, and statistical procedures will be discussed in the next section.

2. Research Procedures

Analysis of teaching materials.-- To build the check list of concepts, attitudes, and abilities everyone should have a chance to learn, an analysis was made of (1) ten industrial arts metalwork textbooks published since 1941, (2) articles in industrial arts professional journals published since

1941, and (3) state and city courses of study and industrial arts bulletins. A list of these sources is given in Appendix B on page 188. The list includes three books which were published after the check list was prepared, but their examination produced no additional items.

As discovered, the items were recorded on 4" x 6" cards. To avoid vagueness, each item was recorded as a complete, declarative sentence. In some instances it was necessary to prepare a statement based on an outlined item or on an implication set forth in the source materials. For example, a topic such as "Working conditions" in itself is too general to be of use in this study. Items such as "Hours of employment," "Training required for employment," "Earnings," "Employment opportunities," and "Stability of employment," on the other hand, could be expressed in a specific manner. Items such as these were recorded as complete sentences so as to provide a basis for objective classification and statistical treatment. The procedure of translating and telescoping items was that described and used by Charters and Waples in the Commonwealth Teacher-Training Study.[1/]

Standard for accepting items.-- As indicated earlier (page 5), it is likely that the same textbooks are used for both vocational-industrial education and industrial arts education. Furthermore, there are various ideas as to what are appropriate outcomes of industrial arts metalwork instruction. Obviously, then, the course outlines and materials of instruction would in some instances include items far beyond the scope of general education. An item was accepted for use in this study (1) if it occurred in three or more of the sources, and (2) if it did not, in the opinion of the

1/W. W. Charters and Douglas Waples, The Commonwealth Teacher-Training Study, University of Chicago Press, Chicago, 1929.

investigator, represent an extremely specialized aspect of metalworking. No attempt was made to record all items which were present in the source materials. Selection was made at the time the materials were read for the first time, and no re-reading was done to search for items which may have been overlooked.

Textbooks provided the greatest number of items for the check list. One textbook in particular, Ludwig's Metalwork Technology and Practice,[1] was especially fruitful. After items were selected from it, further reading in other sources produced relatively few additional items.

To provide a ready check on the reliability of the instrument, certain items were included which, in the opinion of the investigator, were inappropriate because of their highly specialized nature. As Arnold found,[2] consistent rejection of such items was an indication of reliability. But since all the items included in the check list used in this study were taken from actual industrial arts teaching materials, it is apparent that universal rejection of any one item could not be expected.

The list of items finally selected for use in the check list was too long, in the opinion of some of the respondents. Koos,[3] too, warns that a check list should be kept as short as possible. Nevertheless, there was no item in the final list which, in the opinion of at least some respondents did not measure up to their idea of important enough so that everyone should

1/Oswald A. Ludwig, Metalwork Technology and Practice, McKnight and McKnight Publishing Company, Bloomington, Illinois, 1943.

2/Dexter Otis Arnold, "Teacher Sharing in School Administration," Unpublished Doctor's Dissertation, Boston University, 1951, p. 12.

3/Leonard V. Koos, The Questionnaire in Education, The Macmillan Company, New York, 1928, p. 149.

have an opportunity to acquire it. Item Number 98 which has to do with the composition of cast iron, was the item least acceptable to the general educators. Only three of them checked it as important; but, using the same criteria of evaluation, 50 per cent of the supervisors and teacher trainers and 54 per cent of the general metalwork teachers apparently felt the item was significant enough to warrant its being checked as important. In all, there were only five items in the entire check list (numbers 62, 89, 93, 98, and 109) which were not considered important in general education by thirty-three or more of the sixty-six respondents who participated in the study.

Preparing the check list.-- The 354 items which were in the final list selected for use in this study were to be presented to selected respondents in such a manner as might:

1. Produce a rank order of importance in general education
2. Indicate whether the items were appropriate outcomes of industrial arts instruction
3. Indicate whether the items were appropriate for inclusion in courses other than industrial arts or in addition to industrial arts
4. Indicate whether the items should be taught (or learned) through in-school or out-of-school experiences
5. Indicate whether the items were of such a nature that attention should be given to correlation with various studies in the curriculum

At the outset, the items were set up in such a manner that the respondents might weigh the importance of each item on a six-point scale. Items that were considered of greatest importance were to be scored as 5; items of more than average importance, 4 points; average importance, 3 points; less than average importance, 2 points; least importance, 1 point; and no importance in general education, 0 points. The writer checked the items himself according to that scale three different times at intervals of approximately two weeks. He found that his responses were consistent primarily in just one respect: the items that he scored zero were scored that way each time. Similar experimentation was done with a three-point scale, with somewhat more consistent results. In the final check list a dichotomous situation was set up; the items were to be considered either as important or as unimportant.

The reactions of the members of a research seminar at Boston University were influential in determining the rating scale that was finally used. Confronted with printed copies of the check list in which a three-point rating scale was used, the members of the seminar--all of whom would be classed as general educators rather than as industrial arts specialists--indicated they could react to the items as important or unimportant but that they would not care to refine their judgments beyond that. No attempt was made to determine the relative reliability of the various rating scales considered.

<u>Preliminary tryout of the check list</u>.-- Since the respondents who would ultimately react to the check list would be general educators, industrial arts supervisors and teacher trainers, and general metalwork teachers, the check list was submitted to one person in each of those categories for the purpose of checking (1) the accuracy of the items, (2) the clarity of the instructions, and (3) the general usability of the instrument. This valuable assistance was given by the following people:

General educator

Dr. Roy O. Billett, Professor of Education, Boston University

Industrial arts supervisor and teacher trainer

Dr. Ray M. Stombaugh, Professor of Industrial Arts Education, Illinois State Normal University

General metalwork teacher

Floyd L. Keith, Professor and Head of Metalwork Department, The Stout Institute

As a result of the preliminary checking by these three people, numerous refinements were made in the statement of the items. The try-out of the instrument indicated (1) that the check list as set up was comprehensible, (2) that its use would result in discrimination between items, and (3) that the data obtainable through its use would be categorically useful.

Selection of juries.-- Because of known differences of opinion among educators concerning the nature of industrial arts objectives and their relationship to general education, the juries used in this study are larger than those used in most studies of a similar nature in other fields of education. Also, larger-than-usual juries were used so the findings of this study would represent the leading opinion from various parts of the country.

The purpose of this study was not to determine current practice but rather to point toward ideal practice. The jurors whose responses were to be obtained, then, were selected in terms of their professional leadership in education. No mere cross-section of educational opinion would be adequate. In general, three criteria were used in selecting respondents:

1. Professional degrees held

2. Position of influence

3. Recommendation by person whose opinion on the matter is valued

Considerable help was obtained in selecting the respondents. The consultant on industrial arts in the United States Office of Education suggested a number of names as did several teacher trainers and supervisors of industrial arts. Other people were selected because of their authorship of textbooks or articles in professional journals. An attempt was made to have jury members in each classification from similar schools in different parts of the country. A complete list of respondents is given in Appendix C on page 194.

Twenty-five people were solicited for membership on each of the three juries. This number was chosen because that many returns provides a reliable basis for conclusions. Charters and Waples,[1/] in their Commonwealth-Teacher-Training Study, found that ". . . . the predicted coefficient of correlation between the ratings of twenty-five persons and an infinite number was 0.949 ± 0.015."

A copy of the check list and a set of questions and answers concerning the study were sent to each prospective juror. (See appendices A and D.) The response was extremely gratifying. Twenty general educators, twenty-two industrial arts supervisors and teacher trainers, and twenty-four general metalwork teachers responded to the check list with usable data. As the responses were tabulated, it soon became apparent that further responses would not materially alter the findings, so an aggressive

1/W. W. Charters and Douglas Waples, op. cit., p. 70.

follow-up was not used in an attempt to obtain a one hundred per cent response or to have twenty-five responses in each category. It should be stated here, however, that a reply of some kind was received from all but one of the seventy-five people to whom the request for assistance was sent.

It is the writer's belief that the excellent response to his request for assistance is an indication that the juries were composed of people who have a sincere professional interest in industrial arts and in general education. Several of the respondents took time to write extensive comments which contributed greatly to the writer's interpretation of the data.

Reliability of the responses.-- In an effort to establish the fact that the opinions of the jurors in this study are relatively consistent, the juries were divided into random halves and the rank-difference method used to compute a coefficient of reliability. Such coefficients were obtained for the responses of each jury on each of the thirteen groups of items. The Spearman-Brown Prediction Formula was used to correct the coefficients to what they might have been had the check list been used by the same respondents a second time rather than just once on a paired-half basis. These coefficients are given in Table 2. With a few exceptions, the coefficients seem to indicate that the method of the study is adequate for the purposes intended. Although the differences are not great, the higher coefficients seem to show a better consensus with regard to the general education function of industrial arts among general educators than among specialists in the industrial arts field. This may be because the purposes of general education are better understood by general

Table 2. Coefficients of Reliability of the Responses of the Three Juries, as Computed by the Rank-Difference Method

Parts of the Check List	Number of Items	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)	(6)
A. General Information......	32	.76	.74	.78	.76
B. General Mechanical Knowledge..................	51	.87	.72	.66	.75
C. Metals and Metallurgy....	53	.88	.77	.82	.82
D. Layout and Measuring.....	30	.89	.71	.79	.79
E. Hand Work................	44	.86	.84	.77	.82
F. Machine Work.............	31	.89	.68	.62	.73
G. Assembly and Fabrication.	18	.93	.76	.58	.76
H. Sheet Metal Work.........	21	.75	.74	.82	.77
I. Foundry Work.............	10	.73	.94	.36	.68
J. Forge Work...............	14	.60	.65	.43	.56
K. Welding..................	17	.86	.62	.84	.77
L. Pipe Work................	12	.93	.85	.75	.84
M. Metal Finishing, Ornamentation, and Preservation.	21	.68	.77	.86	.77
Weighted averages.......	354	.84	.75	.73	.77

educators than by industrial arts specialists.

In Table 2 it will be noted that the coefficients given for certain parts of the check list are widely divergent. For example, for that part of the check list concerned with foundry work (Part I) the coefficients are given as 0.73, 0.94, and 0.36 for the three juries, respectively. However, if the rank order of the items in Part I as determined by the complete juries (rather than random-half juries) were used, the coefficient of reliability would be 0.82 between the general educators' responses and the responses of the supervisors and teacher trainers. It would be 0.85 between the responses of the supervisors and teacher trainers and the responses of the general metalwork teachers. On the basis of the data produced in this study, it appears that the opinions of industrial arts specialists, with regard to general education goals of industrial arts metalwork, are somewhat less consistent than the opinions of general educators.

The weighted average of the coefficients seems to indicate that the responses of each of the three juries for the entire check list are significantly reliable.

Treatment of data.-- In the chapters that follow, the responses of the jurors will be presented in a manner that will show for each of the three juries the percentages of respondents which checked each item as important in general education. The items will be arranged in rank order, the first-ranking items in each of the thirteen classifications being the ones that were checked as important by the greatest percentage of all respondents as a jury of the whole. Percentages were used rather than number of responses in determining the rank order of items, because the number of respondents was not the same in each jury.

Curriculum placement of items will be shown in percentage of all jurors who checked the items for emphasis in industrial arts, in some other course or courses, or in out-of-school situations.

3. Some Observations Regarding the Respondents' Reactions to the Check List

In general, the respondents followed the instructions given, without question. It is assumed, therefore, that the terms and methods used in the study were sufficiently clear. A number of respondents, however, took the trouble to write a statement explaining their viewpoint regarding the check list. Most of these extra comments were concerned with the definition of general education implied in the instructions: "General education consists of those abilities, attitudes, and concepts everyone should have an opportunity to learn, regardless of vocation, social or economic status, or other specialized considerations." For example, one respondent wrote:

> I interpreted the word "everyone" to mean all boys and girls and all men and women. This places most of the items which you have listed under the classification of the consumer aim, the household mechanics aim, and the creative handicraft aim of industrial arts.

Along the same line, another comment was:

> In your instructions, question 2, I would amend your answer to include "regardless of sex" as well as the other items mentioned. I think that everyone should have the opportunity to learn something of many kinds of things including metalwork. This does not necessarily mean that the schools have an obligation to teach everything that might be learned.

That the definition of general education given was taken by the respondents to include "everyone" is further indicated by still another person who wrote:

> I have interpreted "everyone" literally, i.e., to mean <u>all</u> persons living and being educated in our culture. I have <u>not</u> restricted "everyone" to mean only those who do take or who are eligible to take industrial arts in our schools. My criterion for selection has been simple speculation as to whether the person will need the implied experience to live effectively and with optimum understanding in our culture. In Part D, for example, I checked few items as "Important"--not because I regard drawing as unimportant but rather because I do not see these understandings or segments of knowledge as essential to all people.

Several of the industrial arts specialists found the all-inclusive concept of general education strange to their customary way of thinking.

For example, one teacher said:

> It was very difficult for me to consider "everybody" after nearly thirty years of dealing with pupils and people primarily interested in industrial arts subjects. To these people, all of your items were important, and to draw a line indicating only those important to everybody was extremely difficult for me.

Again, from another teacher:

> One of the difficulties of making proper evaluation of the 354 items is the inability of the respondent to separate the comprehensive learning units that we consider vital to a well-rounded course in general metalworking from the relatively limited list that would logically apply to any and all learners in general education. In other words, I have difficulty realizing that every pupil . . . . is not going to be exposed to the knowledge and skills of a thorough course in general metalworking.

4. Summary

1. The items considered in this study are intended to suggest pupil experiences which will help bring about desirable changes in behavior. They are not materials to be presented directly to pupils; they are learning products which might become educational objectives.

2. The workers in education most likely to be concerned with this problem are (1) general educators, (2) industrial arts supervisors and teacher trainers, and (3) general metalwork teachers.

3. The 354 items included in the check list were derived from textbooks, articles in professional journals, and state and city courses of study and curriculum bulletins.

4. A preliminary tryout of the check list indicated that it was (1) comprehensible, (2) that its use would result in discrimination between items, and (3) that the data obtainable through its use would be categorically useful.

5. The three juries which cooperated in this study represent a cross-section of national leadership in (1) general education, (2) industrial arts supervision and teacher training, and (3) general metalwork teaching.

6. The responses of all three juries are significantly reliable, as determined by the rank-difference method.

7. The responses of the jurors will be treated on a percentage basis in determining rank order of items in relation to general education.

CHAPTER III

IMPORTANCE AND CURRICULUM EMPHASIS OF INDUSTRIAL ARTS METALWORK GENERAL INFORMATION

1. Introduction

In this chapter and in the following two chapters the findings of this investigation will be reported primarily in a series of tables. For each part of the check list--A through M--a basic table will be used to list the items in order of importance in general education. Other tables will be used to bring out other aspects of the findings. This chapter deals entirely with the items of general information included in Part A of the check list.

2. Importance of Items in General Education

Items ranked in order of importance.-- The opinions of the members of all three juries--sixty-six different respondents--regarding the importance of the thirty-two items of general information listed in Part A of the check list are reported in Table 3. The items are ranked in order of importance, as determined from the jurors' responses. Item 1, for example, was checked as important by 100 per cent of the general educators, by 100 per cent of the supervisors and teacher trainers, and by 96 per cent of the teachers of general metalwork. Only one of the sixty-six respondents felt that item 1 was not sufficiently important to be checked

Table 3. Items of General Information Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items of General Information	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Man's ability to utilize metals of various kinds has been a major factor in the development of our present industrial civilization..................	100	100	96	98.7	91	84	29
2. The CIO usually represents all labor in large, concentrated industries; the A. F. of L. represents labor on a craft basis...	95	95	96	95.3	75	83	47
3. From two to five years is required to learn the skills and technical information of a skilled mechanical trade.......	95	95	92	94.0	83	69	22
4. Machines make work easier to do and at the same time increase production....................	95	95	88	92.6	75	85	35
5. When business is profitable, stockholders usually are paid dividends; when it is unprofitable, stockholders do not receive anything for the use of their money and value of their stock may decrease............	100	95	83	92.6	40	91	42
6. Manufacturing industries are usually located close to raw materials, fuel or power supply, transportation or distribution center, and to labor supply...	95	91	92	92.6	70	87	18

(continued on next page)

Table 3. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
7. A journeyman is one who has learned a skilled trade; an apprentice is one who is learning a trade systematically through work experience and related training...............	95	95	88	92.6	82	70	24
8. Both capital and labor are entitled to share in the profits from increased production......	100	77	96	91.0	50	88	47
9. The general economic welfare of our country is closely related to productivity of the metal industries. For example, good business in "heavy steel" means good business and good employment generally.................	85	95	92	90.7	62	87	33
10. More than 10 per cent of the people in the nation's labor force are directly or indirectly engaged in some phase of metalworking, and the proportionate number is likely to increase...	85	91	96	90.7	85	69	19
11. To succeed in the better paid and more responsible jobs in metalworking, a person must have aptitude in mathematics and science....................	90	86	96	90.7	85	77	24
12. Skilled workers are seldom without work, because they are among the last to be laid off when business is slack..............	95	77	100	90.7	78	66	39

(continued on next page)

Table 3. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
13. Sometimes parts of a product are made in different factories and then transported to another plant for assembly and distribution........................	100	82	88	90.0	73	70	22
14. Mass production usually requires such a large investment in plant and machines that it must be financed by groups of people who buy stock in a corporation which assumes the entity of owner and operator......................	100	86	83	89.7	50	84	39
15. The range of employment opportunities in metalworking is from common labor to mechanical and other phases of engineering; and every job is dependent upon every other job..........	90	91	88	89.7	85	64	24
16. Metal trades workers, especially skilled tradesmen, are employed in practically every industry as maintenance and repair men.....	80	86	96	87.3	80	59	22
17. Because many metalworking jobs are hazardous, rules for general conduct in shops as well as safety rules for each shop must be understood and consistently practiced by every metalworker.....	70	95	96	87.0	87	26	33
18. Approximately 10 per cent of the people employed in metalworking are mechanics or technicians—							

(continued on next page)

Table 3. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
jobs that require two or more years of specialized training. The other 90 per cent work as operatives or semiskilled workers--in jobs that can be learned in six months or less, usually on the job............	75	91	92	86.0	80	61	22
19. Highest skilled workers usually get the highest pay............	85	77	96	86.0	77	66	41
20. A trade is a manual or mechanical job or work at which a person earns his living........	90	73	88	85.6	71	65	19
21. For the consumer to benefit optimally from mass production, it is necessary for the manufacturing facilities and labor force to be used steadily, sometimes continuously with shutdowns only for needed repairs........	95	86	71	84.0	49	81	33
22. When times are hard, workers in all industries are affected....	95	82	75	84.0	67	74	32
23. In a factory in which the employees belong to a labor union, certain individuals are designated by the union as shop stewards to watch out for the interests of employees and to see that terms of the contract between the union and the company are carried out...............	90	82	79	83.7	63	68	39

(continued on next page)

Table 3. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
24. The management of large corporations is planned by a board of directors which is elected by the stockholders...............	100	73	75	82.7	31	82	35
25. Production and the demand for products must be kept in careful balance if manufacturing is to be done economically........	95	73	79	82.3	37	79	36
26. A machine operator runs only one machine, doing repetitive work. The machine is set up and adjusted for him by a machine setter, a skilled mechanic.....	85	91	71	82.3	76	38	22
27. Manufacturing is usually done under the direct control of a plant superintendent, with assistant superintendents or foremen directing the work in the various departments........	80	95	63	79.3	61	60	29
28. A machine hand earns his living by running only one kind of machine. In addition to operating the machine, he sets it up and makes needed adjustments...	80	82	75	79.0	72	38	22
29. When a worker in a union shop has a grievance, he carries it to the steward who in turn carries it to a representative of the company assigned to handle labor relations.........	80	73	79	77.3	55	65	38

(concluded on next page)

Table 3. (concluded)

Items of General Information	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
30. Corporations may elect officers, including vice presidents, to take charge of the various divisions such as engineering, legal, industrial relations, finance, public relations, distribution, and sales........................	90	73	67	76.7	29	76	29
31. Hours of employment in metalworking jobs are in general eight hours a day, five days a week........................	65	73	79	72.3	63	43	26
32. Wages change from time to time and may vary in different parts of the country.................	65	59	75	66.3	56	47	26
Mean......................	92	85	85	87.3	67	69	30

as "important enough that everybody should have a chance to acquire" the concept implied by the statement. Item 2 was checked as important in general education by all but three of the respondents, item 3 by all but four, and so on, in the order of decreasing acceptance of the items as important in general education. Item 32, the one ranked as important by the smallest number of respondents, was still considered important by two-thirds of the jurors. Since such a large majority of all three juries checked all the general information items as important in general education, each of these items should suggest to teachers and curriculum planners experiences which will help bring about desirable changes in the behavior of learners.

Opinions of general educators.-- With the exception of items 31 and 32 in Table 3, all the items were considered important by 75 per cent or more of the general educators who cooperated in the investigation. In no other part of the entire check list was there that degree of acceptance of items by the general educator group. The arithmetic means of the per cents indicate that the items of general information in Part A of the check list, for the most part, are considered more important by general educators than they are by industrial arts supervisors and teacher trainers and teachers of general metalwork. For no other part of the check list is that true.

Reliability of the responses.-- As shown in Table 2 on page 31, the data are fairly reliable indications of the opinions of the separate juries. The coefficients of reliability for the responses of the juries, as computed by the rank-difference method, were 0.76, 0.74, and 0.78 for the general educators, the supervisors and teacher trainers, and the general metalwork teachers, respectively. When the responses of the general educators are correlated with the responses of the other two juries, however, relatively low coefficients indicate considerable difference of opinion. The extent of this disagreement is indicated by the coefficient of 0.21, showing the relationship between the responses of the general educators and the responses of the supervisors and teacher trainers. A similar disagreement between the responses of the general metalwork teachers and the responses of the general educators is indicated by the relatively low coefficient of 0.18. There is comparatively good agreement between the responses of the general metalwork teachers and the responses of the supervisors and teacher trainers, the coefficient of correlation being 0.93.

Nature of high-ranking items.-- Aside from the first item in the check list, which was placed in the list as an obvious example of a general education goal, those items dealing with business and economic information were the ones which received 100 per cent acceptance by the jury of general educators. As shown in Table 3, items 5, 8, 13, 14, and 24 were checked as important in general education by all the general educators. Nine other items were rated as important by all but one of the twenty general educators. In the main, these highly acceptable items seem to represent information commonly known by the average well-educated adult. These items are all general in nature. Looking at the responses of the general educators which indicate the least acceptable items, it appears that the more detailed the item is, the less acceptable it is to general educators as a general education goal.

The juries of industrial arts supervisors and teacher trainers and of general metalwork teachers were close to unanimous regarding the importance of certain specific items which have to do with the social or economic significance of metalworking (Items 9 and 10 in Table 3), with safety rules (Item 17), and with occupational information (Item 18).

It was notable that the supervisors and teacher trainers gave a higher percentage of acceptance to items dealing with industrial organization and management than did the general educators or teachers (Items 26 and 27 in Table 3). A possible reason for this is that supervisors and teacher trainers commonly suggest use of an industrial-type organization for managing industrial arts shops. Through such an organization of classes they hope to facilitate activities and care of the shop and at the same time create a situation which will help pupils learn about industrial organization and management.

3. Emphasis in Industrial Arts Courses

Items checked as important not necessarily checked for emphasis in industrial arts.-- The respondents were asked to indicate where in the curriculum the various general information items should be emphasized. They were told that "Emphasize in industrial arts or in some other course" means that learning experiences (such as laboratory, discussion, or reading) should be planned specifically for the purpose of bringing about the desired learning. Table 4 shows how the jurors checked the thirty-two items of general information as to emphasis in industrial arts.

In Table 3 (pages 37-42) the items are arranged in order of importance in general education. In Table 4 (pages 46-51) the items are listed in order of emphasis in industrial arts. A comparison of the two tables

Table 4. Items of General Information Arranged in Order of Emphasis in Industrial Arts

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Man's ability to utilize metals of various kinds has been a major factor in the development of our present industrial civilization......................	95	86	92	91.0
2. Because many metalworking jobs are hazardous, rules for general conduct in shops as well as safety rules for each shop must be understood and consistently practiced by every metalworker.........................	70	95	96	87.0
3. The range of employment opportunities in metalworking is from common labor to mechanical and other phases of engineering; and every job is dependent upon every other job...........	85	82	88	85.0
4. To succeed in the better paid and more responsible jobs in metalworking, a person must have aptitude in mathematics and science....................	90	77	88	85.0
5. More than 10 per cent of the people in the nation's labor force are directly or indirectly engaged in some phase of metalworking, and the proportionate number is likely to increase......................	80	77	96	84.7

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Table 4. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
6. From two to five years is required to learn the skills and technical information of a skilled mechanical trade........	80	86	83	83.0
7. A journeyman is one who has learned a skilled trade; an apprentice is one who is learning a trade systematically through work experience and related training..................	80	86	79	81.7
8. Approximately 10 per cent of the people employed in metalworking are mechanics or technicians--jobs that require two or more years of specialized training. The other 90 per cent work as operatives or semiskilled workers--in jobs that can be learned in six months or less, usually on the job......................	75	82	83	80.0
9. Metal trades workers--especially skilled tradesmen--are employed in practically every industry as maintenance and repair men...	80	77	83	80.0
10. Skilled workers are seldom without work, because they are among the last to be laid off when business is slack...............	75	68	92	78.3
11. Highest skilled workers usually get the highest pay.............	70	73	88	77.0

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Table 4. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
12. A machine operator runs only one machine, doing repetitive work. The machine is set up and adjusted for him by a machine setter, a skilled mechanic..................	75	82	71	76.0
13. The CIO usually represents all labor in large, concentrated industries; the A.F. of L. represents labor on a craft basis......	70	91	63	74.7
14. Machines make work easier to do and at the same time increase production........................	70	91	63	74.7
15. Sometimes parts of a product are made in different factories and then transported to another plant for assembly and distribution.....	80	77	63	73.3
16. A machine hand earns his living by running only one kind of machine. In addition to operating the machine, he sets it up and makes needed adjustments..........	75	73	67	71.7
17. A trade is a manual or mechanical job or work at which a person earns his living..................	70	68	75	71.0
18. Manufacturing industries are usually located close to raw materials, fuel or power supply, transportation or distribution center, and labor supply..........	65	82	63	70.0

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Table 4. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
19. In a factory in which employees belong to a union, certain individuals are designated by the union as shop stewards to watch out for the interests of employees and to see that terms of the contract between the union and the employer are carried out........................	65	73	50	62.7
20. Hours of employment in metalworking jobs are in general eight hours a day, five days a week.........................	55	68	67	63.3
21. When times are hard, workers in all industries are affected.....	75	73	54	67.3
22. The general economic welfare of our country is closely related to productivity of the metal industries. For examplè, good business in "heavy steel" means good business and good employment generally..................	55	82	50	62.3
23. Manufacturing is usually done under the direct control of a plant superintendent, with assistant superintendents or foremen directing the work in the various departments.............	60	86	38	61.3
24. Wages change from time to time and may vary in different parts of the country..................	55	55	58	56.0

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Table 4. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
25. When a worker in a union shop has a grievance, he carries it to the steward who in turn carries it to a representative of the company assigned to handle labor relations................	60	59	46	55.0
26. Both capital and labor are entitled to share in the profits from increased production.......	40	64	46	50.0
27. For the consumer to benefit optimally from mass production, it is necessary for the manufacturing facilities and labor force to be used steadily, sometimes continuously with shutdowns only for needed repairs...	45	77	25	49.0
28. Mass production usually requires such a large investment in plant and machines that it must be financed by groups of people who buy stock in a corporation which assumes the entity of owner and operator......................	55	59	29	47.7
29. When business is profitable, stockholders usually are paid dividends; when it is unprofitable, stockholders do not receive anything for the use of their money and value of their stock may decrease..................	50	45	25	40.0
30. Production and the demand for products must be kept in careful				

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Table 4. (concluded)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
balance if manufacturing is to be done economically............	40	45	25	36.7
31. The management of large corporations is planned by a board of directors which is elected by the stockholders................	30	41	21	30.7
32. Corporations may elect officers to take charge of the various divisions such as engineering, legal, finance, industrial relations, public relations, distribution, and sales............	35	36	17	29.3
Mean........................	66	72	62	67

reveals that while most of the jurors feel the items are important in general education they do not necessarily hold that these items are similarly important as industrial arts goals. The correlation between the importance of the items in general education and their suggested emphasis in industrial arts courses was only 0.37, when computed by the rank-difference method.

Only one item in Table 4 (Item 1, which was intended to be obvious) was checked for emphasis in industrial arts by 90 per cent or more of the respondents. Nine items were so checked by 80 per cent or more of the respondents, and twelve items were so checked by 75 per cent or more of the respondents. Only six items failed to secure the approval of at least half the respondents for emphasis in industrial arts.

It is interesting here to note that the items which were rejected for emphasis in industrial arts by 50 per cent or more of the respondents were checked for emphasis in other courses by 76 per cent or more of the respondents. These items are listed in Table 7 on page 64.

<u>Nature of items most acceptable for emphasis in industrial arts</u>.-- In general, those items having to do with occupational information are the ones which gained the greatest acceptance as goals for industrial arts. Business and economic information items were rejected by one-fourth or more of the respondents as industrial arts goals. Less than half the respondents indicated that goals concerned with business organization and management should be emphasized in industrial arts.

<u>Degree of agreement between juries</u>.-- The arithmetic means of the percentages seem to show that the three juries were in fairly close agreement, on an over-all basis, regarding the emphasis that should be given to general information items in industrial arts courses. More supervisors and teacher trainers, however, checked items for such emphasis than did members of the other two juries. The arithmetic mean of the per cent of the responses of the supervisor-teacher trainer group was 72.4. For the general educators the comparable mean was 65.8 and for the general metalwork teachers, 62.0.

That industrial arts supervisors, teacher trainers, and teachers take seriously the responsibility for teaching safety is indicated by the support they gave Item 2 in Table 4. This item reads, "Because many metalworking jobs are hazardous, rules for general conduct in shops as well as safety rules for each shop must be understood and consistently practiced by every metalworker." From their responses, it would seem that general educators do not attach as much importance to safety instruction in industrial arts as industrial arts specialists do, although every general educator who checked the safety item as important in general education checked it also for emphasis in industrial arts.

The item pertaining to types of labor organizations was almost universally accepted by all three juries as important in general education; yet the same item was rejected for emphasis in industrial arts by about one-third of the general educators and teachers. This item, which ranked second in importance in general education and thirteenth for emphasis in industrial arts, reads: "The CIO usually represents all labor in large, concentrated industries; the A. F. of L. represents labor on a craft basis." Ninety-one per cent of the industrial arts supervisors and teacher trainers, on the other hand, indicated that labor union information, as implied by the foregoing statement, is not only important in general education but that it should be emphasized in industrial arts.

The general metalwork teachers accepted fewer general information items for emphasis in industrial arts than did either of the other juries. As shown in Table 5 following, six of the thirty-two items were checked for emphasis in industrial arts by fewer than 31 per cent of the teachers. Similarly, only one item (pertaining to management of corporations) was checked by fewer than 31 per cent of the general educators. The industrial arts supervisors and teacher trainers generally indicated that the items they checked as important in general education should also be emphasized in industrial arts courses. It is possible that general educators and industrial arts supervisors and teacher trainers have a broader concept than teachers have concerning the outcomes of shop instruction. Shop teachers, on the other hand, probably considered the items in terms of how they might implement them in their own program. Their rejection of items for emphasis in industrial arts may well have been based on practical considerations and actual experience with classes.

Table 5. Per Cent of Jurors Who Checked Items for Emphasis in Industrial Arts Courses

Per Cent of Jurors	Number of Items Checked		
	General Educators	Industrial Arts Supervisors and Teacher Trainers	General Metalwork Teachers
(1)	(2)	(3)	(4)
91-100	1	3	4
81- 90	2	9	6
71- 80	10	9	3
61- 70	7	4	6
51- 60	6	3	2
41- 50	2	3	4
31- 40	3	1	1
21- 30	1	0	5
11- 20	0	0	1
Total	32	32	32

<u>Additional items suggested by respondents</u>.-- As pointed out in the instructions to the respondents, the check list could not possibly contain all conceivable goals for general metalwork in an industrial arts program. The respondents were invited to add items they thought were

significant but which were not included in the check list. Of the additional items suggested, almost all of them fit into the category of general information rather than into the other categories considered in the analysis.

One respondent, a state supervisor of industrial arts, detailed his thoughts as follows:

> Check list shows a limited and scant coverage of:
>
> 1. Romance of the metalworking field, including historical background and industrial development of machines, leaders, etc.
>
> 2. Very limited coverage of social and economic factors related to the field of metalworking.
>
> 3. Limited coverage of safety factors and problems related to metalworking field.
>
> 4. Scant coverage of occupational information and guidance as it relates to shop information, i.e., training requirements, hazards, health, compensation, etc.
>
> 5. Overemphasis on machine shop area, or, conversely, a limited coverage of all other areas.

Another respondent had a somewhat similar thought when he suggested including an item that would help learners acquire information about "men who have been instrumental or famous in development of metalworking industry, i.e., Paul Revere as coppersmith, Henry Ford and mass production, Johannson and 'Jo' bloacks, Walter Chrysler the mechanic, etc." This same respondent also indicated that it was important in his opinion to provide for the kind of learning implied by this suggestion: "Typical life of metalworking apprentice in medieval craft guild--a meaningful picture of the ordinary individual's life during those times."

Other items suggested by respondents, which might fit into the general information category, were:

> . . . . Color has been used extensively in industry as a means of providing a more pleasant working environment.
>
> . . . . Many items formerly made of metal are now being made of plastics.
>
> . . . . Compressed air should not be used to clean machines or clothing.
>
> . . . . Work areas, tools, and machines should be kept clean, orderly, and in good working condition.

It seems appropriate here to state again that the list of items in the check list was derived from teaching materials and courses of study currently in use in industrial arts programs. No attempt was made to include other goals.

4. Emphasis in Other Courses

Items more acceptable for other courses than for industrial arts.--General educators and industrial arts specialists alike indicated that the general information goals of industrial arts should be emphasized in other courses. In Table 6, which follows, the thirty-two items of general information (Part A of the check list) are shown in the order of greatest acceptance for emphasis in courses other than industrial arts. Each of the items was checked for such emphasis by at least one-fourth of all the respondents, and all but five of the items were so checked by one-half or more of the respondents. The mean of the percentages was 78 for emphasis in courses other than industrial arts. The comparable figure for emphasis in industrial arts was only 67. Thus it would seem, on the basis of the data here given, the goals represented by the thirty-two items of industrial arts general information are slightly more acceptable for emphasis in other courses than they are in industrial arts.

It is possible that writers of industrial arts instructional materials have exceeded the purposes of their curriculum area in including some of these general information topics. On the other hand, general information items which are related to industrial arts and at the same time are suggested for emphasis in other courses should offer excellent bases for curricular correlation and integration.

Table 6. Items of General Information Arranged in Order of Emphasis in Courses Other than Industrial Arts

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. When business is profitable, stockholders usually are paid dividends; when it is unprofitable, stockholders do not receive anything for the use of their money and the value of their stock may decrease..............	100	91	83	91.0
2. Both capital and labor are entitled to share in the profits..	100	68	96	88.0
3. Manufacturing industries are usually located close to raw materials, fuel or power supply, labor supply, and a transportation or distribution center.....	95	82	83	86.7
4. The general economic welfare of our country is closely related				

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Table 6. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
to productivity of the metal industries. For example, good business in "heavy steel" means good business and good employment generally..................	90	82	88	86.7
5. Machines make work easier to do and at the same time increase production......................	95	86	75	85.3
6. Mass production usually requires such a large investment in plant and machines that it must be financed by groups of people who buy stock in a corporation which assumes the entity of owner and operator........................	100	73	79	84.0
7. Man's ability to utilize metals of various kinds has been a major factor in the development of our present industrial civilization.......................	95	75	83	83.7
8. The CIO usually represents all labor in large, concentraded industries; the A. F. of L. represents labor on a craft basis....	80	86	83	83.0
9. The management of large corporations is planned by a board of directors which is elected by the stockholders................	100	68	79	82.3
10. For the consumer to benefit optimally from mass production, it is necessary for the manufacturing facilities and labor force				

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Table 6. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
to be used steadily, sometimes continuously with shutdowns only for needed repairs.........	95	77	71	81.0
11. Production and the demand for products must be kept in careful balance if manufacturing is to be done economically............	95	68	75	79.3
12. To succeed in the better paid and more responsible jobs in metalworking, a person must have aptitude in mathematics and science.........................	80	77	75	77.3
13. Corporations may elect officers to take charge of the various divisions such as engineering, legal, finance, industrial relations, public relations, distribution, and sales............	90	68	71	76.3
14. When times are hard, workers in all industries are affected.....	95	64	63	74.0
15. Sometimes parts of a product are made in different factories and then transported to another plant for assembly and distribution.........................	95	64	50	69.7
16. From two to five years is required to learn the skills and technical information of a skilled mechanical trade........	90	68	50	69.3
17. A journeyman is one who has learned a skilled trade; an				

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Table 6. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educa- tors	Supervis- ors and Teacher Trainers	General Metal- work Teachers	All Respond- ents
(1)	(2)	(3)	(4)	(5)
apprentice is one who is learning a trade systematically through work experience and related training..................	90	68	50	69.3
18. More than 10 per cent of the people in the nation's labor force are directly or indirectly engaged in some phase of metalworking, and the proportionate number is likely to increase....	80	68	58	68.7
19. In a factory in which employees belong to a union, certain individuals are designated by the union as shop stewards to watch out for the interests of employees and to see that terms of the contract between union and employer are carried out........	70	68	67	68.3
20. Skilled workers are seldom without work, because they are among the last to be laid off when business is slack...............	80	55	63	66.0
21. Highest skilled workers usually get the highest pay.............	80	50	67	65.7
22. When a worker in a union shop has a grievance, he carries it to the shop steward who in turn carries it to a representative of the company assigned to handle labor relations..........	70	59	67	65.3
23. A trade is a manual or mechanical job or work at which a person earns his living................	90	59	46	65.0

(continued on next page)

Table 6. (continued)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
24. The range of employment opportunities in metalworking is from common labor to mechanical and other phases of engineering; and every job is dependent upon every other job..............................	80	59	54	64.3
25. Approximately 10 per cent of the people employed in metalworking are mechanics or technicians--jobs that require two or more years of specialized training. The other 90 per cent work as operatives or semi-skilled workers--in jobs that can be learned in six months or less, usually on the job...........	65	55	63	61.0
26. Manufacturing is usually done under the direct control of a plant superintendent, with assistant superintendents or foremen directing the work in the various departments	70	59	50	59.7
27. Metal trades workers--especially skilled tradesmen--are employed in practically every industry as maintenance and repair men.............	60	64	54	59.3
28. Wages change from time to time and may vary in different parts of the country............................	60	32	50	47.3
29. Hours of employment in metalworking jobs are in general eight hours a day, five days a week.............	55	27	46	42.7
30. A machine operator runs only one machine, doing repetitive work.				

(concluded on next page)

Table 6. (concluded)

Items of General Information	Per Cent of Jurors Who Checked Item for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
The machine is set up and adjusted for him by a machine setter, a skilled mechanic......	40	50	25	38.3
31. A machine hand earns his living by running only one kind of machine. In addition to operating the machine, he sets it up and makes needed adjustments....	35	50	29	38.0
32. Because many metalworking jobs are hazardous, rules for general conduct in shops as well as safety rules for each shop must be understood and consistently practiced by every metalworker..	30	36	13	26.3
Mean........................	80	64	62	78.0

Reactions of three separate juries.-- On the basis of the data, it would seem that the thirty-two items of industrial arts general information, on the whole, are also more acceptable to general educators than they are to industrial arts specialists for emphasis in other courses. The mean per cent of the responses of the general educators was 80. The comparable figure for the supervisor-teacher trainer jury was 64 per cent, and for the general metalwork teachers only 62 per cent.

Nature of items most acceptable for emphasis in other courses.-- As mentioned above, the responses of the jurors indicate that industrial arts instructional materials and courses of study include goals which might properly be included as goals in courses other than industrial arts. As a matter of fact, fourteen of the items were checked for emphasis in other courses more frequently than they were checked for emphasis in industrial arts, as was seen in Table 3 on pages 37-42. Of these items, several stand out prominently enough to indicate that they are probably more important in other courses than they are in industrial arts. In Table 7, on the following page, are listed those general information items which were checked for emphasis in industrial arts by one-half or fewer of the respondents and at the same time were checked for emphasis in other courses by more than three-fourths of the respondents.

Items which suggest desirability of curriculum correlation.-- In the instructions to respondents it was indicated that the items were not to be checked for emphasis in industrial arts or in some other course. If the respondent thought the item should be emphasized in some other course or courses as well as in industrial arts he was asked to so indicate. In Table 3 on pages 37-42 it was seen that each of the general information items received substantial support for emphasis in some other course or courses. It would seem that this fact points to certain areas for curriculum correlation--to kinds of goals in which other teachers and industrial arts teachers might well be interested cooperatively.

Table 7. General Information Items Which Were Checked for Emphasis in Courses Other Than Industrial Arts by 75 Per Cent or More of the Respondents and for Emphasis in Industrial Arts by 50 Per Cent or Fewer of the Respondents

Rank of Items in Importance	Abbreviated Item	Per Cent of Responses for Emphasis in	
		Other Courses	Industrial Arts
(1)	(2)	(3)	(4)
5	Profit or loss in business..................	91	40
8	Sharing the benefits from technology........	88	50
14	Ownership and financing of large industry......	84	50
21	Economic aspects of continuous production.....	81	49
24	Management of corporations engaged in metal manufacturing..........	82	31
25	Economics of balanced production.............	79	37
30	Divisions in an industrial organization.....	76	29

5. Emphasis in Out-of-School Situations

Lack of responses.-- For one reason or another, the respondents did not check the general information items for emphasis in out-of-school situations as frequently as they did for emphasis in industrial arts or in other courses. This may well be because a large proportion of the respondents do not attach importance to out-of-school experience as a means of achieving educational objectives. Another possible reason might be that, since the school has relatively little control over out-of-school situations, to suggest emphasis of an educational goal is largely academic. On the other hand, some of the respondents--22 per cent--apparently felt that if an item was important at all, it should be emphasized in every possible learning situation--in school or out--because they so checked the items.

Various points of view.-- From the nature of the responses to other parts of the check list regarding emphasis of items in out-of-school situations, it appears as though several of the respondents were suggesting that items should be emphasized in vocational courses. For example, items that were highly technical in nature and probably useful only to specialists were checked for emphasis out of school--presumably in vocational education because such items represent common content of vocational-technical instruction. Such items were included in the check list not because they were considered important in general education but because they would presumably help respondents in their discrimination between items of general education and items which are too highly specialized to be considered important that "everyone should have an opportunity to acquire the particular knowledge or ability." It is probably true that a similar point of view guided respondents to an extent as they checked the items of general information.

Another point of view that may have been held by respondents regarding out-of-school emphasis of industrial arts general information is that certain kinds of learning, while important to everyone, are not the primary responsibility of sxhools. Labor information, for example, might be of that kind.

Nature of items checked.-- As will be seen in Table 8 which follows, those items having to do with adult needs--information about labor organizations and other concerns of adults--are the ones checked for emphasis out of school by more than one-third of the respondents.

6. Summary

1. All the items of general information found in teaching materials and courses of study for industrial arts metalwork are considered important in general education by two-thirds or more of the sixty-six general educators, industrial arts supervisors and teacher trainers, and general metalwork teachers who participated in this investigation. The general educator jury, on the whole, gave somewhat greater acceptance to the importance of the items than did the juries of industrial arts specialists.

2. Items which were checked as important by most general educators were not necessarily considered important by a proportionate number of the industrial arts specialists. Conversely, certain items considered important by industrial arts people were less frequently checked as important by the general educators.

3. On the whole, the items of industrial arts general information were not as acceptable for emphasis in industrial arts courses as they

Table 8. General Information Items Which Should Be Emphasized Out of School or Left to Out-of-School Situations, in the Opinion of More than One-Third of the Respondents

Abbreviated Items	Per Cent of Respondents Suggesting Emphasis Out of School	Rank Order of Importance in General Education (from Table 3)
(1)	(2)	(3)
Types of labor organizations..	47	2
Sharing the profits from advancing technology...........	47	8
Distribution of profits from manufacturing................	42	5
Rates of pay for skilled workers......................	41	19
Stability of employment of skilled workers.............	39	12
Ownership of large industries.	39	14
Function of shop steward in union shop.................	39	23
Grievance procedure in union shop........................	38	29

were for goals of general education. Only twelve of the thirty-two items were checked for emphasis in industrial arts by more than three-fourths of the sixty-six jurors. All but six items, however, were approved for industrial arts emphasis by one-half or more of the jurors.

4. Items pertaining to occupational information received greatest acceptance as industrial arts goals. Items pertaining to business and economics were rejected by one-fourth or more of the respondents.

5. The item which implies the appropriateness of safety instruction in industrial arts was accepted for emphasis in industrial arts almost unanimously by supervisors, teacher trainers, and general metalwork teachers; but it was rejected by nearly one-third of the general educators.

6. The emphasis of labor union information in industrial arts was supported by substantially more supervisors and teacher trainers than by general educators and general metalwork teachers.

7. The data seem to indicate that industrial arts teachers of metalwork are not so much in favor of emphasizing general information in their programs as are the general educators and industrial arts supervisors and teacher trainers.

8. Among a number of additional general information items suggested by respondents, items pertaining to history of metalworking and metalworkers seem to be significant. There were no such items in the check list.

9. All thirty-two items were checked for emphasis in both industrial arts and other courses, indicating areas for curriculum correlation.

10. Items pertaining to business and economics were significantly more acceptable to all jurors for emphasis in other courses than in industrial

arts.

11. The data indicate that the respondents think information about labor organizations and economic concerns of adults should be emphasized in out-of-school situations.

CHAPTER IV

IMPORTANCE AND CURRICULUM EMPHASIS OF INDUSTRIAL ARTS TECHNICAL INFORMATION

1. Importance of Items in General Education

Introduction.-- There is an abundance of technical information in industrial arts instructional materials and courses of study. In many courses, however, the organization and content of materials follows very closely the traditional trade and industrial education pattern which provides specifically for "related technical information." In vocational education a job analysis is usually the basis for a training course. According to Fryklund,[1] such an analysis provides for (1) what the learner must be able to do in order to work successfully at a specific job, and (2) what the learner must know in order to do the job. What the learner must know, then, is limited to the requirements of a job. Obviously, if industrial arts is "a curriculum area comparable to the language arts,"[2] the goals of instruction should not be limited to any specific vocation.

As indicated in Chapter I, there is considerable confusion concerning the goals of industrial arts on the one hand and vocational-industrial education on the other. The same instructional materials are often used in both types of instruction. Moreover, the vocational courses have had

1/Verne C. Fryklund, Trade and Job Analysis, The Bruce Publishing Company, Milwaukee, 1947, p. 146.

2/Proffitt, op. cit., p. 1.

the benefit of Federal subsidy and State direction for many years. Therefore it is only natural that the accumulated instructional materials are highly "job centered."

The items of technical information presented in Parts B and C of the check list reflect this vocational training influence. It is hoped that one of the results of this study will be a better understanding of what technical information is most appropriate in general education and consequently in industrial arts.

The data in this chapter are presented in two parts. The first part covers items of general mechanical knowledge, and the second part covers items classified as metals and metallurgy.

2. Mechanical Knowledge Items

Items ranked in order of importance.-- In Table 9 the fifty-one items of mechanical knowledge contained in Part B of the check list are listed in order of importance in general education, as determined from the responses of all the jurors. Each of the items, except one, was considered sufficiently important by more than half the jurors that everyone should have an opportunity to acquire the knowledge and/or ability implied by the statement. The one item (number 51 in Table 9) which failed to secure approval of at least half the respondents was one of obvious specialized knowledge which was included in the check list only for the purpose of providing a ready indication of the reliability of the instrument.

Reliability of the data.-- As noted in Table 2 on page 31, the weighted average of the coefficients of correlation of the responses of the three

Table 9. Items of Mechanical Knowledge Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Improper lubrication or lack of lubrication is a common cause of overheating. For example, an automobile engine operated with too little oil or improper oil................	100	100	96	98.7	91	61	35
2. Oily rags should be kept in a closed metal container until they can be disposed of by burning. If left lying around there is danger of fire........	95	100	92	95.7	92	68	49
3. All rubbing surfaces, called bearings, should be lubricated regularly according to manufacturer's specifications.........	100	86	96	94.0	88	47	30
4. In lubricating machines, correct lubricants must be used. For example, in an automobile engine thin oil in winter, heavier oil in summer..........	90	100	92	94.0	88	60	36
5. A lubricant is oil, grease, or other material that is put on metal surfaces that rub against each other, to reduce heat, wear, and vibration caused by rubbing.......................	85	100	96	93.7	91	58	22
6. Most metals are good conductors of heat; thus, if a piece of metal is heated in one place,							

(continued on next page)

Table 9. (continued)

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
the heat is transferred throughout the piece..........	90	86	96	90.7	83	70	15
7. Most metals expand when heated and shrink when cooled. For example, a piece of steel one foot long when cold will measure about 12 1/8 inches when red hot......................	80	100	88	89.3	86	64	12
8. A clutch is a device used for engaging and disengaging the driving mechanism of a machine from certain other parts that do the work. The clutch on an automobile is an example......	85	95	88	89.3	80	58	20
9. A machine should be stopped when it is oiled.............	85	91	88	89.0	83	28	34
10. A drop or two of oil in each oil hole is usually enough; too much oil is wasteful, will spatter, and may even damage the machine--particularly an electric motor................	85	91	88	89.0	85	31	30
11. The mechanical advantage gained through the use of levers is applied in numerous ways in metalwork--in the use of hand tools and in the functioning of machines..................	85	95	83	87.7	75	70	12
12. Less effort is required to push or pull a load up an							

(continued on next page)

Table 9. (continued)

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
inclined surface than to lift it vertically. Examples are such common devices as the screw, gib, and taper or wedge........................	85	91	83	86.3	60	76	12
13. A machine or hand tool should not be used for work over its rated capacity................	85	91	83	86.3	82	37	26
14. Metals vary widely in density. That is, some metals are much heavier than others; e.g., lead is heavy, magnesium is light..	80	95	83	86.0	78	59	9
15. Overheating can ruin the usefulness of machines through unequal expansion of parts, melting of bearings, setting up of strains and stresses, changing of molecular structure, and drawing of temper of heat-treated parts............	75	95	88	86.0	80	41	26
16. There are several kinds of oil, in various degrees of viscosity.....................	85	91	79	85.0	80	54	18
17. Friction results in wasted work, and energy from such wasted work is changed into heat energy..................	80	91	83	84.7	74	70	15
18. Gears are used in machines to transmit power or motion and to change direction or rate of motion.......................	75	100	79	84.7	79	68	15

(continued on next page)

Table 9. (continued)

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
19. To reduce friction, bearings are polished smoothly, antifriction metals such as babbit are used, ball or roller bearings are used, and bearings are properly lubricated........	70	91	92	84.3	77	45	18
20. Hard substances like sand, emory, corundum, and diamond dust are used extensively for cutting, grinding, and polishing metal.....................	65	95	92	84.0	82	35	9
21. Metals such as copper, aluminum, and steel, which may be drawn into a wire, are said to be ductile.....................	75	86	88	83.0	81	47	9
22. Most metals are fusible; that is, they can be melted.........	75	91	83	83.0	81	54	10
23. Metals that may be hammered or rolled into sheets are said to be malleable..................	75	86	83	81.3	81	33	9
24. Elasticity is the property of a substance which enables it to resume its original shape after having been stressed by outside forces--an automobile spring, for example....................	75	86	83	81.3	74	53	10
25. Metals may suffer from fatigue. For example, if a load is held by a cable for a long time, the cable may eventually break.....	80	73	88	80.3	79	49	14

(continued on next page)

Table 9. (continued)

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
26. A wheel, to run at a uniform speed without vibration, must be of equal weight at every point on the perimeter. A wheel may be balanced by adding or removing metal at points that are light or heavy. For example, automobile wheels are balanced by attaching lead lugs........................	65	95	79	79.7	71	49	15
27. Malleability is the property that permits metals to be shaped by forging....................	75	82	79	78.7	80	32	9
28. The term "hard" is only relative. When two substances of unequal hardness are rubbed together, the harder wears away the softer more rapidly, unless the soft substance is driven at a high velocity...............	75	77	83	78.3	69	47	12
29. Various metals melt at different temperatures, an important consideration when metals are selected for certain jobs. For example, babbit melts at too low a temperature to be used in bearings that are likely to run at high temperatures..........	65	82	88	78.3	75	45	11
30. We call a substance hard if it cannot be easily scratched or abraded......................	70	82	79	77.0	69	49	9

(continued on next page)

Table 9. (continued)

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
31. Generally, a metal that is hard is also brittle...........	65	82	83	76.7	74	41	13
32. When a wheel is revolved (a grinding wheel, for example), centrifugal force tends to stress the wheel from its axle...........................	60	86	79	75.0	69	51	15
33. Tenacity is the property of a material which enables it to withstand external forces without breaking..................	75	73	75	74.3	76	41	7
34. Belts are used on machines for three reasons: to transmit power, to change the speed or power of pulleys, and to change the running direction of pulleys.........................	65	86	71	74.0	71	36	11
35. A V-belt is less likely to slip than a flat belt..............	45	86	88	73.0	70	27	13
36. In many metals, brittleness may be lessened by heat treatment..	55	82	79	72.0	73	34	10
37. When the driver pulley is larger than the driven pulley, the driven pulley turns faster than the driver but with less power, and vice versa................	55	82	75	70.7	65	52	8
38. Expansion and contraction must be taken into consideration when metals are machined to							

(continued on next page)

Table 9. (continued)

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
exact sizes, when patterns are made for an article that is to be cast, pieces are welded, and when precise measuring is done.	50	77	83	70.0	68	21	12
39. Cutting oil is used to make cutting easier and faster. It carries away some of the heat, washes away chips, and reduces friction between tool and work.	60	77	71	69.3	66	6	11
40. The smaller the pitch of an inclined surface, the greater the mechanical advantage (a small taper, for example); the greater the pitch, the faster the motion but the less force (a lead screw on a lathe, for example)........................	55	82	71	69.3	51	59	8
41. When the driven gear is larger than the driver, the driven gear turns more slowly but with greater power; when the driven gear is smaller than the driver, it turns faster but with less power...........	50	82	75	69.0	62	56	8
42. The heat resulting from cutting metal may change the degree of hardness of the cutting tool.....................	55	73	75	67.7	64	16	9
43. A cam or eccentric is used to change rotary motion to reciprocating motion or vice							

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Table 9. (continued)

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
versa, to vary a rate of motion, or to lock parts together. An example of the use of cams is in the automobile engine for timing valves..................	50	77	75	67.3	57	42	6
44. When designing tools and machines, engineers always plan to use materials heavy enough to carry several times the load that is likely to be put on them. This gives a factor of safety, for it provides for possible flaws in materials and for temporary overloading..	60	73	67	66.7	59	35	12
45. Different lubricants are used for cutting different metals and for different cutting operations.....................	50	68	75	64.3	61	3	10
46. Small cross-sections of a piece of metal will increase in temperature more quickly than large sections. For example, heat will "run" to the end of a pointed tool.................	50	73	67	63.3	57	29	7
47. An oil used mainly to keep the tool and work cool is called a coolant. It is pumped to the surface being machined where it absorbs some of the heat....	45	77	67	63.0	60	6	8
48. As the force of a machine is increased by any mechanical							

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Table 9. (concluded)

Items of Mechanical Knowledge	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
device, the distance and speed of the load is diminished correspondingly. For example, when back gears are used in a lathe, what is gained in cutting force is lost in speed of cutting......................	45	77	67	63.0	54	33	9
49. The tenacity of any material, or its tensile strength, is measured by the force needed to break a rod or wire of that material whose cross-sectional area is unity, e.g., 1 sq. in.	55	64	67	62.0	57	40	9
50. There are four basic types of gearing: spur, helical, miter, and worm......................	30	77	67	58.0	47	27	7
51. In some particularly precise manufacturing, the coolant is kept at a constant temperature through refrigeration.........	25	45	42	37.3	33	5	6
Mean......................	69	85	81	78.3	72	43	15

juries concerning the fifty-one mechanical knowledge items was 0.75. The responses of the general educators appear to be somewhat more reliable than the responses of the other two juries, the coefficient of correlation being 0.87. The coefficient of correlation of the responses of the supervisors and teacher trainers was 0.72 and of the general metalwork teachers, only 0.66. A possible reason for this marked difference is that the general educators' judgments may not have been hindered by knowledge of the traditional content of industrial arts and vocational-industrial courses.

Nature of highest-ranking items.-- The five items which were considered important by the largest number of respondents were all concerned with lubricants and lubrication practices. Of these five items, four were checked as important by 100 per cent of the supervisors and teacher trainers, and two of the five items were so checked by 100 per cent of the general educators. Only one of the sixty-six jurors rejected the highest ranking item; three jurors rejected the second ranking item; and only four jurors rejected the items which ranked third, fourth, and fifth. Moreover, two other items pertaining to lubrication ranked in the first ten items (items ranked 9 and 10). Obviously, in the opinion of the jurors, certain knowledge about lubricants and ability to use them properly are worthy goals of general education.

Knowledge of the properties of metals of conductivity and of expansion and contraction were favored as general education goals by approximately 90 per cent of the respondents. Items concerned with knowledge of the properties of density, ductility, fusibility, malleability, elasticity, hardness, and tenacity all received approval as goals for general education from 75 per cent or more of the jurors. As was indicated in Chapter II, many of the items were part of a continuum. The more specialized or detailed the definition, the statement of a principle, or the application of a principle, the fewer jurors indicated the item was important in general education. Thus, the definition of tenacity (item ranked 33 in importance) was considered important by about three-fourths of the jurors, but a more technical explanation of what is meant by tenacity (item ranked 49) was considered important by only 62 per cent of the respondents.

Knowledge and/or application of certain fundamental principles of mechanics received a surprisingly small vote as general education goals. Less than 75 per cent of the respondents indicated that basic knowledge of belts and pulleys (items ranked 34 and 37), of the inclined plane (item ranked 40), of gearing (item ranked 41), of the cam (item ranked 43), and of mechanical advantage (item ranked 48) was sufficiently impor-tnat that everyone should have an opportunity to acquire it. These items are commonly included in general science and physics courses which, it can be assumed, are offered in most schools for general education purposes. Probably because this study is primarily concerned with industrial arts, items that relate to science were given less importance than they would have been given if the study had been primarily concerned with science objectives. In an investigation of principles desirable for inclusion in an integrated course of physical science for senior high school, Miles[1/] found that the principle of mechanical advantage was given the highest possible importance rating, for example. In the present

1/Vaden Willis Miles, A Determination of the Principles and Experiments Desirable for a High-School Course of Integrated Physical Science, University of Michigan, Ann Arbor, 1947, p. 74.

investigation the same principle was rated as important in general education by only 63 per cent of all the respondents. It was rated as important by only 45 per cent of the general educators.

As reported in Chapter III, the respondents apparently tended to consider important those items in the check list which have the most frequent application in everyday adult life. For example, most adults are probably more concerned with the proper lubrication of their automobile and household mechanical devices than they are in properties of metals or in fundamental mechanical principles. Generalizing then, it is reasonable to assume that industrial arts goals which have to do with mechanical knowledge and practices are most appropriate for general education when they relate directly to common everyday experiences. Further, even though they may be fundamental to understanding of everyday applications, mechanical principles as such are not considered as important general education goals.

It is probable that many respondents, in reacting to the various items, considered also the educational method involved in teaching the knowledge or ability implied. If that is the case, those respondents who lean toward problem-solving, inductive teaching would probably consider applications more important than principles. Those respondents who learn toward systematic, logical analysis would probably consider a basic principle more important than its application--if they made any distinction in importance. The data in regard to industrial arts mechanical knowledge suggest that a majority of the respondents in this study may have been thinking in terms of inductive teaching when they checked the items as important or unimportant in general education.

Differences in responses of the three juries.-- While the three juries reacted to Part B of the check list in a manner that produced three rank orders of items which correlate fairly closely--as shown in Figure 1--more of the industrial arts specialists indicated that the items, on the whole, represent suitable goals for general education. The mean of the responses of the supervisors and teacher trainers was 85 per cent and of the general metalwork teachers, 81 per cent. The responses of the general educators averaged only 69 per cent.

Examination of Figure 1 reveals that through the first eighteen items in rank order, the general educators, for the most part, responded about as strongly in favor of the items as did the other two juries. The responses of the general educators on the remaining items, however, show noticeably less acceptance of specific mechanical information as appropriate goals for general education. Many industrial arts specialists, on the other hand, apparently consider even highly technical concepts as important enough that everyone should have an opportunity to acquire them. Of the fifty-one items of mechanical knowledge in Part B of the check list, all but eight were considered important by 75 per cent or more of the supervisors and teacher trainers. All but ten of the items were considered important by 75 per cent or more of the general metalwork teachers. But twenty-five of the items failed to secure the approval of 75 per cent or more of the general educators.

It seems reasonable to conclude that industrial arts specialists attach more importance to mechanical knowledge than do general educators. It seems reasonable also to conclude that the specialized background of

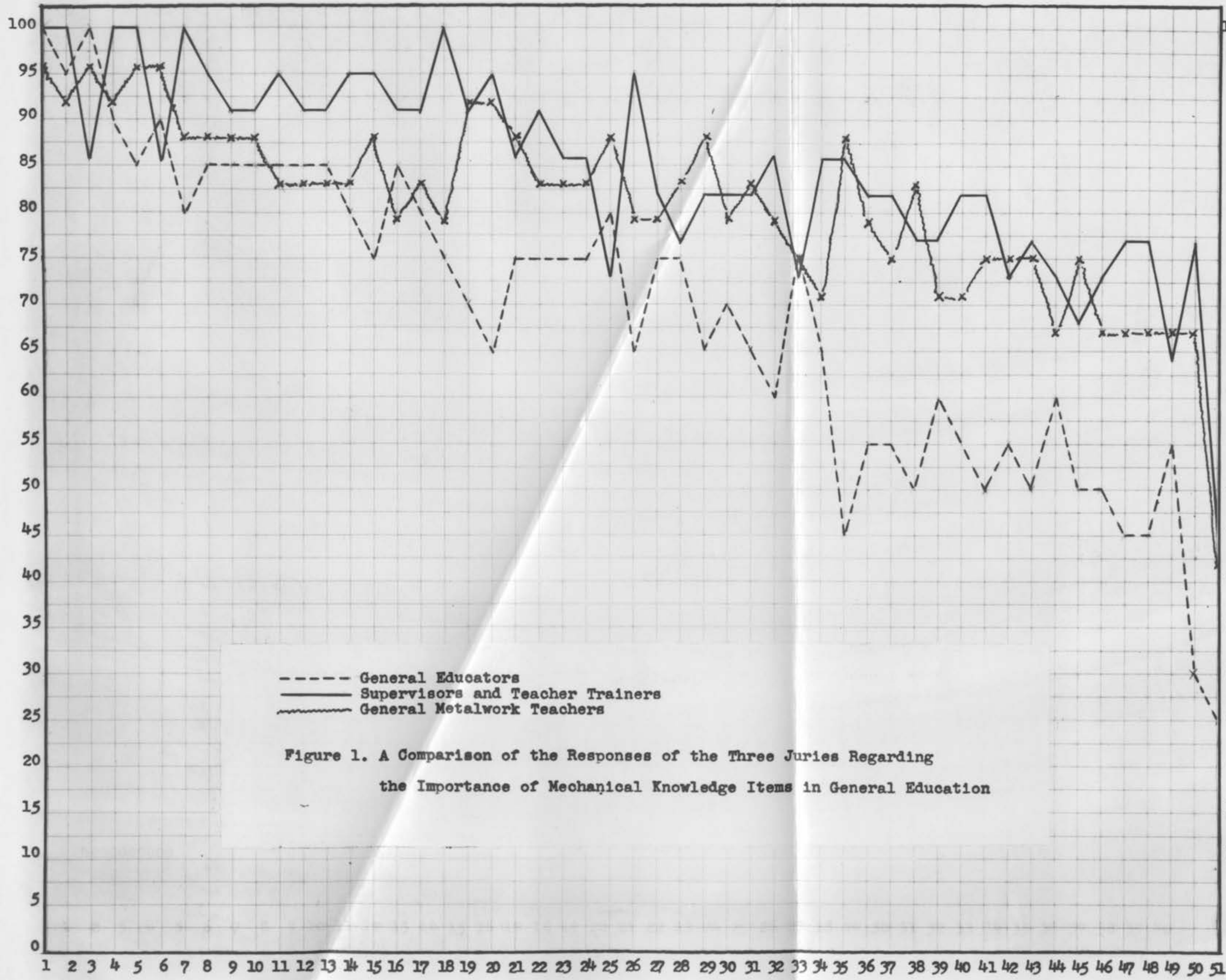

Figure 1. A Comparison of the Responses of the Three Juries Regarding the Importance of Mechanical Knowledge Items in General Education

people who teach and supervise industrial arts may cause them to overvalue items of mechanical knowledge as general education goals.

3. Curriculum Emphasis of Mechanical Knowledge Items

Correlation between importance in general education and emphasis in industrial arts courses.-- The responses of the jurors indicate, in general, that those items which were considered important in general education were also considered appropriate for emphasis in industrial arts. The correlation between the two kinds of responses (columns 5 and 6 in Table 9) was 0.89. The arithmetic mean of the percentage of responses for importance of the items in general education was 78; for emphasis in industrial arts the mean percentage was 72.

In order to save space, and because the rank order of items for emphasis in industrial arts is so similar to the rank order of items in importance, a separate table is not shown here. In the following paragraph the few items which deviated markedly in the two rankings will be listed.

Items less favored for industrial arts emphasis.-- Not all items which were considered important in general education were given the same degree of consideration as industrial arts goals. The item pertaining to the principle of the inclined plane, for example, ranked twelfth in importance in general education and ranked only forty-third for emphasis in industrial arts. The item concerned with the mechanical advantage of levers ranked eleventh in importance but only twenty-fifth for industrial arts emphasis. In Table 10 following are shown those items which ranked ten or more places higher in importance than in industrial arts emphasis.

Table 10. Items of Mechanical Knowledge Which Ranked Ten or More Places Higher in Importance in General Education than in Industrial Arts Emphasis

Abbreviated Item	Rank of Item in Importance in General Education	Rank of Item for Emphasis in Industrial Arts	Rank Difference	Per Cent of Respondents Who Checked Item for Industrial Arts Emphasis		
				General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mechanical advantage of levers.........	11	25	14	77	86	63
Mechanical advantage of inclined plane....	12	43	31	76	59	50
Waste of friction.......	17	27	10	70	86	67

It will be seen that the responses of the general educators were more favorable than those of the teachers for emphasizing the items in industrial arts; but, as was found in all parts of the check list, the supervisors and teacher trainers tended to check more items for industrial arts emphasis than either of the other juries. The item pertaining to mechanical advantage of the inclined plane was a notable exception. It is quite possible that because that item was worded as a physical science principle rather than as an industrial application, its appropriateness as an industrial arts goal was not immediately apparent.

Certain items of mechanical knowledge ranked noticeably higher in industrial arts emphasis than in importance in general education. These items are shown in Table 11, below.

Table 11. Items of Mechanical Knowledge Which Ranked Ten or More Places Higher in Industrial Arts Emphasis than in Importance in General Education

Abbreviated Item	Rank of Item in Importance in General Education	Rank of Item for Emphasis in Industrial Arts	Rank Difference	Per Cent of Respondents Who Checked Item for Industrial Arts Emphasis		
				General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Use of abrasives	20	10	10	60	95	92
Meaning of malleability....	23	12	11	75	86	83
Applications of malleability....	27	17	10	75	82	83
Meaning of tenacity........	33	23	10	75	73	79

The relationship of these items to industrial applications is probably more apparent than the relationship of the three items in Table 10, which ranked higher in importance than in industrial arts emphasis. The items in Table 10 apparently were not considered as vital industrial arts goals.

In Table 11 it will be seen that the industrial arts specialists--industrial arts supervisors, teacher trainers, and teachers--tended to support the items for emphasis in industrial arts more frequently than did the general educators.

Emphasis in other courses.-- As indicated earlier, it was surprising to note that so few jurors, relatively, checked the items of mechanical knowledge as important in general education. In view of the fact that the items are of a physical science nature, it was even more surprising to note that these items were checked so infrequently for emphasis in other courses. (See Table 9, pages 72-80.) Only six of the fifty-one items were checked for emphasis in courses other than industrial arts by 66 per cent or more of the jurors. These items are shown in Table 12, below.

Table 12. Items of Mechanical Knowledge Which Were Checked for Emphasis in Courses Other than Industrial Arts by 66 Per Cent or More of the Jurors

Rank of Item in Importance	Abbreviated Item	Per Cent of Respondents Who Checked Item for Emphasis
(1)	(2)	(3)
2	Care of oily rags to prevent fire..................	68
6	Heat conductivity of metals.........................	70
11	Mechanical advantage of levers......................	70
12	Mechanical advantage of inclined plane.............	76
17	Waste of friction...................................	70
18	Function of gearing in machines....................	68

Emphasis in out-of-school situations.-- While none of the items was checked for out-of-school emphasis by more than half the respondents, each of the items was so checked by at least 6 per cent. The items which were checked most frequently for emphasis out of school--or to be learned out of school--appear to be concerned with lubrication of machines. The item most frequently checked (ranked second in importance in general education) for out-of-school emphasis was concerned with the disposal of oily rags. The responses of the jurors with regard to emphasis of the items in out-of-school situations are shown in Table 9 on pages 72-80. It is highly probable that many of these items were checked as important and for out-of-school emphasis because they are traditional content of speialized, vocational-technical instruction which is offered in evening schools or on a part-time basis to adults.

4. Items Pertaining to Metals and Metallurgy

Large number of items considered.-- The analysis of industrial arts teaching materials revealed fifty-three separate items which were classified in the category "Metals and Metallurgy." This is the largest number of items in any section of the check list. According to the definition of general metalwork used in this study (page 18) metals are a major concern. Since so many items of this nature were found in textbooks, bulletins, and courses of study, it is apparent that the writers of industrial arts teaching materials subscribe to that definition.

Items ranked in order of importance.-- In Table 13 the fifty-three items pertaining to metals and metallurgy contained in Part C of the check list are given in the order of their importance in general education, as determined from the responses of the jurors. None of the items was universally accepted, but twenty-three of the items were considered important in general education by 75 per cent or more of the respondents. Five of the items were rejected as unimportant by more than 50 per cent of the jurors. As with other parts of the check list, the respondents tended to

Table 13. Items Pertaining to Metals and Metallurgy Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. An alloy is a mixture of two or more metals melted together to form a new metal which is different from the original metals. For example, copper and zinc melted together make brass......	95	100	92	95.7	91	76	18
2. Aluminum is relatively light in weight, noncorrosive, and a good conductor of heat. It is used for cooking utensils because of its conductivity; for automobile and aircraft parts when light weight is essential............	90	100	96	95.3	94	69	24
3. Lead is a relatively heavy, soft metal, useful industrially because water and air have little effect on it. Workers with lead must use precautions to avoid lead poisoning.................	95	95	92	94.0	92	69	18
4. When a steel tool (a knife, for example) is heated by grinding or by other means until it appears blue, its hardness has been lost. To make the tool usable again, it should be rehardened and tempered..........	90	95	96	93.6	91	29	20
5. Any mineral body from which metal can be obtained profitably is known as ore................	95	77	96	89.3	69	75	23

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Table 13. (continued)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
6. Copper is a relatively pure metal refined from copper ore which is mined extensively in Arizona, Michigan, Montana, and Utah. It is very ductile and malleable and its most important property, industrially, is its conductivity of electricity.....	80	95	88	87.7	81	67	12
7. Zinc is a relatively hard, brittle, bluish-white metal used as a coating for iron and steel for protection against oxidation. Zinc-coated steel appears flaky or spangled and which is known as galvanized iron, is used for wire fences, eaves troughs, metal roofing, etc.............	80	95	83	86.0	86	40	15
8. Nickel does not rust, and it takes a high polish. It is commonly used for plating iron and brass..........................	75	91	88	84.7	83	44	15
9. Bronze, and alloy of copper and tin, is harder than brass.......	80	95	79	84.7	83	51	14
10. Tin-plate is sheet iron or sheet steel coated with tin to prevent rusting.......................	70	95	88	84.3	84	46	15
11. Iron does not exist in nature in a pure state but is combined chemically with oxygen, carbon, sulphur, and with other minerals such as phosphorous and manganese. The combination is called iron ore.......................	80	77	92	83.0	69	70	23

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Table 13. (continued)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educa-tors	Supervis-ors and Teacher Trainers	General Metal-work Teachers	All Respond-ents	Indus-trial Arts	Other Courses	Out-of-School Situa-tions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
12. Iron ore is transported largely by boat from the Lake Superior region to Chicago, Gary, Detroit, Cleveland, and other cities along the Great Lakes where blast furnaces and steel mills are located.............	80	77	92	83.0	69	67	18
13. One of the cheapest metals, cast iron, is used to make such things as large pipes, stoves, radiators, and frames for machines which must be large and heavy but in which strength is not very important..........................	85	73	88	82.0	79	43	18
14. Pewter, a silvery-white alloy of tin, antimony, and copper, is used for tableware and ornamental work...............	80	91	75	82.0	79	51	14
15. Iron ore becomes pig iron when the impurities are burned out in the blast furnace..........	70	86	88	81.3	78	52	18
16. Many shop products are of little use unless they are heat treated, i.e., hardened, tempered, annealed, or case hardened..........................	60	91	92	81.0	81	26	12
17. Because it is ductile and malleable, steel can be drawn into wire and rolled into							

(continued on next page)

Table 13. (continued)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
sheets, bars, rods, and various commercial shapes such as I-beams and railroad rails.....	70	82	88	80.0	78	38	18
18. Most iron ore is mined by the open-pit process in which hugh shovels are used to strip off the upper layers of earth and, after the ore is loosened by blasting, the shovels are again used to scoop up the ore and load it into railroad cars.....	70	82	88	80.0	73	64	16
19. While machines are used in laboratories for the precise testing of materials for hardness, a rough test can be made in the shop with a file. If the file cuts the steel, it is soft; if the file slips over the steel, it is hard....................	60	86	92	79.3	78	20	14
20. Pure silver, which is the best known electrical conductor, is a relatively soft metal. It is usually alloyed with copper to make it usably hard...........	80	82	75	79.0	74	55	14
21. Pig iron, which is hard and brittle, is used in making cast iron, wrought iron, and steel..	60	86	83	76.3	76	38	12
22. Depending on its carbon content, steel may be soft enough to bend readily, hard enough to cut glass, or resilient enough to be used for springs.........	60	77	88	75.0	75	35	16

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Table 13. (continued)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
23. By the addition of other ingredients while it is molten, steel may be given additional physical properties. For example, tungsten increases hardness; chromium makes steel stainless. These are known as alloy steels..................	60	86	79	75.0	75	41	12
24. Wrought iron is useful for parts which must withstand shock, blows, and jerks--such as railroad equipment and farm tools.........................	55	86	83	74.7	75	27	15
25. When high carbon steel is heated red hot and quickly cooled it is hardened. When, after it is hardened, it is heated to between 400° and 600° F. and quickly cooled, it becomes toughened (tempered). When it is heated red hot and allowed to cool slowly, it loses its hardness, i.e., it is annealed..................	55	86	83	74.7	75	22	12
26. Pure iron is not used in industry because it is too soft.....	70	82	71	74.3	65	48	14
27. Steel made from well selected scrap is just as high in quality as steel made from new pig iron, and the use of scrap conserves the ore supply.......	70	73	79	74.0	65	41	16

(continued on next page)

Table 13. (continued)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
28. Cast iron is usually gray in color and crystalline in texture........................	50	82	88	72.3	70	30	16
29. A machinists' handbook contains most of the technical information regarding characteristics and working properties of metals, as well as machine operation formulas and information concerning fastening devices and other useful data for the metalworker......................	60	77	79	72.0	71	18	19
30. Eight per cent of the earth's crust contains aluminum; but the refining of bauxite, the most important ore, is an expensive process which requires much electrical energy.	55	77	83	71.7	64	53	10
31. Babbit, an alloy of antimony, copper, and tin, is used for bearings for machines and engines......................	50	82	71	67.7	68	29	12
32. Hematite and other iron oxide ores are found in the Lake Superior region, particularly in Minnesota, Michigan, and Wisconsin......................	50	68	83	67.0	57	51	11
33. Malleable iron is cast iron which has been made soft, tough, strong, and malleable by baking in an oven from six							

(continued on next page)

Table 13. (continued)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
to eight days, thus burning out some of the carbon, and then cooling slowly............	40	82	79	67.0	66	24	12
34. When molten, iron is very fluid; steel is less fluid and is sticky. Consequently, iron is frequently cast into desired shapes; steel is more often forged, stamped, or machined, although it is sometimes cast..	55	82	63	66.7	63	23	10
35. Wrought iron, which is purified pig iron, contains almost no carbon; it is very tough and malleable and it bends easily, cold or hot....................	45	77	75	65.7	66	24	16
36. Steel comes from the furnace in the form of large ingots which, after reheating, are passed through huge rolls in a rolling mill and rolled into various shapes........................	45	73	79	65.7	63	31	12
37. Cold rolled and cold drawn steel have a smooth, bright finish, are very exact in size, and may be used without further machining or finishing.........	35	77	83	65.0	64	18	15
38. The highest grades of steel are made in a crucible or electric furnace in which air or furnace gases do not touch the metal and in which it is possible to control the content of the steel very accurately..........	35	82	75	64.0	61	26	12

(continued on next page)

Table 13. (continued)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
39. When being ground, different kinds of steel give off different appearing sparks which provide a means of roughly determining what kind of steel it is. For example, high-carbon steel gives off white sparks which explode into bright stars..................	35	77	79	63.7	64	10	10
40. Cold rolled and cold drawn steel are made from hot rolled steel by removing the scale and bathing the steel in acid and then rolling or drawing it cold.........................	35	82	71	62.7	61	21	9
41. When wrought iron or low carbon steel in contact with carboniferous material such as leather scrap is heated to a bright red heat, the surface of the metal absorbs carbon and thus gains the properties of high-carbon steel. This process is called case hardening................	40	73	75	62.7	63	21	12
42. The rolling of steel refines its grain and increases its tensile strength......................	45	77	65	61.7	58	27	11
43. In the steel-making process, carbon is removed from the molten metal through combining with oxygen in the hot air, which is blown across the surface; and limestone added							

(continued on next page)

Table 13. (continued)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
to the charge acts as a scavenger, removing impurities through chemical reactions....	25	82	75	60.7	56	33	15
44. Hematite, which is a red oxide of iron, is the most important iron ore because of its high iron content and ease of smelting.....................	45	55	75	58.3	49	36	7
45. Steel is iron combined with from .05 per cent to 1.7 per cent of carbon................	35	68	71	58.0	56	36	13
46. Various colored oxides form on steel at different tempering heats, i.e., yellow at 430°, blue at 570°. These colors may guide the worker in drawing temper to the desired degree........................	20	73	79	57.3	57	13	9
47. Steel can be made in an open-hearth furnace from 100 per cent pig iron, from 100 per cent scrap, or from a mixture of new pig iron and scrap steel.........................	35	73	63	57.0	52	21	13
48. To identify steels in specifications, the S.A.E. steel numbering system is used. For example, 1020 means ordinary carbon steel containing .20 per cent of carbon............	25	64	71	53.3	50	9	10

(continued on next page)

Table 13. (concluded)

Items Pertaining to Metals and Metallurgy	Per Cent of Jurors Who Checked Item as Important				Per Cent of Jurors Who Checked Item for Emphasis in		
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents	Industrial Arts	Other Courses	Out-of-School Situations
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
49. It takes about two tons of ore, one ton of coke, one-half ton of limestone, and four tons of air to make one ton of pig iron........................	30	64	63	52.3	46	27	9
50. Pig iron contains about 93 per cent pure iron, 3 to 5 per cent carbon, and from 5 to 7 per cent silicon, sulphur, phosphorous, and manganese....	30	55	63	49.3	44	33	6
51. During the steel-making process the metal may be sampled and additional ingredients added to produce the type of steel desired................	25	68	54	49.0	46	22	12
52. Limonite, a yellow oxide of iron, is found in various parts of the United States but it is seldom used because the iron content is relatively low. It is used in Europe, however, where hematite is less plentiful than in this country......................	50	32	54	45.3	34	34	8
53. Cast iron contains from 1.50 to 6.00 per cent of carbon....	15	50	54	39.7	38	14	5
Mean......................	57	79	79	71.7	68	38	14

reject, for general education purposes, those items which were most technical or detailed.

Reliability of the data.-- As noted in Table 2 on page 31, the weighted average of the coefficients of correlation of the responses of the three juries concerning the fifty-three items pertaining to metals and metallurgy was 0.82. The coefficients of correlation for the three separate juries were as follows: general educators, 0.88; supervisors and teacher trainers, 0.77; and general metalwork teachers, 0.82.

Nature of highest-ranking items.-- Only four items--the ones ranked first through fourth in Table 13 on page 91--were checked as important in general education by 90 per cent or more of each of the three juries. Items ranking sixth and seventh were checked as important in general education by 80 per cent or more of each of the three juries. These highest-ranking items appear to have no particular common denominator other than their being a part of the general knowledge of average well-educated adults. With the exception of the item pertaining to heat treatment of a steel tool (item ranked fourth), each of the highest-ranking items was merely a definition. It is interesting to note that while definitions of alloy, aluminum, lead, copper, and zinc ranked high, those items pertaining to iron and steel, the most widely used metals, ranked considerably lower. Items pertaining to iron and steel probably would have been checked more frequently as important if they had not been presented in such detail. Those items appeared in the check list in such detailed form because they are given such detailed treatment in industrial arts teaching materials. It is suggested that if items concerned with iron and steel had been worded simply as definitions they would have ranked as high or higher than the items concerned with other common metals.

Difference in responses of the three juries.-- Figure 2 on the next page shows that, in general, the juries of supervisors and teacher trainers and of general metalwork teachers gave stronger support, for general education purposes, to items pertaining to metals and metallurgy than did the jury of general educators. The average of the responses of the industrial arts specialists was 75 per cent. The responses of the general educators averaged only 57 per cent.

Figure 2 also reveals the fact that in regard to certain items the jury of general educators tended to oppose the judgment of the other two juries. Items 43, 46, and 53, for example, the ones checked least frequently by the general educators, were given noticeably greater support as general education goals by the industrial arts specialists. These items all pertain to the chemistry of steel.

Items 20, 26, 27, and 52 are low-ranking items which the general educators tended to favor about as strongly as did the industrial arts specialists. Item 26, pertaining to pure iron, has no industrial significance. Item 27 has to do with conservation. Item 20 implies acquaintance only with the metal silver. Item 52 is concerned with low-grade European ores and has obvious social, economic, and political implications.

As in other parts of the check list, the general educators tended to reject, as general education goals, the items that were most technical. The responses of the industrial arts specialists, on the other hand, seemed to indicate that they accept many technical concepts in the area

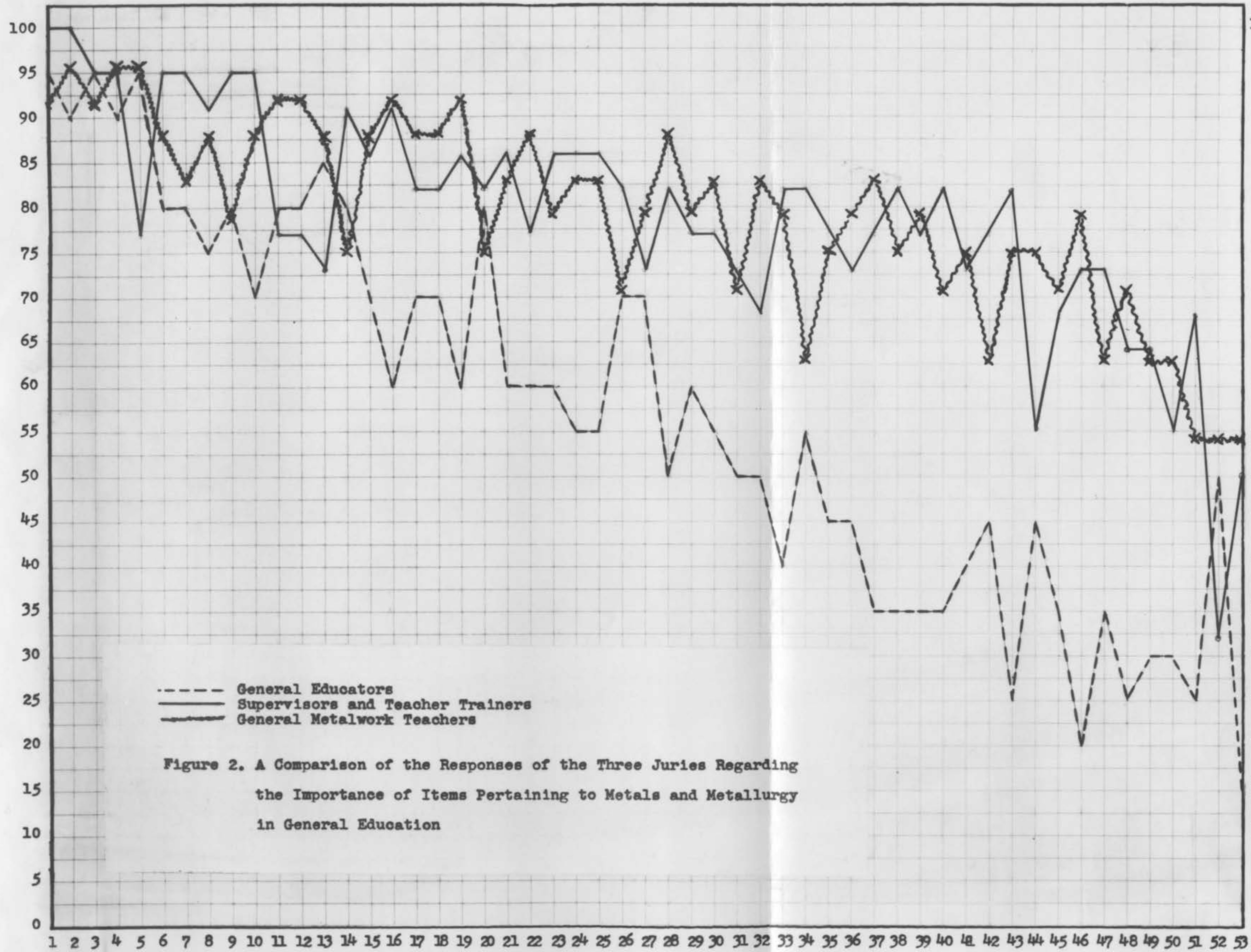

Figure 2. A Comparison of the Responses of the Three Juries Regarding the Importance of Items Pertaining to Metals and Metallurgy in General Education

of metals and metallurgy as appropriate in general education. In Table 14, below, are listed those items which were considered important by 80 per cent or more of the industrial arts specialists but which were checked for importance by 60 per cent or fewer of the general educators.

Table 14. Items Pertaining to Metals and Metallurgy Which Were Considered Important by 80 Per Cent or More of the Industrial Arts Specialists* and by 60 Per Cent or Fewer of the General Educators

Rank of Item in Importance in General Education	Abbreviated Item	Per Cent of General Educators Who Checked Item As Important	Per Cent of Industrial Arts Specialists Who Checked Item As Important
(1)	(2)	(3)	(4)
16	Importance of heat treatment..	60	91
19	Rough test for hardness of metals......................	60	89
21	Products made from pig iron...	60	84
22	Effect of carbon content on steel.......................	60	82
23	Nature of alloy steels........	60	82
24	Use of wrought iron...........	55	84
25	Knowledge of heat treatment processes....................	55	84
28	Appearance of cast iron.......	50	85

*Average of responses of supervisors and teacher trainers and of general metalwork teachers.

5. Curriculum Emphasis of Items Pertaining to Metals and Metallurgy

Correlation between importance in general education and emphasis in industrial arts courses.-- In general, each of the jurors who checked an item in Part C of the check list as important in general education checked the item again for emphasis in industrial arts courses. For that reason, responses of the separate juries with regard to curriculum emphasis of the items pertaining to metals and metallurgy were not shown in Table 13 on pages 91-100. For all practical purposes, Table 13 ranks the items in order of emphasis in industrial arts courses.

Items less favored for industrial arts emphasis.-- Those items for which the two types of responses (emphasis in industrial arts and importance in general education) varied by more than one vote in any of the three juries are shown in Table 15 on the next page. Percentages are used instead of numbers because the juries were of different sizes. Since each of the items in Table 15 was checked more often as important in general education than it was for emphasis in industrial arts, those items probably are less favored for emphasis in industrial arts than in some other area of the curriculum.

Only the item about transportation of iron ore was, in effect, voted out of the industrial arts field by as many as three members of each of the juries who had checked the item as important. (See item ranked eleventh in Tables 13 and 15.) Other items which were rejected by as many as two members of each of the juries who had checked the items as important were those defining a metallic ore (item ranked fifth); giving the geographical

Table 15. Items Pertaining to Metals and Metallurgy Which Failed by Two or More Votes in One of the Juries to Receive the Same Number of Votes for Emphasis in Industrial Arts as Was Given the Item for Importance in General Education

Rank of Item in Importance in General Education	Abbreviated Item	Per Cent of General Educators Who Checked Item		Per Cent of Supervisors and Teacher Trainers Who Checked Item		Per Cent of General Metalwork Teachers Who Checked Item	
		Important in General Education	For Emphasis in Industrial Arts	Important in General Education	For Emphasis in Industrial Arts	Important in General Education	For Emphasis in Industrial Arts
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Definition of alloy..........	95	80	100	100	92	92
5	Definition of metallic ore...	95	55	77	68	96	83
6	Physical properties of copper and where it is mined........	80	65	95	95	88	83
11	Information about iron ore...	80	65	77	64	92	79
12	Transportation of iron ore...	80	50	77	68	92	88
18	Description of mining process	70	60	82	77	88	83
26	Non-industrial nature of pure iron........................	70	65	82	68	71	63
27	Use of scrap steel...........	70	60	73	64	79	71
32	Where iron ores are found....	50	40	68	59	83	71
43	How steel is made............	25	25	82	77	75	67
44	Importance of hematite ore...	45	40	55	45	75	63
47	Steel making in open hearth furnace.....................	35	35	73	64	63	58
48	S.A.E. steel numbering system	25	25	64	55	71	71
49	Ingredients of pig iron......	30	25	64	59	63	54
52	Infrequent use of limonite ore........................	50	50	32	18	54	38

location of iron ores (item ranked thirty-second); and discussing the economy of scrap iron (item ranked twenty-seventh).

Emphasis in other courses.-- Seven of the fifty-three items pertaining to metals and metallurgy were checked by 66 per cent or more of the respondents for emphasis in courses other than industrial arts as well as in industrial arts. Those items are shown in Table 16, below. It is quite likely that those items which ranked high in importance and were also checked for emphasis in other courses may well suggest to curriculum workers fruitful areas for coordination between various subject matter fields.

Table 16. Item Pertaining to Metals and Metallurgy Which Were Checked for Emphasis in Courses Other than Industrial Arts by 66 Per Cent or More of the Jurors

Rank of Item in Importance	Abbreviated Item	Per Cent of Respondents Who Checked Item for Emphasis
(1)	(2)	(3)
1	Definition of alloy..................................	76
2	Nature and use of aluminum..........................	69
3	Nature and use of lead in industry.................	69
5	Definition of metallic ore..........................	75
6	Physical properties of copper and where it is mined..	67
11	Chemical nature of iron ores........................	70
12	Transportation of iron ore on Great Lakes.........	67

It should be pointed out again (see discussion on pages 101-102) that items concerned with iron and steel probably should be given as much or more consideration in other subjects than some of the items in Table 16.

Emphasis in out-of-school situations.-- Comparatively few of the respondents felt that the items pertaining to metals and metallurgy that they checked as important in general education should be emphasized in out-of-school situations, or left to be learned outside the influence of the school. Examination of Table 13 on pages 91-100 reveals the fact, however, that each item, in the opinion of some respondents, deserves out-of-school consideration.

Substantially more supervisors and teacher trainers than general metalwork teachers and general educators checked items for out-of-school emphasis. No item was so checked by more than three of the twenty general educators, and only three of the items received that many votes. No more than six of the twenty-four teachers voted for out-of-school emphasis of any one item, and only two items received that many votes from the teachers. Any substantial support of the items for out-of-school emphasis, then, came from the supervisors and teacher trainers. No particular item stood out as being significantly more important than the others for emphasis in out-of-school situations.

6. Summary

1. Thirty-two of the fifty-one items of mechanical knowledge were considered important in general education by 75 per cent or more of the respondents. The industrial arts specialists, on the whole, tended to accept more items as important than did the general educators. Even so, all but five of the items were checked as important by 50 per cent or more of the general educators.

2. Items concerned with lubrication were considered important by the largest number of respondents.

3. Knowledge of physical properties of metals were checked as important general education goals by more than 75 per cent of the respondents.

4. Items pertaining to knowledge and/or application of fundamental mechanical principles ranked relatively low in importance as general education goals.

5. In general, the mechanical knowledge items which were considered important in general education were also considered as appropriate industrial arts goals. Notable exceptions were the items concerned with mechanical advantage of levers and of the inclined plane.

6. Although many of the mechanical knowledge items represent content of traditional physical science courses, only six of the fifty-one items were checked by 66 per cent or more of the jurors for emphasis in courses other than industrial arts.

7. None of the items of mechanical knowledge was checked by as many as half the respondents for emphasis in out-of-school situations.

8. Only four of the fifty-three items pertaining to metals and metal-

lurgy were checked as important in general education by 90 per cent or more of the jurors. Only eighteen of the items were checked as important by 80 per cent or more of the jurors. The highest-ranking items seem to have no common denominator other than their being a part of the general knowledge of average well-educated adults.

9. The industrial arts specialists tended more frequently than the general educators to accept items pertaining to metals and metallurgy as general education goals.

10. For the most part, the items pertaining to metals and metallurgy which were considered as important in general education were also considered as appropriate industrial arts goals. Only seven of the items were checked by as many as 66 per cent of the respondents for emphasis in courses other than industrial arts. Comparatively few of the respondents checked items for emphasis (or left to be learned) outside the influence of the school.

CHAPTER V

IMPORTANCE OF SHOP WORK IN GENERAL EDUCATION

1. Introduction

Content of this chapter.-- The preceding two chapters dealt with those items in the check list which were largely informational in nature. In this chapter will be reported those aspects of the investigation which deal primarily with shop or laboratory work, Parts D through M of the check list.

Items generally accepted as industrial arts.-- In general, each of the jurors who checked a shop work item as important in general education also checked the item for emphasis in industrial arts. In most instances, the number of jurors who checked items for emphasis in courses other than industrial arts or in out-of-school situations was so small as to be negligible. For that reason curriculum emphasis is not shown in the tables used to report the responses of the jurors to each group of items. Any items which received noticeable support for emphasis in courses or situations other than in industrial arts will be given special consideration as indicated by the data.

Items arranged in rank order.-- In the tables which follow, the items pertaining to shop work are arranged in order of importance in general education. Because the jurors, as a rule, checked the items for emphasis only in industrial arts, the order of the items in the tables may be considered also as the order of emphasis in industrial arts courses.

2. Layout and Measuring

Relatively few jurors accepted items.-- In Table 17 the thirty items pertaining to layout and measuring contained in Part D of the check list are given in order of importance in general education, as determined from the responses of the jurors. In comparison with the responses to items in parts A, B, and C of the check list (General Information, General Mechanical Knowledge, and Metals and Metallurgy), relatively fewer items of Part D were acceptable to the jurors as general education goals. The mean of the responses of all jurors to the items of general information was 87 per cent; to the items of general mechanical knowledge, 78 per cent; and to the items pertaining to metals and metallurgy, 72 per cent. The mean of the responses of all jurors to the items pertaining to layout and measuring was only 67 per cent.

None of the items was universally accepted as an appropriate general education goal, and only eight of the items received the vote of 75 per cent or more of the jurors. On the other hand, all thirty items were checked as important in general education by 50 per cent or more of the respondents.

Items more acceptable to industrial arts specialists.-- More items were accepted as general education by the industrial arts specialists than by the general educators. The average of the responses of the supervisors and teacher trainers was 76 per cent and of the general metalwork teachers, 75 per cent. The average of the responses of the general educators, by comparison, was only 50 per cent. Only three of the thirty items were checked as important by as many as 80 per cent of the general educators. Sixteen

Table 17. Items Pertaining to Layout and Measuring Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Layout and Measuring	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Measurements in precision work are commonly expressed in decimal parts of an inch............	85	91	92	89.3
2. A working drawing contains all the information needed to make an object. It is prepared in the language of all mechanical operations, the shop, the drafting room, and the industrial world. It shows (1) the shape of every part of the object, (2) sizes of all parts, (3) kinds of material, (4) kind of finish, and (5) how many of each part are wanted...........	70	95	92	85.7
3. Dimensions of finished articles can be only as accurate as the measuring instruments used. Accurate measuring tools and ability to use them are essential to all precision work.............	80	82	88	83.3
4. Greater ability is needed to lay out work than to run a machine. A small mistake in layout means that work may be cut incorrectly afterward......................	85	77	83	86.7
5. Manufactured articles usually are rigidly inspected for materials, performance, finish, measurements, and interchangeability. Inspection may be done				

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Table 17. (continued)

Items Pertaining to Layout and Measuring	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
by both the manufacturer and the purchaser at any stage in the manufacturing process.....	70	91	71	77.3
6. No two manufactured pieces can be exactly the same size. For this reason, dimension limits--minimum and maximum--are usually given for precision-made pieces. The difference between limits is known as tolerance..	70	86	71	75.7
7. A divider may be used to lay off or to measure distances. This procedure is particularly useful in measuring along irregular lines................	60	77	88	75.0
8. Centers where holes are to be drilled should be punched with a center punch................	55	82	88	75.0
9. A templet, a pattern usually made of sheet steel, is commonly used for marking the shape of pieces or for marking the location of holes and irregularly shaped parts........	45	82	92	73.0
10. Layouts are made in reference to centerlines or to baselines	55	77	83	71.7
11. Centers for holes must be laid off in reference to at least two points....................	55	82	75	70.7
12. The combination square may be used as a tool to test the				

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Table 17. (continued)

Items Pertaining to Layout and Measuring	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
squareness of stock, as a marking gauge to lay off lines parallel to a straight edge, as a plumb or level, as a tool to lay off 45° angles from a straight edge, and as a height or depth gauge........................	50	82	79	70.3
13. A micrometer caliper measures in thousandths of an inch.......	40	77	92	69.7
14. In quantity manufacturing, every piece may be inspected or pieces may be inspected only periodically or at random. One hundred per cent inspection insures greatest possible uniformity of product........................	65	73	67	68.3
15. In setting a divider, one point is placed into one of the scribed lines on the rule and the other point is moved until it exactly splits the other line at which the divider is to be set......................	50	77	75	67.3
16. For accurate measurements with the steel scale, the scale must be held on its edge so the graduations are in contact with the surface being measured..........	45	77	75	65.7
17. Because precision manufacturing is costly and time consuming it is wasteful to specify closer tolerances than are necessary......................	65	77	54	65.3

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Table 17. (continued)

Items Pertaining to Layout and Measuring	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
18. An outside caliper is used to measure the diameter of round stock; an inside caliper is used to measure inside dimensions. The caliper is adjusted to a given dimension and then slipped over the work, or it is slipped over the work first and the distance between points then measured..................	40	77	79	65.3
19. Thickness or feeler gauges consist of a series of blades of varying thickness. This gauge is used to check the clearance between two surfaces..........	45	77	71	64.3
20. If metal bluing or copper sulphate is applied to a bright metal surface before a layout is made on it, the scribed lines will be more legible. Rough surfaces may be covered with white chalk..............	40	73	75	62.7
21. Work to be laid out with the greatest precision is placed on a surface plate which has an extremely flat surface and which serves as a true foundation upon which the word and gauges may rest................	45	73	67	61.7
22. The common layout instruments are the scriber, a sharp-pointed tool which incises a fine line when drawn across a metal surface; dividers, for				

(continued on next page)

Table 17. (continued)

Items Pertaining to Layout and Measuring	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
drawing arcs and circles; hermaphrodite calipers for scribing lines parallel to an edge and for locating centers of round stock; trammel points, for scribing large arcs and circles; and surface and height gauges, for scribing lines on vertical surfaces......................	30	73	75	59.3
23. Gauge blocks are used for the accurate setting of gauges and measuring instruments, the blocks themselves being accurate to within two millionths of an inch..........	35	64	75	58.0
24. Since measurement with a micrometer depends to an extent on the touch of "feel" of the mechanic and since the touch of mechanics vary, a micrometer should be set by the person who is to use it..	40	64	67	57.0
25. Fixed gauges of the go-not-go type are used to determine whether measurements are within specified limits......	35	68	67	56.7
26. A vernier scale on such instruments as the caliper scale and height gauge permits measuring in thousandths of an inch. On the micrometer caliper, which already				

(concluded on next page)

Table 17. (concluded)

Items Pertaining to Layout and Measuring	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
permits measuring in thousandths, the vernier makes possible readings in ten thousandths of an inch............	35	64	67	55.3
27. All micrometers read alike. The screw has 40 threads per inch, thus each turn of the screw equals 1/40 of an inch (.025) and 1/25 of a turn equals 1/1000 of an inch (.001). Graduations on the barrel and thimble permit the user to determine how many turns and parts of turns of the screw have been made................	35	59	67	53.7
28. Welds are tested by the following devices: guided bend test, free bend, tensile, visual inspection, magnafluxing, and X-raying. Because most of the tests destroy the work or are expensive and time consuming, the skill of the operator is tested periodically and he is depended upon to do good work.....................	30	73	58	53.7
29. An angle plate is used in layout work to hold work at a right angle to a surface plate	25	64	67	52.0
30. To lay off a line perpendicular to a line on a surface, the work may be placed on an angle plate so that the surface line is perpendicular to the surface plate, and the desired perpendicular line then scribed with a surface gauge..............	25	64	63	50.7
Mean......................	50	76	75	67.0

of the items failed to be checked as important by as many as 50 per cent of that jury. Only one item (item ranked 27 in Table 17, page 118) was checked as important in general education by fewer than 60 per cent of either of the juries of industrial arts specialists.

Reliability of the data.-- The responses of the general educators tended to be slightly more reliable than those of the other two juries. As computed by the rank-difference method, the coefficient of reliability of the responses of the general educators was 0.89. For the responses of the general metalwork teachers the coefficient was 0.79. For the supervisors and teacher trainers the coefficient of reliability was only 0.71.

Curriculum emphasis of the items.-- Only two of the thirty items pertaining to layout and measuring were checked by one-fourth or more of the members of each of the three juries for emphasis in courses other than industrial arts. These were items ranked 1 and 5 in Table 17 on page 113. The responses of the juries with regard to those two items are shown in Table 18 on the following page. No item was checked for emphasis in out-of-school situations by more than three members of each of the three juries.

Table 18. Items Pertaining to Layout and Measuring Which Were Checked for Emphasis in Courses Other than Industrial Arts by 25 Per Cent or More of Each of the Three Juries

Rank of Item in Importance	Abbreviated Item	Per Cent of Jurors Who Checked Item for Emphasis in Other Courses			
		General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)	(6)
1	Use of decimal measurements in precision work..	40	50	25	38
5	Kinds of inspection given manufactured articles....	50	55	25	43

3. Handwork

<u>Acceptability of items in general education</u>.-- The analysis of instructional materials produced a list of forty-four items which pertained to hand operations in industrial arts metalwork. These items, which were included in Part E of the check list, are arranged in order of importance in general education in Table 19 on the following pages. Three of the items were considered by more than 90 per cent of the respondents to be important enough that everyone should have an opportunity to acquire the knowledge, skill, habit, or attitude implied. Fifteen of the items were checked as important by 80 per cent or more of the respondents, and twenty-nine of the items were checked as important by 70 per cent or more of the respondents. The lowest-ranking item was considered important in general education by 56 per cent of the jurors. The mean of the responses was 74.3 per cent.

Table 19. Items Pertaining to Handwork Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. For the best work, tools should be in first-class condition and they should be used only for the purposes for which they were designed..................	95	95	92	94.0
2. Pliers should not be used ordinarily for turning nuts and screws, because such practice usually results in scarring the nut or screw head.............	90	91	96	92.3
3. In order to avoid damage to a screw head and to drive a screw properly and safely, the screw driver must fit the slot in the screw and its blade must have a square end with parallel sides.........................	85	95	92	90.7
4. A wrench must fit the part to be turned and it must be used in a proper manner; otherwise the wrench may slip, causing damage to the part and possibly injury to the worker..........	90	91	88	89.7
5. To tighten or loosen a nut or similar part with a wrench, the proper wrench should be selected. Besides the common monkey wrench, which is a general-purpose tool, there are other				

(continued on next page)

Table 19. (continued)

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
wrenches designed to grip nuts securely, conveniently, and without damage to the nut and danger to the user............	85	95	88	89.3
6. Pliers are used for firmly gripping small metal pieces for purposes of pulling, twisting, and pushing. Some pliers, such as side-cutting pliers, can also be used to cut small sizes of wire........................	90	95	79	88.0
7. When a screw is being driven in a small piece, the work must be held securely in a vise or laid on a bench. It is dangerous to use a screw driver on work held in the hands..................	80	86	88	84.7
8. The hack saw is used for cutting all metals except hardened steel..........................	65	95	88	82.7
9. Portable tools, such as electric drills and grinders, are useful because they may be brought to work that is too large to be placed in a vise or in a machine................	75	82	88	81.7
10. A nut or screw that has become rusted often cannot be turned by means of a wrench or screw driver. Soaking the threads with penetrating oil sometimes will remedy the trouble. If it does not, or if penetrating				

(continued on next page)

Table 19. (continued)

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
oil is not available, the nut or screw may be turned by driving it with a punch or hammer. Expanding a nut through heating is another way to loosen it....	75	95	75	81.7
11. An oilstone or slipstone is used to hone or finish the sharpening of a tool and to remove any burrs that are the result of grinding...............	65	91	88	81.3
12. Cold chisels, which are driven with a hammer, are useful in such work as shearing off rivet heads, chipping grooves in metal, cutting holes in sheet metal, and cutting off small rods and bars..................	65	86	92	81.0
13. Goggles should always be worn when chipping is being done with a cold chisel............	65	82	96	81.0
14. In order that a grinder may be operated safely, the tool rest should be set as close to the wheel as possible without touching it, and the operator must always wear goggles.......	65	95	83	81.0
15. Since the jaws of a vise are usually rough, copper or brass plates may be used as covers to protect the stock being clamped. Small pieces of metal may also be used to protect				

(continued on next page)

Table 19. (continued)

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
work from the grip of pliers...	70	82	88	80.0
16. A grinder, operated either by hand or by power, is used in renewing edges on cutting tools and in removing burrs from the heads of such tools as punches and chisels.........	70	86	83	79.7
17. A handle must always be fitted to a file (except jeweler's) before it is used; particles of metal which collect in the file teeth must be cleaned out by brushing with a file card...	60	86	92	79.3
18. Holding work securely in a stationary position is very important in practically all metal-work operations--both hand and machine. The most common device for this purpose is the vise........................	75	77	83	78.3
19. Filing properly is one of the most difficult operations in the mechanical field. As in sawing, pressure is applied on the forward stroke and the file is lifted slightly on the return stroke. The entire length of the file should be used..........................	65	82	88	78.3
20. Bench metalwork is basic to all phases of metalworking. It includes laying out, shaping, forming, assembling, and testing				

(continued on next page)

Table 19. (continued)

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important			
	General Educa-tors	Supervis-ors and Teacher Trainers	General Metal-work Teachers	All Respond-ents
(1)	(2)	(3)	(4)	(5)
work at the bench, using hand tools and instruments..........	60	77	92	76.3
21. A soft hammer or mallet with a head of such material as lead, copper, leather, or wood is used where a steel hammer would dent or nick the surface of the metal or where pounding a hardened steel surface might break either the surface or the hammer.......	60	86	83	76.3
22. With ordinary grinding wheels, all grinding should be done on the face of the wheel. Grinding on the side of the wheel spoils its shape and burns the tool quickly. Cup wheels are available for grinding work that cannot be ground on the ordinary grinding wheel..................	60	82	83	75.0
23. The machinist's hammer is used in such operations as driving punches, heading rivets, and cutting with the cold chisel....	60	82	79	73.7
24. Outside screw threads are cut by hand with a tool known as a threading die, which is made of hardened steel and roughly resembles a threaded nut..........	35	86	96	72.3
25. To drill holes in stone, brick, or concrete, a star drill or a carbide tipped drill in a brace or electric drill is used. The				

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Table 19. (continued)

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
star drill is struck with a hammer and is turned slightly between blows..................	60	73	83	72.0
26. The use of an improperly ground drill results in inaccurately drilled holes and frequently in damage to the drill.............	45	77	92	71.3
27. Inside screw threads (e.g., the threads in a nut) are cut by hand with a tool called a tap. It is made of hardened steel and roughly resembles a screw....	35	86	92	71.0
28. Metal to be sawed or chiseled in a vise should be clamped with the line to be cut close to the jaws of the vise. This will prevent the stock from vibrating when the cut is made............	55	77	79	70.3
29. When using a hand hack saw, the worker should press down on the forward stroke and lift a little on the return stroke, making about 40 cutting strokes per minute and using the entire length of the saw blade.........	55	73	83	70.3
30. A reamer, a tool which has cutting edges on the sides, is used to true and smooth holes which are purposely drilled slightly undersize. The reamer is used in the same manner as a tap.....	55	77	75	69.0

(continued on next page)

Table 19. (continued)

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
31. Twist drills with a straight shank are used in a hand drill. When used in a drill press, a straight-shank drill usually must be held in a chuck fitted with a Morse taper which fits into the drill press spindle....	40	77	88	68.3
32. If a stud or screw, broken off above the hole, cannot be turned out with a pair of pliers, it sometimes may be removed by sawing a slot in the end of the extending piece and turning it out with a screw driver. If the screw or stud is broken off even with or below the surface of the part into which it is screwed, it may be screwed out by driving it with a prick punch or by drilling a hole into the end and screwing it out by means of a screw extractor................	55	82	67	68.0
33. A drift or pin punch is used to drive out cotter pins and dowel pins.........................	55	77	71	67.7
34. Thin metal may be cut with the jeweler's saw which is useful in cutting out designs in metal (piercing)...................	50	82	71	67.7
35. The cutting angle of tools should be appropriate for the material to be cut, i.e., the harder the material to be cut, the greater should be the angle				

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Table 19. (continued)

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
of the cutting edge............	55	73	71	66.3
36. When it is necessary to remove a rivet, the head may be sheared off with a cold chisel and the rivet driven out with a drift punch. A hole the size of the rivet drilled through the rivet head will make the rivet easier to remove......................	45	82	71	66.0
37. For sawing metal with a hack saw, a blade should be chosen that will have at least two teeth cutting at one time.......	35	77	83	65.0
38. Hand taps must be used with great care because they are easily broken, and, when broken off in a hole, they are difficult to remove.................	25	77	92	64.7
39. The bench shear is used to rough cut metal up to $\frac{1}{4}$ inch in thickness........................	45	68	71	61.3
40. The cutting edges of twist drills (lips) must be equal in length and there must be from 12^{o} to 15^{o} clearance angle. The recommended lip angle is 59^{o}....	30	73	79	60.7
41. A hole to be tapped must be no smaller than the minor diameter of the threads to be cut; nor should it be larger than three fourths the major diameter......	25	77	75	59.0

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Table 19. (concluded)

Items Pertaining to Handwork	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
42. Broken taps may be removed by the same procedure as used in removing a broken screw, except that a tap must be annealed before it can be cut. Also, a tap extractor is available......	40	73	58	57.0
43. Rectangular and irregularly shaped holes are made by forcing a broach through an opening which is slightly undersize.....	35	68	67	56.7
44. Hand scrapers are used to remove high spots on metal surfaces to make them smooth and level. The operation consists of shearing or paring off thin flakes of metal, removing scratches and tool marks as well as high spots.............	50	68	50	56.0
Mean........................	59	82	82	74.3

<u>Differences in opinions of juries</u>.-- As in most other parts of this investigation, industrial arts specialists more than general educators tended to check items pertaining to handwork as important in general education. The average of the responses of these specialists was 82 per cent, while the mean of the responses of the general educators was only 59 per cent. This difference in degree of support for the items in general education had little effect on the rank order of the items as

reported in Table 19, however.

Reliability of the data.-- The coefficients of reliability of the responses of the three juries averaged 0.82. The responses of the general educators produced a coefficient of 0.86, when computed on a rank-difference basis. The coefficient of reliability of the responses of the supervisors and teacher trainers was 0.84, and the responses of the general metalwork teachers produced a coefficient of 0.77.

Curriculum emphasis of items pertaining to handwork.-- It was hardly to be expected that items pertaining to the use of hand tools should be checked by the respondents for emphasis in courses other than industrial arts, yet items which ranked in the first six in general education were so checked by a substantial number of respondents in each of the three juries. It may be that the respondents felt that the items were of sufficient importance that they should be emphasized wherever possible in the curriculum, regardless of the workshop nature of the items. Or, they may have had in mind the fact that hand tools are sometimes used in science laboratories, in the care of musical instruments, and in the care of athletic equipment. The percentage of respondents from each jury who checked the first six ranking items for emphasis in courses other than industrial arts are given in Table 20 on the following page.

Twenty-seven per cent of the jurors checked the item pertaining to the relation of good tools and good work for emphasis in out-of-school situations. No other item in this section of the check list was given significant support for out-of-school emphasis. Here again, it is difficult to determine what the respondents had in mind when they checked items

Table 20. Items Pertaining to Handwork Which Were Checked Most Frequently for Emphasis in Courses Other than Industrial Arts

Rank of Item in Importance	Abbreviated Item	Per Cent of Jurors Who Checked Item for Emphasis in Other Courses: General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)	(6)
1	Relation of good tools to good work.............	45	27	25	32
2	Improper use of pliers on nuts and screws.......	25	27	21	24
3	Importance of choosing proper screw driver......	30	32	25	27
4	Proper use of wrenches for safety...............	30	32	25	27
5	Kinds of wrenches........	30	32	25	27
6	Kinds of pliers and their uses....................	25	23	21	23

for out-of-school emphasis. It is probable in this case, however, that the item was so checked simply because it was thought to be important enough to be given attention everywhere possible.

4. Machine Work

Acceptability of items in general education.-- Part F of the check list contains thirty-one items pertaining to machines used or studied in industrial arts metalwork. These items are arranged in order of importance in general education in Table 21 on the following pages. None of the items was accepted as important in general education by all the

Table 21. Items Pertaining to Machine Work Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Machine Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. When they are operated properly, machines are not dangerous to the operator....................	95	82	92	89.7
2. An abrasive is a very hard, tough material which has many sharp cutting edges or points when crushed or ground..........	75	91	88	84.7
3. Wire is made by drawing a metal rod through a series of dies, the hole in each successive die being smaller than the material entering it....................	75	91	83	83.0
4. Machining is the term used to describe the cutting of metal to shape through use of machines such as the lathe, mill, and shaper. Metal is removed by cutting tools held in the machine. Machine shop work consists primarily of shaping metals by use of machines.......	70	86	88	81.3
5. The lathe is used principally for cutting round work. The piece to be machined is held between centers, in a chuck, or on a face plate. As the piece is revolved, a cutting tool is fed, either by hand or automatically, across the surface, removing metal as desired by the operator	65	91	88	81.3

(continued on next page)

Table 21. (continued)

Items Pertaining to Machine Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
6. Grinding is the process of removing metal through use of an abrasive wheel. Grinding machines are used to machine exact and finely finished surfaces..........................	70	86	88	81.3
7. Work being drilled must be held securely during the operation. If the work springs or moves while it is being drilled, the drill may bend or break, the work may be thrown from the table, and injury may result to the operator and to the machine. Commonly used holding devices are: drill vise, clamps or various kinds, V-blocks.........	55	91	88	78.0
8. Grinding wheels are made of abrasive grains cemented or bonded together to form a wheel. Wheels are available to serve every conceivable grinding requirement......................	65	82	79	75.3
9. Feeding a drill into the work too fast will cause the drill to break or the point to burn. The feed should be reduced when breaking through the work.......	55	82	88	75.0
10. A press is a powerful machine which is used to punch holes of different shapes or to press flat sheets of metal into a certain shape or form, such as an				

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Table 21. (continued)

Items Pertaining to Machine Work	Per Cent of Jurors Who Checked Item as Important			
	General Educa-tors	Supervis-ors and Teacher Trainers	General Metal-work Teachers	All Respond-ents
(1)	(2)	(3)	(4)	(5)
automobile body. The sheet of flat metal to be punched or formed is placed between two matching dies which are forced together with enormous pressure.	65	82	75	74.0
11. The shaper is a machine tool used for planing flat surfaces. The work is clamped in the shaper and the cutting tool moves back and forth over it, cutting on each forward stroke.	50	86	83	73.0
12. Production machine tools are used in manufacturing on a mass production basis. Examples are the turret lathe and automatic screw machine. They may be set up to cut duplicate pieces automatically or semi-automatically......................	65	77	75	72.3
13. Boring is the process of machining an internal round surface. It is done on a boring mill, drill press, lathe, and other machines. The cylinders of an automobile engine are bored, for example.............	60	77	75	70.7
14. The speed at which a drill is rotated in a drill press should be varied with the size of the drill and the composition of the material being drilled. The usual practice is to use a slow speed for hard metals				

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Table 21. (continued)

Items Pertaining to Machine Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
and a high speed for soft metals; the larger the drill the slower it should revolve...............	45	77	88	70.0
15. The milling machine is used to cut all kinds of grooves such as the keyways on shafts or the teeth on gears. The work is clamped in position and passed under revolving cutters of the desired shape. A universal mill may be used to cut spirals and cams as well as simpler work....	40	86	83	69.7
16. Handles on some tools and screws are made rough in order to provide a better hand grip. This process is known as knurling. It is usually done in a lathe with a knurling tool, although it may be done in other machines or by hand.....................	55	77	75	69.0
17. The planer is used to machine flat surfaces too large to be planed in a shaper..............	50	82	75	69.0
18. When a grinding tool has become clogged it will not cut and it will cause the work to heat unnecessarily. To put the wheel in good working condition it is dressed and trued with a dressing tool..................	45	82	79	68.7
19. When large holes are to be drilled, a smaller pilot hole				

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Table 21. (continued)

Items Pertaining to Machine Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
should be drilled first. The pilot hole should be the size of the web of the larger drill...	45	77	79	67.0
20. Extruding is a process in which metal heated to a plastic condition is forced through a die. Variously shaped strips can be made by this process. Aluminum moldings are an example..........	35	91	75	67.0
21. Besides its use in drilling holes, a drill press may be used for reaming, countersinking, counterboring, spot facing, tapping, and spot finishing.........	55	73	71	66.3
22. Screw threads may be cut in a lathe by using a properly shaped tool which traverses the work a given distance for each revolution of the work.................	35	77	83	65.0
23. Two basic motions are used in machine tools: reciprocating motion and rotary motion. Some of the machines that use reciprocating motion are: hack saw, shaper, planer. Some machines that use rotary motion are: drill press, lathe, milling machine, grinder.................	45	73	71	63.0
24. If many pieces of the same kind are to be drilled, a drill jig may be used to hold the work in				

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Table 21. (continued)

Items Pertaining to Machine Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
place and to insure drilling holes in the exact location desired........................	40	73	71	63.0
25. A piece of metal that is to be turned between centers must have small holes center drilled in both ends which are supported by lathe centers. If the lathe centers are not exactly aligned, a tapered cylinder will result. A lathe dog clamped to the work and inserted in the face plate causes the work to revolve......	30	77	75	60.7
26. Grinding wheels are usually run at a surface speed of 4000 to 6000 feet per minute. If a wheel is run too fast it is likely to break. If it is run too slowly it will not grind efficiently.......................	35	77	63	58.3
27. An abrasive-coated disc or a specially designed wheel may be used to cut off pieces of metal.	30	77	67	58.0
28. Lapping is the fine grinding off of small amounts of metal from work, usually hardened steel, that is slightly oversize. A lapping tool, called a lap, softer than the material to be finished, is coated with lapping compound and rubbed against the surface of the work.........................	30	77	58	55.0

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Table 21. (concluded)

Items Pertaining to Machine Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
29. Indexing is the procedure used in rotating work or tools to exact fractions of a complete revolution. For example, as in milling the teeth on a gear. A divider head is used for this purpose........................	20	73	71	54.7
30. Small, light work may be drilled in the sensitive drill--so-called because the operator can feel all the strains on the drill in the feed handle. Larger work is drilled in a back-geared drill press or in a radial drill which feeds the drill into the work automatically....................	25	73	63	53.7
31. The basic machine tools are known as toolroom machines because they are used in making tools, dies, jigs, and fixtures..	35	64	58	52.3
Mean........................	50	80	77	69.0

respondents, but six of the items were so accepted by 80 per cent or more of the jurors. Fourteen items were checked as important by 70 per cent or more of the respondents. No item failed to be checked as important by less than half the jurors, the lowest-ranking item being considered important by 52 per cent. The mean of the responses was 69.1 per cent.

Differences in opinions of juries.-- The judgment of the supervisors and teacher trainers and of the general metalwork teachers paralleled rather closely. The mean of the responses of the supervisors and teacher trainers was 80 per cent; of the general metalwork teachers, 77 per cent. The responses of the general educators, on the other hand, averaged only 50 per cent. The item given the least support by industrial arts specialists as a general education goal (item ranked last in Table 21 on page 138) was considered important by 61 per cent of that group. Fifteen items failed to receive the votes of half the general educators, and five items failed to receive the votes of one-third of that group of respondents.

Reliability of the data.-- The general educators seemed to be somewhat more consistent than the industrial arts specialists in their opinions regarding the general education importance of machine work items. By the rank-difference method, the coefficient of reliability of the general educators' responses was 0.89. The comparable coefficient for the responses of the supervisors and teacher trainers was 0.68; for the responses of the general metalwork teachers, 0.63.

Curriculum emphasis of the items.-- Every item checked by the respondents as important was also checked for emphasis in industrial arts. Only negligible support was indicated for emphasis of items in other areas of the curriculum or out of school. One item, however (the item ranked first in Table 21), was checked for emphasis in other courses and in out-of-school situations by 36 per cent of the respondents. This item pertains to the safeness of machines when they are operated properly. It seems reasonable to assume that a substantial proportion of the respondents believe that safe operation of machines should be emphasized everywhere possible.

5. Assembly and Fabrication

Acceptability of items in general education.-- In Table 22 on the following pages are listed in order of importance the eighteen items in Part G of the check list pertaining to assembly and fabrication. While none of the items was checked as important by all the jurors, six items were considered important by 85 per cent or more of the respondents. The item concerned with the direction a screw thread is turned (item ranked second in Table 22) was checked as important by all twenty general educators. Four other items (ranked 1, 3, 4, and 6) concerned with bolts and screws were checked as important by all but one of the twenty general educators. The average acceptance of the items as general education goals was 76.3 per cent. The lowest-ranking item was considered important by 59.3 per cent of the respondents.

Differences in opinions of juries.-- As mentioned in the paragraph above, more general educators than industrial arts specialists tended to accept certain of the assembly and fabrication items as general education goals. At the same time, more general educators than industrial arts specialists tended to reject items which seem to be technical in nature. Only seven of the twenty general educators checked as important items 16 and 18 which have to do with fitted bearings and pressed fits.

Reliability of the data.-- The mean of the coefficients of reliability of the responses of the three juries was 0.76, a figure which would indicate that the agreement among the jury members is significant. The

Table 22. Items Pertaining to Assembly and Fabrication Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Assembly and Fabrication	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Bolts are available in shapes and sizes to serve various purposes, e.g., stove bolts, machine bolts, studs. Screws available include machine screws, cap screws, set screws. When a bolt or screw is replaced, the proper kind should be used.............	95	91	88	91.3
2. Screws and bolts usually have right-hand threads. To tighten them they are turned in a clockwise direction; to loosen them they are turned counterclockwise..........................	100	91	83	91.3
3. To prevent a bolt or screw from becoming loose through vibration, a lock nut, lock washer, or castelated nut may be used...	95	91	88	91.3
4. Bolts and screws are usually used to fasten together parts in such a manner that they may be taken apart later............	95	82	88	88.3
5. Riveting is a process of fastening metal pieces together permanently. The rivet is placed through a hole in the pieces and is hammered to form a head. Structural steel work, boilers, and airframes are examples of riveted construction...........	90	91	83	88.0

(continued on next page)

Table 22. (continued)

Items Pertaining to Assembly and Fabrication	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
6. The common washer consists of a flat, circular piece of metal with a hole in the middle. The purposes of using a washer in connection with a bolt or screw are to provide a smooth bearing surface for the nut or screw head and to serve as a shim......	95	86	75	85.3
7. The principal means of fabricating or assembling metal parts are: riveting, fastening with screws or bolts, welding, soldering, locking (as sheet metal seams), and fitting as press or shrink fit.....................	75	86	79	80.0
8. Bolts and screws used in metalwork today are usually threaded according to national standards. The threads are either National Course, National Fine, or National Special..................	70	82	83	78.3
9. Hardware or standard parts such as bolts, nuts, screws, washers, small springs, and ball or roller bearings are usually purchased from a specialty manufacturer. Machines and devices are designed so as to utilize standard parts, for reasons of economy and efficiency...........	70	77	83	76.7
10. Set screws are used to hold objects like pulleys on shafts. They are made with or without heads. Headless screws are slotted for a screwdriver or				

(continued on next page)

Table 22. (continued)

Items Pertaining to Assembly and Fabrication	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
contain a hexagonal hole for a wrench. Headless set screws are safer than screws with heads....	65	82	79	75.3
11. A bolt is used when the worker can get at both sides of the work with wrenches, turning a nut on one side and holding the bolt head on the other side. A screw, which does not require a nut, is used where only one side can be reached with a wrench or screw driver..........	85	77	63	75.0
12. Keys are commonly used to keep pulleys and gears from revolving on shafts. Part of the key fits into a slot in the shaft; the other part fits into a slot in the pulley or gear...........	50	77	79	68.7
13. In metalwork, fitting means putting parts together so that they touch or join each other in such a way that one will turn inside the other, that one will slide upon the other, or that the parts will hold tightly together so they cannot move..........................	60	73	71	68.0
14. A shim is a thin sheet of metal, wood, or paper placed between two surfaces to keep them a certain distance apart or so that the shim is a support......	55	77	71	67.7

(concluded on next page)

Table 22. (concluded)

Items Pertaining to Assembly and Fabrication	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
15. A dowel pin is a metal peg used to keep two parts in a certain relation to each other and to keep them from moving or slipping. Sometimes tapered pins are used to fasten a pulley, collar, gear, or handle on a shaft..........................	50	77	71	66.0
16. When a shaft is fitted to a bearing, the diameter of the shaft should be a little smaller than the diameter of the bearing, to allow space for a film of oil between the surfaces and to allow the shaft to expand from heat caused by friction..........................	35	77	75	62.3
17. For maximum efficiency of a screwed or bolted joint, the surface upon which the bolt head, screw head, or nut rests is machined to form a perfect seat, e.g., countersunk, counterbored, or spot faced.....	55	68	58	60.3
18. Machine parts are often pressed together on an arbor press--a pulley on a shaft, for example..	35	68	75	59.3
Mean........................	71	81	77	76.3

responses of the general educators produced a much higher coefficient than the responses of the industrial arts specialists, however. The coefficient of reliability of the responses of the general educators was 0.93; of the supervisors and teacher trainers, 0.76; and of the general metalwork teachers, only 0.58. A possible reason for this is that the general educators tended to discriminate more critically than did the other two juries. The industrial arts specialists tended to accept more items as important, and the range of their responses was relatively narrow. For example, the responses of the general educators ranged from 35 per cent to 100 per cent, a difference of 65. The comparable range in responses of the supervisors and teacher trainers was from 68 per cent to 91 per cent, a difference of only 23. The range in responses of the general metalwork teachers was from 58 per cent to 88 per cent, a difference of 30.

6. Sheet Metal Work

Acceptability of items in general education.-- In Table 23 on the following pages the twenty-one items in Part H of the check list pertaining to sheet metal work are shown in order of importance in general education, as determined from the responses of the three juries. The highest-ranking item, which is simply a description of sheet metal work, was considered important by 88 per cent of the respondents. Nine of the items were checked as important by 75 per cent or more of the respondents. The other twelve items were considered important by from 61.7 per cent to 73.3 per cent of the respondents.

Table 23. Items Pertaining to Sheet Metal Work Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Sheet Metal Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Sheet metal work deals with laying out, cutting, shaping, and assembling thin sheet stock such as galvanized sheet steel, tinplate, copper, black iron, and aluminum. A person who specializes in sheet metal work is called a sheet metal worker, a tinsmith, or a tin knocker...	90	91	83	88.0
2. Slivers of sheet metal along a cut edge are sharp and dangerous. Such irregularities should be filed off before the piece is handled...............	80	82	92	84.7
3. Such metals as sheet copper, brass, aluminum, and silver may be shaped by hammering the metal into molds, over stakes, or on a sand bag. The process is known as raising, and the appearance of the raised article is distinguished by the hammer marks.........................	80	91	79	83.3
4. Successful soldering is dependent upon (1) having the pieces of metal to be joined clean, (2) having the pieces in mechanical contact with each other, (3) using the proper solder and flux for the metal, (4) heating the pieces to a				

(continued on next page)

Table 23. (continued)

Items Pertaining to Sheet Metal Work	Per Cent of Jurors Who Checked Item as Important: General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
temperature which will melt the solder and permit it to run freely, (5) having work placed on a surface that will not conduct heat too rapidly, and (6) heating the pieces in such a manner as to cause the solder to flow into the seam..........	65	91	88	81.3
5. The purpose of soldering flux is to help clean the metal, to prevent oxidization during soldering, and to help solder flow........................	65	91	88	81.3
6. The equipment needed in most soldering is a soldering copper and a source of heat, such as a soldering furnace or a blow torch. The soldering copper must be large enough to carry adequate heat and small enough so that the heat may be controlled. An electric copper may be used..................	65	95	79	79.7
7. Sheet metal articles such as aluminum, copper, or pewter trays are often shaped by spinning in a lathe. A sheet metal disc is revolved and pressed over a mold of the desired shape.......................	70	86	79	78.3
8. The faces on the point of a soldering copper must be clean and coated with solder (tinned) before it can be used for soldering......................	60	91	83	78.0

(continued on next page)

Table 23. (continued)

Items Pertaining to Sheet Metal Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
9. The most common means of fastening sheet metal pieces together are seaming, soldering, and riveting. Sometimes self-threading screws are used............	60	77	88	75.0
10. Sheet metal may be bent in a vise, over the surface or edge of variously shaped stakes, or in a bar folder or cornice brake. Curved parts are formed in a forming machine............	55	82	83	73.3
11. The most common solder is an alloy consisting of half lead and half tin, 50-50 solder......	60	77	83	73.3
12. The thickness of sheet metal is designated by gauge numbers which range from #000 to #36. The larger the gauge number the thinner the metal...............	60	86	71	72.3
13. To make an article out of sheet metal usually requires the making of a pattern or templet which indicates lines to be cut, allowances for seams, and places and direction metal is to be bent. Patterns are usually drawn on paper...............	55	77	79	70.3
14. To make a sheet metal pattern requires an understanding of geometric principles...........	60	68	83	70.3

(continued on next page)

Table 23. (continued)

Items Pertaining to Sheet Metal Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
15. Seams such as the locked seam, grooved seam, and double seam hold pieces together securely without other fastening. To be watertight, however, all seams are usually soldered.....	50	77	79	68.7
16. To punch a hole in sheet metal with solid or hollow punches, the sheet is placed over a block of lead or wood, the punch is placed on the sheet in the proper position, and the punch is struck with a hammer. Thin sheet metal may be punched with a hand punch similar to the kind used in punching paper.................	55	73	75	67.7
17. Sheet metal workers use several kinds of hammers for special purposes, e.g., a setting hammer for setting down seams, planishing hammers for smoothing and shaping................	55	73	75	67.7
18. To stiffen the metal and to protect users of sheet metal articles, edges are single or double hemmed, bent over a wire, or otherwise built up....	50	73	79	67.3
19. Operations such as grooving, turning, beading, and crimping are done on hand-powered machines in most sheet metal shops. Power machines are				

(concluded on next page)

Table 23. (concluded)

Items Pertaining to Sheet Metal Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
used for these operations in sheet metal manufacturing plants........................	45	77	75	65.7
20. Sheet metal which is 20 gauge or thinner may be cut by hand with snips. Heavier sheet metal must be cut with a bench shear, power shear, hack saw, cold chisel, squaring shear, or oxy-acetylene cutting torch.	50	73	71	64.7
21. When layout lines are scratched on sheet metal, care must be taken to mark only the lines that are to be cut. Scratches mar the surface of the metal, and, in case of coated sheets, the base metal is likely to become rusted where scratch-awl marks cut through the coating........................	45	73	67	61.7
Mean........................	61	81	80	74.0

Differences in opinions of juries.-- In regard to the items pertaining to sheet metal work, the three juries seemed to be in fair agreement. No items seem to stand out as being significantly more important to one jury than to another jury.

Reliability of the data.-- As shown in Table 2 on page 31, the coefficients of reliability of the responses of the three juries, when computed by the rank-difference method, were significant. The coefficient for responses of the general educators was 0.75; of the supervisors and teacher trainers, 0.74; and of the general metalwork teachers, 0.82. The mean of the coefficients was 0.77.

Curriculum emphasis of sheet metal work items.-- The checking for emphasis in industrial arts was identical with the checking for importance in general education. Thus the order of items in Table 23 represents the order of emphasis in industrial arts as well as the order of importance in general education.

The data revealed no tendency on the part of the respondents to want any of the items emphasized (or left to be learned) outside the influence of the school. Two items, however, were checked by a substantial number of jurors for emphasis in other courses. These items (ranked 1 and 14) were a general description of sheet metal work and a statement to the effect that geometry is applied in sheet metal work. The description of a major area of employment is undoubtedly appropriate for consideration in courses dealing with occupations. The relationship between sheet metal work and geometry presents an opportunity for teachers to reinforce each other's work.

7. Foundry Work

Acceptability of items in general education.-- The ten items in Part I of the check list pertaining to foundry work are given in order of importance in general education in Table 24 on the following pages. Aside from the highest-ranking item, which is simply a general description

Table 24. Items Pertaining to Foundry Work Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Foundry Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Metals which flow freely when molten may be cast into desired shapes by pouring the molten metal into molds. The process is known as casting or founding. It is done in a foundry, e.g., iron foundry, brass foundry......	85	100	92	92.3
2. The mold into which the metal is poured must be made from a sample or full-scale model known as a pattern. Patterns are made of wood, metal, wax, or plaster..	60	91	83	78.0
3. Molds for casting metal are commonly made of sand or plaster. When many castings are to be made from one mold, as in die casting, the mold is made of metal.........................	65	86	79	76.7
4. Metals such as bronze and white metal are often shaped by a process known as die casting. The metal is in either a fluid or plastic state and it is forced into a die under high pressure. Die cast articles have a smooth surface and require no finishing unless they are to be plated.....	50	91	79	73.3
5. In order to allow the molten metal to flow into all parts of the mold, the mold must be vented				

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Table 24. (continued)

Items Pertaining to Foundry Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
to permit air, gas, and steam to escape......................	55	77	79	70.3
6. Molds must be free from moisture when the metal is poured in; otherwise steam will form and cause an imperfect casting and possibly cause the mold to explode......................	50	73	79	67.3
7. Cast iron and most other metals take up more space when hot than they do when cold. For this reason, patterns must be made larger than the finished article to allow for shrinkage.	35	77	79	63.7
8. When an article to be molded contains holes or hollow parts, a core is placed in the mold so the metal will flow around it. Cores are usually made of sand and oil. They are molded in a core box and baked in an oven prior to insertion in the mold.	40	73	75	62.7
9. In order that a pattern may be lifted from a mold, the sides of the pattern must be tapered. The taper is called draft......	35	77	75	62.3
10. When castings have solidified and cooled, they are taken from the mold and placed in an irregularly-shaped barrel (called) a rattler) to clean off molding sand and to shake out cores. A cold chisel is used to chip off burrs and irregularities.......	25	68	67	53.3
Mean......................	50	81	79	70.0

of foundry work, none of the items was considered important by as many as 80 per cent of the respondents. The first five ranking items were checked as important by 70 per cent or more of the jurors. The remaining items were considered important by from 53.3 per cent to 67.3 per cent of the respondents.

Differences in opinions of juries.-- The industrial arts specialists more frequently than the general educators checked foundry work items as important in general education. Nevertheless, there is good agreement between the rank order of items as determined by the responses of the separate juries. As explained on page 31, the coefficient of correlation between the responses of the general educators and those of the supervisors and teacher trainers was 0.82. The coefficient indicating the relationship of the responses of the two industrial arts specialist juries was 0.85.

Curriculum emphasis of foundry work items.-- The ten items pertaining to foundry work appear to be almost entirely the province of industrial arts. Each item that was checked as important by a respondent was also checked by that respondent for emphasis in industrial arts courses. As in the case of the responses to the list of sheet metal work items reported in the preceding section, the data revealed no tendency on the part of the jurors to want any of the items emphasized (or left to be learned) outside the influence of the school. Fifty-five per cent of the general educators and 41 per cent of the supervisors and teacher trainers indicated that the highest-ranking item--the one concerned with the general nature of foundry work--should be emphasized in other courses. Only five of the twenty-four teachers, on the other hand (21 per cent), checked this item for emphasis in other courses.

8. Forge Work

Acceptability of items in general education.-- The fourteen items in Part J of the check list pertaining to forge work are given in order of importance in general education in Table 25 on the following pages. Only the first-ranking item, which has to do with the general nature of forge work, was checked as important by more than 90 per cent of the respondents. No other item was checked by as many as 70 per cent, but even the lowest-ranking item apparently was considered important by more than half the respondents. The mean of the responses of all juries combined was 64 per cent, the lowest figure for any section of the entire check list. It seems reasonable to conclude that forge work, as characterized by the fourteen items in the check list, is of less importance in general education than other aspects of metalwork.

Differences in opinions of juries.-- The mean per cent of the general educators' responses was 39; of the supervisors and teacher trainers' 79; and of the general metalwork teachers' 74. Thus the three juries reacted to the items pertaining to forge work about as they did to all other sections of the check list. That is, the per cent of general educators who checked items as important was significantly less than the per cent of industrial arts specialists who checked items as important. Only four of the twenty general educators checked the technical item concerned with upsetting stock (item ranked 13) as important, and the last six ranking

Table 25. Items Pertaining to Forge Work Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Forge Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Historically the first metalworking process was forging, which means beating metal into shape. The process is important today, but most of it is done by machine (drop forge) instead of by hand, although hand forging is still done by ornamental iron workers and by maintenance mechanics......................	80	95	96	91.3
2. Scrolls are used in ornamental iron work to lessen the monotony of straight lines. Scrolls are usually formed cold, through use of a variety of devices such as bending forks, jigs, and bending machines................	50	82	75	69.0
3. The process of forging refines the grain of metal in such a way that forgings are tougher than castings or machined pieces. For this reason such parts as crankshafts are usually forged to shape before they are machined to finished dimensions.	45	82	75	67.3
4. The principal equipment for hand forging is a coal or gas forge, an anvil, tongs for holding the heated metal, and hammers, chisels, forming tools, and punches..............	50	77	75	67.3

(continued on next page)

Table 25. (continued)

Items Pertaining to Forge Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
5. In most ornamental iron work the appearance is improved by shaping or marking the ends of metal pieces. This is commonly done by forging, filing, grinding, or hammer marking..........	40	86	75	67.0
6. A drop hammer is a large, powerful machine which has a heavy weight that acts as a hammer. The weight has a die fastened to its bottom. The hot metal is laid upon another die which is fastened on the base or anvil. The weight then drops on the metal and hammers it into both dies. The object thus formed is called a drop forging........	50	73	75	66.0
7. Wrought iron and mild steel up to and including one-fourth inch in thickness can be bent cold. Thicker pieces must be red hot or hotter...............	40	77	71	62.7
8. When a metal bar is to be bent at an angle, an allowance must be made to compensate for the shrinkage in the length of the piece. The rule for allowance is to add an amount equal to one-half the thickness of the metal for each right-angle bend.	35	77	71	61.0
9. Circular bends may be made over an anvil or around some cylindrical piece such as a rod or pipe. A common procedure when				

(continued on next page)

Table 25. (continued)

Items Pertaining to Forge Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
bending metal bars cold is to use a pipe or rod with a slot in one end, inserting the end of the bar in the slot and slowly bending around it........	30	73	79	60.7
10. In forging iron or steel, the metal should be hammered only when it is bright red hot or hotter. The work can be damaged if it is hammered at an improper heat...........................	25	77	79	60.3
11. Metal bars are often twisted to give them additional stiffness, to alter their position for fastening purposes, and for ornamental reasons. Mild steel square bars up to $\frac{1}{2}$ inch and strap iron up to $\frac{1}{4}$ inch in thickness and $1\frac{1}{2}$ inches in width usually can be bent cold. To prevent stock from twisting out of line, it may be twisted inside a section of pipe of the proper size................	30	73	71	58.0
12. To stretch or draw out an iron or steel rod or bar, it may be heated white hot and then hammered over the horn of the anvil...........................	25	73	75	57.7
13. To thicken or upset the end of an iron or steel rod or bar, the end to be upset is heated white hot, placed on an anvil,				

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Table 25. (concluded)

Items Pertaining to Forge Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
and the other end struck with a hammer or the heated end rammed against the anvil...............	20	73	71	54.7
14. Wrought iron or steel may be welded by heating the pieces to welding heat, placing the pieces together, fluxing the joint, and hammering the pieces together. This process, which requires much skill, has been almost entirely replaced by gas and electric welding....................	30	82	50	54.0
Mean.........................	39	79	74	64.0

items were checked as important by 30 per cent or fewer of the general educators.

Reliability of the data.-- When computed by the rank-difference method, the responses to the fourteen items pertaining to forge work proved to be the least consistent of all the groups of items studied. The coefficients of reliability were as follows: general educators, 0.60; supervisors and teacher trainers, 0.65; general metalwork teachers, 0.43. The mean of the coefficients was 0.56. Aside from the first-ranking item, which was checked as important by 91.3 per cent of all respondents, the range in the per cent of jurors who checked the other items as important was so small that the rank-order seems to have little significance. The responses of the supervisors and teacher trainers, for example, ranged narrowly from 73 per cent to 86 per cent.

Curriculum emphasis of forge work items.-- Those respondents who checked forge work items as important also checked the items for emphasis in industrial arts. Only the first-ranking item was checked for emphasis in other courses by a significant number of respondents. Forty-five per cent of the general educators, 41 per cent of the supervisors and teacher trainers, and 42 per cent of the general metalwork teachers so checked the item. None of the items was checked by more than eleven of the sixty-six respondents for learning in out-of-school situations, 17 per cent, and only one item (ranked first in Table 26) was checked by that many jurors. Except for general understanding of the forging process, forge work seems to be appropriate for emphasis only in industrial arts.

9. Welding

Acceptability of items in general education.-- In Table 26 which follows, the seventeen items pertaining to welding contained in Part K of the check list are arranged in order of importance in general education. The first-ranking item, which is a general description of the welding process, was considered important in general education by all but two of the sixty-six respondents. The items ranked in the first six were checked as important by from 81.7 per cent to 97.0 per cent of the jurors. The lowest-ranking item was considered important by 59.0 per cent of the respondents, and the mean of the responses for all seventeen items was 73.0 per cent. Except for the most technical items, in the opinion of most of the

Table 26. Items Pertaining to Welding Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Welding	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Welding is the process of fusing metals together. Oxy-acetylene and electric arc are the two principal kinds of welding, both processes supplying intense and concentrated heat which melts the metal and the filler rod which fills the space in the joint..............	95	100	96	97.0
2. Shipbuilding, automobile and farm implement manufacture, and the refining and transportation of oil and gas are major industries which employ many welding operators. In cities and even rural communities there is work for welders in the repair and maintenance of machinery........	90	95	92	92.3
3. The infra-red and ultra-violet rays from the welding flame or arc are injurious to the eyes; therefore the welders' goggles or helmet must be in place before an arc is struck or a torch lighted--whether you are watching or welding.............	70	95	92	85.7
4. The hazards of welding--from the electric current, from the hot metal, from flying scale, and from injurious light rays--				

(continued on next page)

Table 26. (continued)

Items Pertaining to Welding	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
require rigid adherence to all safety precautions..............	70	86	96	84.0
5. Sheet steel articles such as children's toys, lockers, and office furniture are frequently fabricated by a process known as spot welding. The pieces of metal are placed between two electrodes and pressed together. The current passing through the pieces produces sufficient heat to fuse them together at that spot...........................	70	95	83	82.7
6. Because of the strength of welded joints, welded construction makes it possible to save much weight in many manufactured products and consequently decrease costs and sometimes improve performance and appearance of the products. Welded ships are an example...........	80	82	83	81.7
7. Steel may be "cut" with an oxy-acetylene cutting torch. The oxy-acetylene flame heats the metal to a temperature at which it will oxidize quickly and then a stream of oxygen, directed toward the place to be cut, burns through the metal. The process is called flame cutting or burning..............	60	85	83	76.0

(continued on next page)

Table 26. (continued)

Items Pertaining to Welding	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
8. By the welding process it is possible to add a coating of extremely hard metal on surfaces which are subjected to excessive wear--for example, a hard-surfaced plow share......	60	82	79	73.7
9. In oxy-acetylene welding, acetylene and oxygen gases are supplied to a welding torch where they are mixed and burned.......	35	86	88	69.7
10. Bronze welding (brazing) is similar to welding except that brass (known as spelter) is used as the filler rod, and the base metal is not melted. The process is sometimes called hard soldering......................	40	86	79	68.3
11. In arc welding, a heavy current is required, often as great as 400 amperes for a single welding machine.....................	40	77	83	66.7
12. Both edges of the base metal and the end of the filler rod must be molten simultaneously if a weld is to be sound........	30	82	82	65.0
13. Defective welds are indicated when the pattern of the weave is irregular, when blow holes are present, and when fine cracks are visible.............	40	73	75	62.7

(concluded on next page)

Table 26. (concluded)

Items Pertaining to Welding	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
14. A flux is used to increase fluidity of the molten metal and to prevent the heated metal from becoming oxidized. In arc welding, the filler rod (electrode) is usually coated with flux...........................	30	77	75	60.7
15. Welding in a flat position (downhand) is relatively simple; vertical and overhead welding are difficult skills. About 200 clock hours of intensive training is required to develop minimum employable skills to arc weld steel in all positions. The skills are lost if not used regularly..........................	30	77	71	59.3
16. Stock to be welded must be clean, and the space between the pieces must be such that the weld metal can flow freely and make a sound joint..........................	25	77	75	59.0
17. Both AC and DC machines are used, but the DC machine is generally considered superior for most work. With either machine, the work is connected to one side of the circuit and the electrode to the other. When the electrode touches the work a hot arc results..........................	25	77	75	59.0
Mean..........................	52	84	83	73.0

respondents, welding seems to be appropriate in a program of general education.

Differences in opinions of juries.-- A smaller per cent of the general educators than of the industrial arts specialists checked welding items as important. The mean of their responses was only 52 per cent, while the mean of the responses of the other two juries were 84 per cent and 83 per cent, respectively. In regard to items ranked 1, 2, and 6, however, the three juries seemed to be in good agreement. These items, it should be pointed out, are non-technical in nature. As in all parts of the check list, the general educators tended to reject technical or specific items.

Reliability of the data.-- The mean of the coefficients of reliability of the responses of the three juries, as computed by the rank-difference method, was 0.77. The responses of the general educators and general metalwork teachers seemed to be somewhat more consistent than the responses of the supervisors and teacher trainers, the coefficients of reliability being as follows: general educators, 0.86; supervisors and teacher trainers, 0.62; general metalwork teachers, 0.84. Nevertheless, the rank order of items as shown in Table 26 seems to be based on significantly reliable data.

Curriculum emphasis of welding items.-- All respondents who checked items pertaining to welding as important in general education checked the items also for emphasis in industrial arts. Only an occasional respondent checked welding items for emphasis out of school; but 50 per cent of the jurors checked the second-ranking item, which is concerned with the kind of industries employing welders, for emphasis in courses other than industrial arts. The first-ranking item was checked for emphasis in other courses by 36 per cent of the respondents.

10. Pipe Work

<u>Acceptability of items in general education</u>.-- In Table 27 on the following pages, the twelve items pertaining to pipe work contained in Part L of the check list are arranged in order of importance in general education. Only three respondents, two teachers and one general educator, failed to check the first-ranking item as important. The item which ranked last was checked as important by 57 per cent of the respondents. The mean of the responses was 74.6 per cent. As in other parts of the check list, the items which were checked as important by the greatest number of respondents were non-technical and general in nature.

<u>Differences in opinions of juries</u>.-- More supervisors and teacher trainers tended to accept items as important than did the teachers. The teachers, on the other hand, tended to accept more items than did the general educators. This is characteristic of all sections of the check list. As in most other sections, too, all three juries were in substantial agreement regarding the top-ranking items, with the support of the general educators dropping off rather sharply when the items were technical in nature.

<u>Reliability of the data</u>.-- The coefficients of reliability of the responses, as computed by the rank-difference method, were higher for this section of the study than they were for any other section. The mean of the coefficients was 0.84. For the separate juries the coefficients were as follows: general educators, 0.93; supervisors and teacher

Table 27. Items Pertaining to Pipe Work Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Pipe Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Pipes made of wrought iron or steel are used in the home to run water, steam, gas, and electric wires. Copper pipe is considered superior to steel pipe for water lines..................	95	100	92	95.7
2. Pipe fitting means measuring, cutting, threading, and putting pipes and fittings together. A plumber installs water pipes; a steam fitter, steam pipes; a gas fitter, gas pipes; and an electrician, conduit--the name given to pipes that carry electrical wires....................	95	91	88	91.3
3. The size of a pipe is designated by its internal diameter. The hole is usually somewhat larger than the nominal size...........	80	82	88	83.7
4. Pipes are most often connected by means of threaded fittings such as elbows, tees, couplings, plugs, and caps. Copper pipes, however, may be soldered to the fittings......................	65	86	83	78.0
5. Pipes made of thin metal--chiefly brass, copper, aluminum--are called tubing. Tubing is fitted similarly to pipes....	65	86	79	76.7

(continued on next page)

Table 27. (continued)

Items Pertaining to Pipe Work	Per Cent of Jurors Who Checked Item as Important			
	General Educa-tors	Supervis-ors and Teacher Trainers	General Metal-work Teachers	All Respond-ents
(1)	(2)	(3)	(4)	(5)
6. Because pipe is usually round, it must be held in a special vise (called a pipe vise) when it is being cut or threaded. Also, a special wrench (pipe wrench) is used to screw pipes and fittings together...........	60	86	75	73.7
7. Pipes may be cut with a hack saw. The general practice, however, is to use a pipe cutter which is fastened over the pipe and revolved around it. The cutter is tightened with each revolution until the pipe is cut off. After cutting, the rough edge of the hole is reamed so it is smooth..........	60	86	75	73.7
8. Pipe threads are almost always right hand. When the ends of two pipes in a fixed position are joined, a fitting called a union is used..................	55	82	79	72.0
9. Pipe threads are tapered so as to make the joints tight. Red lead is smeared on pipe threads before pipe and fittings are screwed together, so as to make the joints gastight and to keep the metal from corroding.......	45	82	83	70.0
10. In machines, pipes are used to carry oil, gasoline, and a variety of fluids. They are installed and maintained by appropriate mechanics, e.g.,				

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Table 27. (concluded)

Items Pertaining to Pipe Work	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
hydraulic lines in an airplane by an airplane mechanic........	60	68	67	65.0
11. When a pipe or tube is bent, the outer part is stretched while the inner part is squeezed together. For this reason the pipe or tube tends to flatten when bent. To prevent this, the pipe may be tightly packed with fine, dry sand during the bending......................	35	82	67	61.3
12. There are two main classifications of pipe: welded and seamless. The shaping and welding of pipe is usually done by a rolling process; seamless pipe is made from a solid rod of metal which is rolled and pushed over a long mandrel.....	45	68	58	57.0
Mean......................	63	83	78	74.7

trainers, 0.85; general metalwork teachers, 0.75.

Curriculum emphasis of pipe work items.-- No respondent who checked an item as important in general education failed to check the item again for emphasis in industrial arts. The order of items in Table 27, therefore, is the order of emphasis in industrial arts courses. The highest-ranking item, concerned with the use of pipes in homes, was checked for emphasis in other courses by 60 per cent of the general educators, by 50 per cent of the supervisors and teacher trainers, and by 29 per cent of the general metalwork teachers. No other item was given more than an occasional vote for emphasis in courses other than industrial arts or for learning outside the school curriculum.

11. Metal Finishing, Ornamentation, and Preservation

Acceptability of items in general education.-- In Table 28 on the following pages, the twenty-one items pertaining to metal finishing, ornamentation, and preservation contained in Part M of the check list are arranged in order of importance in general education. All twenty-one items were checked as important by 60 per cent or more of the respondents, and nine of the items received the votes of 80 per cent or more of the jurors. Next to the group of items pertaining to assembly and fabrication, this group of items pertaining to metal finishing, ornamentation, and preservation received the greatest percentage of votes of the shop work areas.

Differences in opinions of juries.-- In regard to the items pertaining to metal finishing, ornamentation, and preservation the juries seemed to be in essential agreement. With the exception of just one item (ranked last) one-half or more of the members of each jury checked all the items as important.

Reliability of the data.-- The mean of the coefficients or correlation of the responses of the three juries, as computed by the rank-difference method, was 0.77. The coefficients for the separate juries were as follows: general educators, 0.68; supervisors and teacher trainers, 0.77;

Table 28. Items Pertaining to Metal Finishing, Ornamentation, and Preservation Arranged in Order of Importance in General Education, as Determined by 20 General Educators, 22 Industrial Arts Supervisors and Teacher Trainers, and 24 General Metalwork Teachers

Items Pertaining to Metal Finishing, Ornamentation, and Preservation	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
1. Metal must be clean, dry, and free from rust and grease before it can be painted or plated successfully....................	90	100	92	94.0
2. Metal articles are finished in various ways for the purpose of protecting the surface from becoming tarnished or corroded and for the purpose of improving the appearance.............	80	100	92	90.7
3. Etching is done by coating the metal surface with melted wax or asphaltum, scratching through this coating the marks to be etched, and then applying an acid which eats out the design..	80	91	83	84.7
4. Rust and dirt may be removed with a wire brush, either by hand or with a brush on a grinder. If a grinder is used, goggles must be worn and the work should be held against the lower edge of the brush.........	80	86	83	83.0
5. Clear lacquer or wax provides a transparent protective covering for metal. This finish is often used on brass to keep its appearance bright and on steel when it is desired to retain the coloration of the oxides resulting from heating..........	65	91	92	82.7

(continued on next page)

Table 28. (continued)

Items Pertaining to Metal Finishing, Ornamentation, and Preservation	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
6. Hand polishing means to rub the surface of the metal by hand with an abrasive cloth or with steel wool, beginning with coarse abrasive and continuing with finer grades successively until using the finest grade....	80	86	79	81.7
7. Iron and steel articles such as lawn furniture and ornamental iron work may be painted, enameled, or lacquered. Cast iron parts, however, should be filled before painting, if a smooth surface is desired.......	75	91	75	80.3
8. Red lead and zinc chromate paints are used to keep iron, steel, and other metals from becoming rusted. For example, red lead on structural steel....	75	82	83	80.0
9. Through use of hard, sharp engraving tools, designs may be incised on metal surfaces. This process is known as engraving........................	70	95	75	80.0
10. To polish is to change a rough, uneven, dull surface with irregular scratches to a surface with very fine, uniform, parallel cuts or grooves which cannot be seen with the naked eye..	80	77	79	78.7
11. Grains of abrasive glued to cloth makes an abrasive cloth, e.g., emery cloth...............	60	91	83	78.0

(continued on next page)

Table 28. (continued)

Items Pertaining to Metal Finishing, Ornamentation, and Preservation	Per Cent of Jurors Who Checked Item as Important			
	General Educa-tors	Supervis-ors and Teacher Trainers	General Metal-work Teachers	All Respond-ents
(1)	(2)	(3)	(4)	(5)
12. Metals are elctroplated with another metal to improve appearance or to increase wearing properties of the article. The process consists of separately suspending in an electrolytic solution the article to be plated and an anode of the plating metal and causing a direct current to flow through the solution from the anode onto the article...............	50	91	88	76.3
13. Rusty metal, covered with grease or paint, may be cleaned by boiling it in a solution of caustic soda and water.........	65	91	67	74.3
14. Machine buffing consists of holding the work against a cloth buffing wheel to which has been applied a buffing compound such as lime, tripoli, or rouge. The process is also done by hand rubbing...........	60	77	75	70.7
15. Metal articles may be given an antique finish by applying various chemicals..............	70	68	71	69.7
16. Identifying marks are placed on tools and machine parts by stamping, stenciling, and etching, or, in the case of cast articles, by molding the marks as part of the pattern.........	60	73	75	69.3

(concluded on next page)

Table 28. (concluded)

Items Pertaining to Metal Finishing, Ornamentation, and Preservation	Per Cent of Jurors Who Checked Item as Important			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
17. Ornamental iron work can be given a distinctive appearance by hammer marking the surface with a ball-peen or cross-peen hammer or with punches of various kinds..........................	50	77	79	68.7
18. Crackle lacquer, used on commercial products such as radios and typewriters, provides an attractive appearance and effectively conceals small irregularities on the surface. It is applied just as ordinary paint and the article is then baked...........	55	73	75	67.7
19. Spot finishing may be done by applying emery flour to the surface and then rubbing the spots lightly with the end of a revolving dowel held in a drill press..........................	55	77	54	62.0
20. Burnishing is a process of making a surface shiny by rubbing it with a hard, smooth tool and pressing out minute high spots...	55	73	58	62.0
21. Relief designs may be placed on sheet metal articles by a process called chasing or repousse. The design to be embossed is traced with tools of various shapes which are tapped lightly with a hammer....................	40	77	67	61.3
Mean..........................	66	84	77	75.7

general metalwork teachers, 0.86.

Curriculum emphasis of the items.-- All of the items considered important in general education were checked by the same number of respondents for emphasis in industrial arts. None of the items was given more than scattered support for emphasis in other curriculum areas.

12. Summary

1. The items discussed in this chapter are essentially industrial arts in nature. Relatively few items were checked by respondents for emphasis in any other learning situation than industrial arts.

2. Items pertaining to assembly and fabrication were checked as important by the largest percentage of respondents. The average of the responses to the different groups of items in the field of shop work are shown in Table 29 on the next page.

3. Shopwork items which were non-technical in nature were more acceptable as general education goals than were technical items.

4. As seen in Table 29, the percentage of general educators who checked shop work items as important was substantially smaller than the percentage of industrial arts specialists who checked items as important.

5. Relatively few shop work items suggest possibilities for curriculum correlation. Those general items which are concerned with occupational information probably offer the greatest possibilities.

Table 29. Average Percentage of Jurors Who Checked Shop Work Items as Important in General Education

Area of Shop Work	Average Percentage of Jurors Who Checked Items as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
Assembly and Fabrication............	71	81	77	76.3
Metal Finishing, Ornamentation, and Preservation......................	66	84	77	75.7
Pipe Work..........................	63	83	78	74.6
Hand Work..........................	59	82	82	74.3
Sheet Metal Work...................	61	81	80	74.0
Welding............................	52	84	83	73.0
Foundry Work.......................	50	81	79	70.0
Machine Work.......................	50	80	77	69.0
Layout and Measuring...............	50	76	75	67.0
Forge Work.........................	39	79	74	64.0
Mean..............................	56	81	78	71.7

CHAPTER VI

CONCLUSIONS

1. Introduction

In the preceding chapters a detailed report of the results of this study is given. In this chapter will be presented a summary of the findings, suggestions for their possible use, and recommendations for other studies the need for which seems to be indicated by the present investigation. As stated in Chapter I, one of the purposes of this study is to draw from the findings implications for all areas of industrial arts rather than to limit considerations to the field of industrial arts metalwork. That purpose will be incorporated in the paragraphs that follow.

2. Summary of the Data

Importance of items.-- As shown in Table 30 at the top of the next page, general information items were checked more frequently as important in general education than were items concerned with other phases of metalwork. The general educators in particular indicated that these items serve general education aims. The items which were accepted by the greatest number of jurors were, in the main, items which represent information commonly known by the average well-educated adult. In other words, the respondents seemed to consider knowledge which they themselves possess to be important enough that everyone, by some means or another, should have the opportunity to acquire. All thirty-two general information

Table 30. Average Percentage of Jurors Who Checked Industrial Arts Metalwork Items as Important in General Education

Areas of Industrial Arts Metalwork	Average Percentage of Jurors Who Checked Items as Important			
	General Educators	Supervisors and Teacher Trainers	General Metalwork Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
General Information................	92	85	85	87
Technical Information..............	63	83	80	75
Shop Work..........................	56	81	78	72

items were checked as important by 66 per cent or more of the respondents.

Technical information items, on the whole, were considered important by fewer general educators than industrial arts specialists, as shown in Table 30. Shop work items were supported less frequently than items in the other two categories.

By the nature of items checked as important, it is reasonable to assume that respondents tended to consider as important technical information with which they themselves are familiar--items which have the most frequent possibilities for application in everyday life.

Generalized items were checked more frequently as important than specific items.

Respondents tended to check applications of technical principles as important more frequently than they checked the principles themselves.

Each of the foregoing statements applies in the same way to the responses of the jurors with regard to the shop work items in the check list.

Table 31. Average Percentage of Jurors Who Checked Industrial Arts Metalwork Items for Emphasis in Industrial Arts Courses

Areas of Industrial Arts Metalwork	Average Percentage of Jurors Who Checked Items for Emphasis			
	General Educators	Supervisors and Teacher Trainers	General Metal-work Teachers	All Respondents
(1)	(2)	(3)	(4)	(5)
General Information................	66	72	62	67
Technical Information..............	57	78	75	70
Shop Work..........................	56	81	78	72

Appropriateness of items in industrial arts courses.-- While the thirty-two items of general information were checked as important more frequently, on the whole, than the items in other categories of this study, they were checked less frequently for emphasis in industrial arts courses. As shown in Table 31, above, and in Table 30 on page 178, only 67 per cent of the respondents checked the items, on the average, for industrial arts emphasis, as compared with 87 per cent for importance in general education. Seventy-eight per cent of the respondents checked the items, on the average, for emphasis in courses other than industrial arts.

Industrial arts teachers tended to reject general information items as being less suitable, on the whole, for emphasis in industrial arts than items in other categories. This may mean that teachers of industrial arts, while recognizing the general information items as important, do not feel responsible for planning definite curriculum experiences for the purpose of bringing about the implied learning. The average percentage of general educators who checked general information items for emphasis in industrial arts was slightly greater than for items in other categories. This may mean that general educators feel that industrial arts teachers should plan as definitely to help learners acquire general information as they do to help learners acquire technical information and ability in shop work. Industrial arts supervisors and teacher trainers tend to share the general educators' point of view.

In each of the juries, respondents who checked technical information items as important generally checked the items for emphasis in industrial arts. Certain kinds of technical information, then, seem to be appropriate for consideration by teachers in planning learning experiences in industrial arts.

Shop work, of course, is the prime nature of industrial arts. Every item which was considered important by a juror was also checked by that juror for emphasis in industrial arts.

Curriculum correlation.-- General information goals related to industrial arts work frequently were checked for emphasis in courses other than industrial arts. The same is true of many items of a technical nature. The fact that such items have been checked by general educators, industrial arts supervisors and teacher trainers, and industrial arts teachers alike for emphasis in both industrial arts and in other courses suggests that industrial arts work can often reinforce and supplement work in other curriculum areas and vice versa. This also suggests the need for school-wide curriculum planning so that teachers of all subjects will be aware of the possibilities for integration and correlation.

3. Method of the Investigation

Criticisms from industrial arts teacher trainers.-- General educators and general metalwork teachers for the most part seemed to accept without question the methods used in this study. The same is true of the industrial arts supervisors. A few of the industrial arts teacher trainers, on the other hand, took issue over the approach used. For example, one respondent wrote:

> I personally feel that this study is being approached from the wrong angle. I do not believe that any items which you have listed are either important or unimportant per se. I am sure, and I think you will agree with me, that the activities and items of information which you have indicated are of importance only if they are reflected in changes in the behavior of students who are exposed to them. Would it not be more valuable, therefore, to attempt to determine what behavior changes are needed rather than to concentrate on a rather extensive and minute analysis of information and operations?

And, along the same line, another teacher trainer said:

> Personally I think deriving ideas from courses of study, state bulletins, textbooks, and the like, a poor approach to obtaining a better answer than is now available concerning the nature of general metalwork in a program of general education. It would seem that we would thus be trying to solve our perennial problems by age-old methods which have failed. It is a matter of holding to traditional subject-matter ideals when we should be thinking about child development.

From these and other similar comments from industrial arts teacher trainers, it is obvious that this type of investigation, which has been used with good results in other general education areas, is not commonly used in the industrial arts field.

Adequacy of instructions.-- The fact that some industrial arts teacher trainers were critical of the approach used in this investigation suggests that the instructions for use of the check list may not have been thoroughly understood by all. The two statements which provoked controversy were: (1) the definition of general education, and (2) the answer to the question, What is the nature of the items in the check list? While more adequate instructions might have prevented controversy, it is not likely that the final results of the study would have been materially different.

Adequacy of the check list.-- While the respondents reacted to the check list in a manner which produced data suited to the purposes of this study, it now seems likely that a three-point scale might have resulted in greater discrimination between items. In the dichotomous situation imposed by the present check list, many respondents tended to check all the items as important and none as unimportant. Again, it is not likely that the final results of the study would have been materially different if a three-point scale had been used. Nevertheless, in effect the results of this study are based on the reactions of only those respondents who checked items discriminately.

4. Suggested Use of the Findings

Improvement of teaching materials.-- In the body of this report, the various items from instructional materials are arranged in rank order of importance in general education. It is likely that those items which rank high offer richer possibilities for general education experiences than low-ranking items. To writers of instructional materials and to all people concerned with industrial arts teaching, then, these lists should be a useful guide in planning industrial arts experiences.

Use of items in planning.-- The purpose of industrial arts is to change behavior of learners in keeping with certain broad aims. The items classified and ranked in this study should suggest possible teacher's objectives for units of instruction which contribute to the achievement of each of these broad aims. The selected teacher's objectives in turn should suggest core learning activities as well as additional activities for enrichment and individual differences in pupils. The selected objectives should also suggest evaluative activities.

Looking beyond the present status.-- The items ranked in this study were derived from present-day materials. If teachers limited their source of goals to these and similar lists, teaching would become static. The high-ranking items presented here, then, do not represent the ultimate. Instead, they might well suggest the general nature of new items designed to keep teaching materials fresh and up-to-date.

5. Need for Further Study

Other industrial arts areas.-- This study was concerned only with industrial arts metalwork. Similar studies might be made to determine the relative importance in general education of teachers' objectives in woodwork, electricity, graphic arts, and other industrial arts areas.

Analysis of objectives.-- In curriculum building proper use of the items set forth in each area of this study would require: (1) consideration of the nature of capacities for pupil behavior implied by each objective; (2) development of suggested activities and experiences likely to promote the pupils' growth in the implied capacities for behavior; and (3) evaluative procedures for determining the extent and nature of the growth made.[1/]

Items neglected.-- Several respondents indicated that items pertaining to the history of metalworking and to the story of famous people whose lives were associated with metalworking were important in general education, although such items were not revealed in the analysis of teaching materials. A search for such items would undoubtedly be profitable.

Teaching facilities.-- Industrial arts programs should have facilities appropriate for providing experiences which will contribute to high-ranking goals. An analysis of facilities in relation to the findings of this study should be useful.

General information.-- The general information items in this study ranked higher, on the whole, than any other type of item, yet industrial arts specialists tended to reject many such items for emphasis in industrial arts courses. The need for a study to disclose means of implementing general information through industrial arts seems to be indicated.

Technical information.-- The comments above regarding general information apply also to technical information.

1/See page 9.

APPENDICES

APPENDIX A

QUESTIONS AND ANSWERS CONCERNING THE CHECK LIST

QUESTION: What is the purpose of this study?

ANSWER: To obtain a better answer than is now available concerning the essential nature of general metalwork instruction in a program of general education.

QUESTION: What is the meaning of general education, so far as this study is concerned?

ANSWER: General education consists of those abilities, attitudes, and concepts everyone should have an opportunity to learn, regardless of vocation, social or economic status, or other specialized considerations.

QUESTION: What is the meaning of general metalwork, so far as this study is concerned?

ANSWER: "Industrial arts is a phase of general education that concerns itself with the materials, processes, and products of manufacture, and with the contributions of those engaged in industry." General metalwork is that aspect of industrial arts which is concerned with metals, metalworking processes, metal products, and with the relations of the metalworking industries to social and economic life.

QUESTION: What is the basis for the items included in the check list?

ANSWER: The items have been derived from courses of study, state bulletins, textbooks, and articles in professional journals. Only such items are included as have been discovered in several sources; infrequently mentioned items have been omitted.

QUESTION: Does the check list represent a complete list of possible learnings through instruction in general metalwork in an industrial arts program?

Obviously such a check list cannot be complete. Respondents are invited to add any items they feel are significant. Blank pages are provided for that purpose.

QUESTION: What is the nature of the items in the check list?

ANSWER: The statements of things to be learned are potential teacher's objectives; they are not materials to be presented directly to pupils. They are specific clues to the kinds of experiences that should be provided pupils.

QUESTION: Who is to use the check list?

ANSWER: The list will be checked by twenty-five general educators, twenty-five industrial arts teacher trainers and supervisors, and twenty-five general metalwork teachers. The respondents have been carefully selected so as to give representative leading opinions in each classification.

QUESTION: What are the respondents requested to do with the check list?

ANSWER: Respondents are to evaluate the items for purposes of determining (1) relative importance in general education, and (2) in what curriculum area or areas the items should be emphasized.

QUESTION: What is meant by relative importance in general education?

ANSWER: The term importance refers to how important it is that everybody have a chance to acquire the particular knowledge or ability. It is not a question as to where it will be acquired. The items are to be thought of in terms of such questions as: How frequently is this useful? How many people will have use for it? Will it help people to have a better understanding of modern industry and our industrial society? Will it help people to become better citizens? Better consumers? Will it help a person perform common jobs as "man of the house"? Will it help a young person plan his future education? Will it provide a useful background for other learnings such as scientific, mathematical, and social?

QUESTION: What is meant by emphasis?

ANSWER: Emphasize in industrial arts or in some other course means that learning experiences (laboratory, discussion, reading, etc.) should be planned specifically for the purpose of bringing about the learning.

QUESTION: What point of view should the respondent have while checking the list?

ANSWER: The respondents' reactions should be in terms of ideals rather than existing curriculum status, i.e., what should be done in a valid program of studies which recognizes modern objectives of industrial arts teaching.

QUESTION: What grade level should the respondent have in mind?

ANSWER: This study is not concerned in any way with grade levels. Some of the items may very appropriately suggest elementary school experiences; others may more appropriately suggest senior high school or adult education experiences.

QUESTION: How much time will it take to check the list?

ANSWER: This depends upon how the respondent attacks the problem. For those familiar with the subject, it will probably take longer than for respondents not familiar in the field of general metalwork. If a respondent will record his first reactions to each item and then quickly pass to the next item, he should be able to complete the list in about two hours. To expedite checking the list it is suggested that the respondent first read the instructions and then glance through the entire check list, reading items at random.

QUESTION: What will be done with findings from the study?

ANSWER: A summary of the responses will be sent to each of the respondents. The complete findings will be available to any person who wishes to consider them in curriculum work.

APPENDIX B

TEACHING MATERIALS ANALYZED

Textbooks

1. Dewey F. Barich and Leonard C. Smith, Metalwork for Industrial Arts Shops. American Technical Society, Chicago, 1952.

2. Alexander Frederick Bick, Artistic Metalwork. Bruce Publishing Company, Milwaukee, 1940.

3. A. W. Dragoo and H. O. Reed, General Shop Metalwork, Third Edition. McKnight and McKnight, Bloomington, Illinois, 1947.

4. John Lewis Feirer, General Metals. McGraw-Hill Book Company, 1952.

5. John Lewis Feirer, Modern Metalcraft. The Manual Arts Press, Peoria, Illinois, 1946.

6. J. W. Giachino and John L. Feirer, Basic Bench-Metal Practice and Precision Measuring. The Manual Arts Press, Peoria, Illinois, 1943.

7. Alfred B. Grayshon, General Metalwork, Second Edition. D. Van Nostrand Company, Inc., New York, 1946.

8. Chris Harold Groneman, Ornamental Tin Craft. Bruce Publishing Company, Milwaukee, 1949.

9. William H. Johnson and Louis V. Newkirk, The Metal Crafts. The Macmillan Company, New York, 1942.

10. Emil Fritjoff Kronquist, Art Metalwork. McGraw-Hill Book Company, New York, 1942.

11. Oswald A. Ludwig, Metalwork Technology and Practice. McKnight and McKnight Publishing Company, Bloomington, Illinois, 1943.

12. Morris J. Ruley, Projects in General Metalwork. McKnight and McKnight Publishing Company, Bloomington, Illinois, 1951.

13. Robert Ernest Smith, Machining of Metal, Revised Edition. McKnight and McKnight Publishing Company, Bloomington, Illinois, 1949.

Industrial Arts Professional Journals

American Vocational Journal, American Vocational Association, 1010 Vermont Avenue, N.W., Washington 5, D.C.

Industrial Arts and Vocational Education, Bruce Publishing Company, Milwaukee, Wisconsin.

Industrial Arts Teacher, American Industrial Arts Association, 123 East Ninth Street, Cincinnati, Ohio.

School Shop Magazine, 330 South State Street, Ann Arbor, Michigan.

Bulletins

U. S. Office of Education:

Industrial Arts: Its Interpretation in American Schools. U. S. Office of Education, Bulletin 1937, No. 34. 125 p.

American Vocational Association:

Improving Instruction in Industrial Arts. American Vocational Association, Industrial Arts Division, 1948. 96 p.

A Guide to Improving Instruction in Industrial Arts, A Revision of Standards of Attainment in Industrial Arts and Improving Instruction in Industrial Arts. American Vocational Association, 1010 Vermont Avenue, N.W., Washington 5, D.D. 120 p.

Connecticut:

The Redirection, Reorganization, and Retooling of Secondary Education. Hartford: Connecticut State Department of Education, Bulletin 37, Revised March 1948. 56 p.

A Handbook in Industrial Arts for Connecticut Secondary Schools, Part I, Guiding Principles, 76 p.; Part II, Curriculum Guides. Hartford: Connecticut State Department of Education, Curriculum Laboratory Bulletin 15, July 1945.

Delaware:

Industrial Arts for Junior and Senior High Schools. Dover: State of Delaware, Department of Public Instruction, 1942. Mimeographed, reprinted and revised. 54 p.

District of Columbia:

Manual Arts Courses of Study for Junior High Schools, Grades 7-9. Washington: Public Schools of the District of Columbia, 1945. Mimeographed.

Florida:

A Brief Guide to Teaching Industrial Arts in the Secondary Schools. Tallahasee: State Department of Education, Bulletin No. 12, Second Edition, 1948. 117 p.

Georgia:

The General Industrial Arts Laboratory and General Shop: A suggested program for industrial arts in the public schools of Georgia. Atlanta: State Department of Education, Bulletin No. 2, April, 1939. 97 p.

Idaho:

Tentative Course of Study in Industrial Arts for Junior and Senior High Schools. Boise: State Board of Education, 1933. 90 p.

Illinois:

Industrial Arts in the Modern School: Its Function and Organization. Springfield: State of Illinois, Board for Vocational Education, Series B, Bulletin No. 94, March 1949. 51 p.

Indiana:

Instructional Aids in Industrial Arts. Indianapolis: Department of Public Instruction, Bulletin No. 100-95, 1939. 164 p.

General Shop Metalwork: Bench Metal, Forging, Sheet Metal--Objectives, Content, Enrichment. Indianapolis: Indiana Industrial Education Association. 24 p.

Iowa:

Industrial Arts for Secondary Schools. Des Moines: Iowa Secondary School Cooperative Curriculum Program, Volume III, Department of Public Instruction, 1948. 190 p.

Kansas:

Manual of Guides, Part IX: Industrial Arts Subjects. Topeka: Department of Education, 1940.

Kentucky:

Industrial Arts for Kentucky High Schools. Frankfort: Department of Education.

Louisiana:

Industrial Arts in Louisiana: A Handbook for Secondary Schools. Baton Rouge: State Department of Education, Bulletin No. 627, January 1948. 140 p.

Minnesota:

The Secondary School Curriculum, Bulletin C-5, Industrial Arts. St. Paul: Department of Education, 1935. 212 p.

Missouri:

Industrial Arts Handbook. Jefferson City: State Department of Education, Curriculum Committee, Bulletin 7-B, Revised 1945. 153 p.

Nebraska:

Industrial Arts in High School. Lincoln: Department of Public Instruction, Nebraska High School Improvement Progress Bulletin No. 8, 1942. Mimeographed.

New Hampshire:

Program of Studies, Part VII, Practical Arts, Industrial Arts, and General Industrial Work. Concord: State Board of Education.

New Jersey:

Recommended Activities for Industrial Arts Classes in the Secondary Schools. Trenton: State Department of Education, 1947. 27 p.

New Mexico:

Rural Industrial Arts for New Mexico. Santa Fe: State Department of Education. Mimeographed, 28 p.

New York:

Industrial Arts: Tentative Syllabus in Comprehensive General Shop for Grades 7, 8, and 9. Albany: State Department of Education, 1940. Mimeographed, 105 p.

Tentative Syllabus in General Metalwork. Albany: The State Education Department, 1941 Revision. Mimeographed, 61 p.

North Dakota:

A Course of Study for North Dakota Schools: Industrial Arts. Bismark: Department of Public Instruction, 1938. Mimeographed, 57 p.

Ohio:

A Prospectus for Industrial Arts in Ohio. Columbus: Ohio Education Association and State Department of Education, 1934. 101 p.

Industrial Arts Education for Junior and Senior High Schools. Columbus: State Department of Education, 1949. 37 p.

Oregon:

State Course of Study for Industrial Arts for Oregon Secondary Schools. Salem: Oregon State Board of Education, 1939. 150 p.

Pennsylvania:

Industrial Arts for Secondary Schools. Harrisburg: Commonwealth of Pennsylvania, Department of Public Instruction, 1939. 175 p.

Industrial Arts. Harrisburg: Commonwealth of Pennsylvania, Department of Public Instruction, Bulletin 331, 1951.

South Dakota:

An Introductory General Shop Course for Small High Schools. Pierre: Department of Public Instruction, Bulletin No. 31, 1941. 29 p.

Texas:

Industrial Arts Programs in Junior and Senior High Schools in Texas. Austin: State Department of Education, 1938. 125 p.

Utah:

Industrial Arts in Utah, Volumes I and II. Salt Lake City: Department of Public Instruction, 1942. Mimeographed.

Washington:

Junior and Senior High School Industrial Arts. Olympia: State Department of Education, Course of Study Bulletin, 1930. 50 p.

West Virginia:

Program of Studies for Individual Needs: Industrial Arts, Home Economics, Commerce, Physical Education, Music, Art. Charleston: State Department of Education, 1937. (Fifteen pages devoted to industrial arts)

Wisconsin:

Philosophy and Objectives for Industrial Arts in the Wisconsin Schools. Madison: State Department of Education. (Mimeographed copy for bulletin to be published in 1950)

Course of Study Construction in Industrial Education. Menomonie: The Stout Institute, Graduate Studies, 1949. Mimeographed, 121 p.

APPENDIX C

MEMBERS OF THE PARTICIPATING JURIES

General Educators

Will G. Ballentine, Superintendent of Schools, Menomonie, Wisconsin

Leslie J. Bishop, Director of Core Program, Evanston Township High School, Evanston, Illinois

Roy O. Billett, Professor of Education, Boston University, Boston, Massachusetts

Orville W. Connett, Principal, Bryant H. Trewyn Junior High School, Peoria, Illinois

J. Bernard Everett, Director of Research, Association for Supervision and Curriculum Development, Washington, D.C. (Formerly director of curriculum in the Newton, Massachusetts, Public Schools)

Parmer Ewing, Superintendent of Schools, White Plains, New York

Luther E. Hail, Principal, Sherrard School, Detroit, Michigan

R. Milton Hall, Principal, Clifton Park Junior High School, Baltimore, Maryland

Bertram F. Holland, Principal, High School, New London, Connecticut

Victor Houston, Head, Department of Education, Chico State College, Chico, California

Wayne P. Hughes, Director, School and College Division, National Safety Council, Chicago, Illinois

Russell D. Johnson, Assistant Superintendent, Community High School, Granite City, Illinois

Clarence A. Michelman, Chief, Occupational Information and Guidance, State Department of Education, Springfield, Illinois

Frank Steeves, Professor of Education, State Teachers College, St. Clous, Minnesota

J. H. Thorp, Superintendent of Schools, Cheshire, Connecticut

J. Lloyd Trump, Head of Teacher Placement, University of Illinois, Urbana, Illinois (Formerly Superintendent, Waukegan Township High School, Waukegan, Illinois)

Sherman G. Waggoner, Superintendent of Practice Schools, State Teachers College, New Britain, Connecticut

Morris Williams, Curriculum Director, Board of Education, San Francisco, California

Harry Williams, Principal, Fort Collins Senior High School, Fort Collins, Colorado

J. Wendell Yeo, Vice President in Charge of Academic Affairs, Boston University, Boston, Massachusetts

Industrial Arts Supervisors and Teacher Trainers

Lawrence J. Ashley, Director of Industrial Arts and Vocational Education, Public Schools, Yonkers, New York

Dewey Barich, Director, Industrial Arts Awards, Ford Motor Company, Detroit, Michigan (Formerly Head of Industrial Arts Department, Kent State University, Kent, Ohio)

Edward Claude, Chief, Industrial Education, Board for Vocational Education, State Department of Education, Springfield, Illinois

John F. Friese, Professor of Industrial Arts Education, The Pennsylvania State College, State College, Pennsylvania

Lyman Goldsmith, Supervisor of Industrial Arts, Los Angeles Public Schools, Los Angeles, California

Chris A. Groneman, Professor of Industrial Education and Head of Industrial Education Department, Texas College of Agriculture and Mechanic Arts, College Station, Texas

James Hammond, Head, Department of Industrial Arts Education, State Teachers College, Fitchburg, Massachusetts

George Henry, Head, Department of Industrial Arts Education, Colorado State College of Agriculture and Mechanic Arts, Fort Collins, Colorado

Lee Hornbake, Professor of Education, University of Maryland, College Park, Maryland

Wesley Ketchum, Supervisor of Industrial Arts, State Department of Education, Hartford, Connecticut

William Mason, Supervisor of Industrial Arts, Public Schools, Cleveland, Ohio

William D. Micheels, Associate Professor of Industrial Education, University of Minnesota, Minneapolis, Minnesota

Louis V. Newkirk, Director, Industrial Arts and Handwork, Chicago Public Schools, Chicago, Illinois

Milo T. Oakland, Head, Department of Industrial Arts Education, Northern Illinois State Teachers College, DeKalb, Illinois

Alan Pawelek, Head, Department of Industrial Arts Education, State Teachers College, Bellingham, Washington

Stanley J. Pawelek, Supervisor of Industrial Education, Baltimore Public Schools, Baltimore, Maryland

Herman Pohlman, Supervisor of Industrial Arts, City Schools, Newton, Massachusetts

Ray M. Stombaugh, Professor and Head of Department, Industrial Arts Education, Illinois State Normal University, Normal, Illinois

Fred Swan, Supervisor of Industrial Education, State Department of Education, Board for Vocational Education, Springfield, Illinois (Formerly Supervisor of Industrial Education, Evanston Township High School, Evanston, Illinois)

H. O. Thomas, Assistant Supervisor for Industrial Arts Education, State Department of Education, Baton Rouge, Louisiana

Gordon O. Wilber, Director, Division of Industrial Arts, State Teachers College, Oswego, New York

Sylvan Yager, Chairman, Department of Industrial Arts and Trades and Industry, Indiana State Teachers College, Terre Haute, Indiana

<u>General Metalwork Teachers</u>

John Bicanich, Central High School, Sheboygan, Wisconsin

Oliver Bumb, Ball State Teachers College, Muncie, Indiana

Clarence Carter, Woodruff High School, Peoria, Illinois

John E. Cogeli, Hartford Senior High School, Hartford, Connecticut

Douglas Cox, Bloomington High School, Bloomington, Illinois

Roland R. Fraser, Wayne University, Detroit, Michigan

J. W. Giachino, Western Michigan State College, Kalamazoo, Michigan

Richard Hamilton, Senior High School, Hayward, California

Lawson Hockey, Maine Township High School, Des Plaines, Illinois

J. Morris Johnson, West High School, Denver, Colorado

Floyd Keith, The Stout Institute, Menomonie, Wisconsin

John C. Kleir, Clifton Park Junior High School, Baltimore, Maryland

Don Lux, DuPont Manual Training High School, Louisville, Kentucky

Frank Marschik, Kent State University, Kent, Ohio

Frank Owens, Oak Park-River Forest High School, Oak Park, Illinois

John Prepolec, Sherrard Intermediate School, Detroit, Michigan

William Petryk, Senior High School, Hartford, Connecticut

Howard O. Reed, Illinois State Normal University, Normal, Illinois

Henry Schroeder, Southern Illinois University, Carbondale, Illinois

Ted R. Sturm, Thornton Township High School, Harvey, Illinois

Bruce Thompson, Senior High School, Salem, Oregon

George Tinetti, Ohio University, Athens, Ohio

Amos G. Williams, Southeast Missouri State College, Cape Girardeau, Missouri

Paul Yadlosky, Senior High School, Ypsilanti, Michigan

KENYON S. FLETCHER 18 GAY COURT NEWTONVILLE 60, MASS.

DIRECTIONS

A. In the parentheses at the left of each item, place the letters *I*, *N*, or *U* according to the following scale:

I means that the respondent feels the item represents something which is *important* that everyone have a chance to learn.

N means that the respondent feels that he is *not sufficiently informed* to have an opinion one way or the other.

U means that the respondent feels the item represents something which is *unimportant* that everyone have a chance to learn (although it might be very important to a few people).

B. In columns (2), (3), and (4) indicate *where* in the curriculum whatever is represented by the item should be emphasized:

If you think it should be emphasized in *industrial arts* courses, place an X in column (2).

If you think it should be emphasized in some course or courses *other* than industrial arts (e.g., science, social studies, etc.) place an X in column (3).

If you think the item represents something which should be emphasized in out-of-school situations (e.g., church, labor union, etc.) place an X in column (4).

X's should be placed in both columns (2) and (3) to indicate that the item should be emphasized both in industrial arts and in some other subject or subjects. Likewise, an X should be placed in column (4) as well as in column (2) and/or (3) to indicate that the item should be emphasized out of school as well as in school.

Do not place any X's at the right of items judged by you as *unimportant*.

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize		
	In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
PART A			
( ) 1. Man's ability to utilize metals of various kinds has been a major factor in the development of our present industrial civilization.			
( ) 2. More than 10 per cent of the people in the nation's labor force are directly or indirectly engaged in some phase of metalworking, and the proportionate number is likely to increase.			
( ) 3. The range of employment opportunities in metalworking is from common labor to mechanical and other phases of engineering; and every job is dependent upon every other job.			
( ) 4. Approximately 10 per cent of the people employed in metalworking are classified as mechanics or technicians—jobs that require two or more years of specialized training. The other 90 per cent work as operatives or semiskilled workers—in jobs that can be learned in six months or less, usually on the job.			
( ) 5. The hours of employment in metalworking jobs are in general eight hours a day, five days a week.			
( ) 6. Wages change from time to time and may vary in different parts of the country.			
( ) 7. Highest skilled workers usually get the highest pay.			
( ) 8. When times are hard, workers in all industries are affected.			
( ) 9. Skilled workers, however, are seldom without work because they are among the last to be laid off when business is slack.			
( ) 10. A trade is a manual or mechanical job or work at which a person earns his living.			
( ) 11. From two to five years is required to learn the skills and technical information of a skilled mechnical trade.			
( ) 12. A journeyman is one who has learned a skilled trade; an apprentice is one who is learning a trade systematically through work experience and related training.			
( ) 13. A machine hand earns his living by running only one machine, but he knows all about that machine. He sets up the machine as well as operates it.			
( ) 14. A machine operator runs only one machine, doing repetitive work. The machine is set up and adjusted for him by a machine setter, a skilled mechanic.			
( ) 15. Metal-trades workers—especially skilled tradesmen—are employed in practically every industry as maintenance and repair men.			
( ) 16. A person to succeed in the better paid and more responsible jobs in metalworking must have aptitude in mathematics and science.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 17. Because many metalworking jobs are hazardous, rules for general conduct in shops as well as safety rules for each shop job must be understood and consistently practiced by every metalworker.			
( ) 18. There are two principal types of labor organizations in metalworking industries: the CIO which usually represents all labor in large concentrated industries, and the A. F. of L. which represents labor on a craft basis.			
( ) 19. In a factory in which the employees belong to a labor union, certain individuals are designated by the union as shop stewards to watch out for the interests of employees and to see that terms of the contract between the union and the employer are carried out.			
( ) 20. When a worker in a union shop has a grievance, he carries it to the steward who in turn carries it to a representative of the company assigned to handle labor relations.			
( ) 21. Mass production usually requires such a tremendous investment in plants and machines that it must be financed by large groups of private individuals who buy stock in a corporation which assumes the entity of owner and operator.			
( ) 22. When the business is profitable, the stockholders are paid dividends; when the business is unprofitable, the stockholders do not receive anything for the use of their money and sometimes the value of the stock decreases.			
( ) 23. The management of large corporations is planned by a board of directors which is elected by the stockholders.			
( ) 24. The board may elect officers, including vice presidents, to take charge of the various divisions such as engineering, legal, industrial relations, finance, public relations, distribution, and sales.			
( ) 25. Manufacturing is usually done under the direct control of a plant superintendent, with assistant superintendents or foremen directing the work in the various departments.			
( ) 26. Metal manufacturing industries are usually located geographically close to the source of raw materials, to fuel or power supply, to a transportation or distribution center, and to an adequate labor supply.			
( ) 27. Sometimes parts of the product are made in many different factories and then transported to another plant for assembly and distribution.			
( ) 28. For the consumer to benefit optimally from mass production, it is necessary for the manufacturing facilities and labor force to be used steadily, sometimes continuously with shutdowns only for needed repairs.			
( ) 29. Production and the demand for products must be kept in careful balance if manufacturing is to be done economically.			
( ) 30. Machines make work easier to do and at the same time increase production.			
( ) 31. Both capital and labor are entitled to share in the profits from increased production.			
( ) 32. The general economic welfare of our country is closely related to productivity of the metal industries. For example, good business in "heavy steel" means good business and good employment generally.			
PART B			
( ) 33. Metals that may be hammered or rolled into sheets are said to be malleable.			
( ) 34. Malleability is the property that permits metals to be shaped by forging.			
( ) 35. Tenacity is the property of a material which enables it to withstand external forces without breaking.			
( ) 36. The tenacity of any material, or its tensile strength, is measured by the force needed to break a rod or wire of that material whose cross-sectional area is unity—one square inch, for example.			
( ) 37. Metals may suffer from fatigue. For example, if a load is held by a cable for a long time, the cable may eventually break.			
( ) 38. Metals such as copper, aluminum, and steel, which may be drawn into a wire, are said to be ductile.			
( ) 39. Elasticity is the property of a substance which enables it to resume its original shape after having been stressed by outside forces—an automobile spring, for example.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 40. Most metals are fusible; that is, they can be melted.			
( ) 41. Various metals melt at different temperatures, an important consideration when selecting metals for certain jobs. For example, babbit melts at too low a temperature to be used in bearings that are likely to run at higher temperatures.			
( ) 42. We call a substance hard if it cannot be easily scratched or abraded.			
( ) 43. The term hard is only relative. When two substances of unequal hardness are rubbed together, the harder wears away the softer more rapidly, unless the soft substance is driven at a high velocity.			
( ) 44. Hard substances like sand, emory, corundum, and diamond dust are used extensively for cutting, grinding, and polishing.			
( ) 45. Generally, a metal that is hard is also brittle.			
( ) 46. Brittleness in many metals may be lessened by heat treatment.			
( ) 47. Metals vary widely in density. That is, some metals are much heavier than others. For example, lead is heavy; magnesium is light.			
( ) 48. Most metals expand when heated and shrink when cooled. For example, a piece of steel one foot long when cold will measure about $12\frac{1}{8}$ inches when red hot.			
( ) 49. Expansion and contraction must be taken into consideration when machining metals to exact sizes when making patterns for an article that is to be cast, when welding, and when doing precise measuring.			
( ) 50. Friction results in wasted work, and the energy from such wasted work is changed into heat energy.			
( ) 51. The heat resulting from cutting metal may change the degree of hardness of the cutting tool.			
( ) 52. A lubricant is oil, grease, or other material that is put on metal surfaces that rub against each other to reduce the heat, wear, and vibration caused by the rubbing.			
( ) 53. There are several kinds of oil, in various degrees of viscosity.			
( ) 54. In lubricating machines, correct lubricants must be used. For example, in an automobile engine thin oil in winter, heavier oil in summer.			
( ) 55. All rubbing surfaces, called bearings, should be lubricated regularly according to manufacturer's specifications.			
( ) 56. A machine should be stopped when it is oiled.			
( ) 57. A drop or two of oil in each oil hole is usually enough; too much oil is wasteful, will spatter, and may even damage the machine—particularly electric motors.			
( ) 58. Oily rags should be kept in a closed metal container until they can be disposed of by burning. If left lying around the shop there is danger of fire.			
( ) 59. A cutting oil is usually a heavy oil which is put on a cutting tool to make it cut easier and faster. It carries away some of the heat, washes away the chips, and reduces friction between the cutting tool and the work.			
( ) 60. Different lubricants are used when cutting different metals and for different cutting operations.			
( ) 61. An oil used mainly to keep the tool and work cool is called a coolant. It is pumped to the surface being machined where it absorbs some of the heat.			
( ) 62. In some particularly precise manufacturing, the coolant is kept at a constant temperature through refrigeration.			
( ) 63. Overheating can ruin the usefulness of machines through unequal expansion of parts, the melting of bearings, the setting up of strains and stresses, the changing of molecular structure, and the drawing of temper of heat-treated parts.			
( ) 64. Improper lubrication or lack of lubrication is a common cause of overheating. For example, an automobile engine operated with too little oil or with improper oil.			
( ) 65. Belts are used on machines for three reasons: to carry power from one pulley to another, to change the speed and power of pulleys, and to change the running direction direction of pulleys.			
( ) 66. A V-belt is less likely to slip than a flat belt.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 67. When the driver pulley is larger than the driven pulley, the driven pulley turns faster than the driver but with less power, and vice versa.			
( ) 68. Gears are used in machines to transmit power or motion and to change direction or rate of motion.			
( ) 69. When the driven gear is larger than the driver, the driver gear turns more slowly but with greater power; when the driven gear is smaller than the driver, the driver gear turns faster but with less power.			
( ) 70. There are four basic types of gearing: spur, helical, mitre, and worm.			
( ) 71. A cam or eccentric is used to change a rotary motion to reciprocationg motion or vice versa, or as a locking device. An example of the use of cams is in the automobile engine for timing valves.			
( ) 72. A clutch is a device used for engaging and disengaging the driving mechanism of a machine from certain other parts that do the work. The clutch on an automobile is an example.			
( ) 73. Most metals are good conductors of heat; thus, if a piece of metal is heated in one place the heat is transferred throughout the piece.			
( ) 74. Small cross sections of the piece will increase in temperature more quickly than large sections. For example, heat will "run" to the end of a pointed tool.			
( ) 75. Less effort is required to pull or push a load up an inclined surface than to lift it vertically. Examples are such common devices as the screw, gib, and taper.			
( ) 76. The smaller the pitch of the inclined surface, the greater the mechanical advantage (a small taper, for example); the greater the pitch, the faster the motion but the less force (a lead screw on a lathe, for example).			
( ) 77. The mechanical advantage gained through the use of levers is applied in numerous ways in metalwork—in the use of hand tools and in the functioning of machine tools.			
( ) 78. To reduce friction, bearings are polished smoothly, anti-friction metals such as babbit are used, ball or roller bearings are used, and the bearing is properly lubricated.			
( ) 79. A wheel, to run at a uniform speed and without vibration, must be of equal weight at every point on the perimeter. A wheel may be balanced by adding or removing metal at points that are light or heavy. For example, automobile wheels are balanced by attaching lead lugs.			
( ) 80. When designing tools and machines, engineers always plan to use materials heavy enough to carry several times the load that is likely to be put on them. This gives a factor of safety, for it provides for possible flaws in materials and for temporary overloading.			
( ) 81. A machine or hand tool should not be used for work over its rated capacity.			
( ) 82. As the force of a machine is increased by any mechanical device, the distance and speed of the load is diminished correspondingly. For example, when back gears are used in a lathe, what is gained in cutting force is lost in speed of cutting.			
( ) 83. When a wheel is revolved (a grinding wheel, for example), centrifugal force tends to stress the wheel from its axle.			
PART C			
( ) 84. Iron does not exist in nature in a pure state but is combined chemically with oxygen, carbon, or sulphur and with other minerals such as phosphorous and manganese. The combination is called iron ore.			
( ) 85. Any mineral body from which metal can be obtained profitably is known as ore.			
( ) 86. Pure iron is not used in industry because it is too soft.			
( ) 87. Hematite, which is a red oxide of iron, is the most important iron ore because of its high iron content and ease of smelting.			
( ) 88. Hematite and other oxide ores are found in the Lake Superior region, particularly in Minnesota, Michigan, and Wisconsin.			
( ) 89. Limonite, a yellow oxide of iron, is found in various parts of the United States but it is seldom used because the iron content is relatively low; it is used in Europe, however, where hematite is less plentiful.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 90. Most iron ore is mined by the open-pit process in which huge shovels are used to strip off the upper layers of earth and, after the ore is loosened by blasting, the shovels are again used to scoop up the ore and load it into railroad cars.			
( ) 91. Iron ore is transported largely by boat from the Lake Superior region to Chicago, Gary, Detroit, Cleveland, and other cities along the Great Lakes where blast furnaces and steel mills are located.			
( ) 92. Iron ore becomes pig iron when the impurities are burned out in a blast furnace.			
( ) 93. Pig iron contains about 93 per cent pure iron, 3 to 5 percent carbon, and from 5 to 7 per cent silicon, sulphur, phosphorus, and manganese.			
( ) 94. Pig iron, which is hard and brittle, is used in making cast iron, wrought iron, and steel.			
( ) 95. It takes about 2 tons of ore, 1 ton of coke, ½ ton of limestone, and 4 tons of air to make 1 ton of pig iron.			
( ) 96. One of the cheapest metals, cast iron is used to make such things as large pipes, stoves, radiators, and frames for machines which must be large and heavy but in which strength is not very important.			
( ) 97. Cast iron is usually gray in color and crystalline in appearance.			
( ) 98. Cast iron contains from 1.50 to 6.00 per cent carbon.			
( ) 99. Malleable iron is cast iron which has been made soft, tough, strong, and malleable by baking in an oven from six to eight days, thus burning out some of the carbon, and then cooling slowly.			
( ) 100. Wrought iron is useful for parts which must withstand shock, blows, and jerks—such as railroad equipment and farm tools.			
( ) 101. Wrought iron, which is purified pig iron, contains almost no carbon and is very tough and malleable and bends easily, cold or hot.			
( ) 102. When molten, iron is very fluid—flows freely; steel is less fluid and is sticky. Consequently, iron is frequently cast into desired shapes; steel is more often forged, stamped, or machined, although it is sometimes cast.			
( ) 103. Steel is iron combined with from .05 per cent to 1.7 per cent of carbon.			
( ) 104. Because it is ductile and malleable, steel can be drawn into wire and rolled into sheets, bars, rods, and various commercial shapes such as I-beams and railroad rails.			
( ) 105. Depending on its carbon content, steel may be soft enough to bend readily, hard enough to cut glass, or resilient enough to be used for springs.			
( ) 106. Steel can be made in an open hearth furnace from 100 per cent pig iron, from 100 per cent scrap, or from a mixture of new pigs and scrap.			
( ) 107. Steel made from well selected scrap is just as high in quality as steel made from new pig iron, and the use of scrap conserves the ore supply.			
( ) 108. In the steel-making process, carbon is removed from the molten metal through combining with oxygen in the hot air which is blown across the surface; and limestone added to the charge acts as a scavenger, removing impurities through chemical reactions.			
( ) 109. The metal may be sampled during the refining process, and additional ingredients may be added to the charge to produce the type of steel desired.			
( ) 110. Steel comes from the furnace in the form of large ingots which, after reheating, are passed through huge steel rolls in a rolling mill and rolled into various shapes.			
( ) 111. The rolling of steel refines its grain and increases its tensile strength.			
( ) 112. Cold rolled and cold drawn steel are made from hot rolled steel by removing the scale in acid and then rolling or drawing the steel cold.			
( ) 113. Cold rolled and cold drawn steel have a smooth, bright finish, are very exact in size, and may be used without further machining or finishing.			
( ) 114. The highest grades of steel are made in a crucible or electric furnace in which air or furnace gases do not touch the metal and in which it is possible to control the content of the steel very accurately.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 115. To identify steels in specifications, the S.A.E. steel numbering system is used. For example, 1020 means plain carbon steel containing .20 per cent carbon.			
( ) 116. When being ground, different kinds of steel give off different appearing sparks which provide a means of roughly dtermining what kind of steel it is. For example, high-carbon steel gives off white sparks which explode into bright stars.			
( ) 117. Many shop products are of little use unless they are properly heat treated, i.e., hardened, tempered, annealed, or case hardened.			
( ) 118. When high carbon steel is heated red hot and quickly cooled it is hardened. When, after hardening, it is heated to between 400 and 600 degrees Fahrenheit and quickly cooled, it becomes toughened (tempered). When it is heated red hot and allowed to cool slowly, it loses its hardness, i.e., it is annealed.			
( ) 119. While machines are used in laboratories for the precise testing of materials for hardness, a rough test can be made in the shop with a file. If the file cuts the steel, it is soft; if the file slips over the steel, it is hard.			
( ) 120. By adding other ingredients while it is molten, steel may may given additional physical properties. For example, tungsten increases hardness; chromium makes steel stainless. These are known as alloy steels.			
( ) 121. When wrought iron or low carbon steel in contact with carboniferous material such as leather scrap is heated to a bright red heat, the surface of the metal absorbs carbon and thus gains the properties of high-carbon steel. This process is called case hardening.			
( ) 122. Various colored oxides form on steel at different tempering heats, i.e., yellow at 430 degrees, blue at 570 degrees. These colors serve to guide the worker in drawing temper to the desired degree.			
( ) 123. When a steel tool (a knife, for example) is heated, by grinding or by other means, until it appears blue, its hardness has been lost. To make the tool usable again, it should be rehardened and tempered.			
( ) 124. Zinc is a hard, brittle, bluish-white metal used as a coating for iron and steel for protection against rust. Zinc-coated steel, the surface of which appears flaky or spangled and which is known as galvanized iron, is used for wire fences, eaves troughs, metal roofing, etc.			
( ) 125. Pure silver, which is the best known electrical conductor, is a relatively soft metal. It is alloyed with copper to make it usably hard.			
( ) 126. Aluminum is very light in weight, is relatively noncorrosive, and is a good conductor of heat. It is used for cooking utensils because of its conductivity; for automobile and aircraft parts, when light weight is essential.			
( ) 127. Eight per cent of the earth's crust contains aluminum, but the refining of bauxite, the most important ore, is an expensive process which requires much electrical energy.			
( ) 128. Copper is a relatively pure metal refined from copper ore which is mined extensively in Arizona, Michigan, Montana, and Utah. It is very ductile and malleable and its most important property, industrially, is its conductivity of electricity.			
( ) 129. Lead is a heavy, soft metal, useful industrially because water and air have little effect on it; however, workers with lead must use precautions to avoid lead poisoning.			
( ) 130. Tin plate is sheet iron or steel coated with tin to prevent rusting.			
( ) 131. Nickel does not rust and it takes a high polish. It is used for plating iron and brass.			
( ) 132. An alloy is a mixture of two or more metals melted together to form a new metal which is different from the original metals. For example, copper and zinc melted together make brass.			
( ) 133. Bronze is an alloy of copper and tin and is harder than brass.			
( ) 134. Pewter is a silvery-white alloy of tin, antimony, and copper used for table ware and ornamental work.			
( ) 135. Babbit is an alloy of antimony, copper, and tin which is used for bearings for machines and engines.			
( ) 136. A machinist's handbook contains most of the technical information regarding characteristics and working properties of metals, as well as machine operation formulas and information concerning fastening devices and other useful data for the metal worker.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
PART D			
( ) 137. A working drawing contains all the information needed to make an object. It is prepared in the language of all mechanical operations, the shop, the drafting room, and the industrial world. It shows (1) the shape of every part of the object, (2) sizes of all parts, (3) kinds of material, (4) kind of finish, and (5) how many pieces of each part are wanted.			
( ) 138. Greater ability is needed to lay out work than to run a machine. A small mistake in layout means that work may be cut incorrectly afterward.			
( ) 139. For accurate measurements with the steel scale, the scale must be held on its edge so the graduations are in contract with the surface being measured.			
( ) 140. The common layout instruments are the scriber, a sharp-pointed tool which incises a fine line when it is drawn across a metal surface; dividers, for drawing arcs and circles; hermaphrodite caliper for scribing lines parallel to an edge and for locating centers of round stock; trammel points, for scribing large arcs and circles, and surface and height gauges, for scribing lines on vertical surfaces.			
( ) 141. A divider may be used to lay off or measure distances. This procedure is particularly useful in measuring along irregular lines.			
( ) 142. To set a divider, one point is placed into one of the scribed lines on the rule and the other point is moved until it exactly splits the other line at which the divider is to be set.			
( ) 143. If metal bluing or copper sulphate is applied to a bright metal surface before a layout is made on it, the scribed lines will be more legible. Rough surfaces may be covered with white chalk.			
( ) 144. Centers where holes are to be drilled should be punched with a center punch.			
( ) 145. Work to be layed out with the greatest precision is placed on a surface plate, which has an extremely flat surface and serves as a true foundation upon which the work and gauges may rest.			
( ) 146. An angle plate is a device used in layout work to which an object may be clamped at a right angle to a surface plate.			
( ) 147. The combination metal square may be used as a tool to test the squareness of stock, as a marking gauge to lay off lines parallel to a straight edge, as a plumb or level, as a tool to test or lay off 45-degree angles from a straight edge, and as a height or depth gauge.			
( ) 148. Layouts are made in reference to centerlines or to a baseline.			
( ) 149. Centers for holes must be layed off in reference to at least two points.			
( ) 150. To lay off a line perpendicular to a line on a surface, the work may be placed on an angle plate so that the surface line is perpendicular to the surface plate, and the desired perpendicular line scribed with a surface gauge.			
( ) 151. Measurement for precision work is expressed in decimal parts of an inch.			
( ) 152. A templet is a pattern, usually made of sheet steel, for marking the shape of pieces of work or for marking the location of holes and irregularly shaped parts of the work.			
( ) 153. Manufactured articles usually are rigidly inspected for materials, performance, finish, measurements, and interchangeability. Inspection may be done by both the manufacturer and the purchaser at any stage in the manufacturing process.			
( ) 154. In quantity manufacturing, every piece may be inspected or pieces may be inspected only periodically or at random. One hundred per cent inspection insures greatest possible uniformity of product.			
( ) 155. Welds are tested by the following tests: guided bend, free bend, tensile, visual inspection, magnafluxing, and X-raying. Because most of the tests destroy the work or are expensive and time consuming, the skill of the operator is tested periodically and he is depended upon to do good work.			
( ) 156. The dimensions of finished articles can be only as accurate as the measuring instruments used. Accurate measuring tools and ability to use them are essential to all precision work.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 157. An outside caliper is used to measure the diameter of round stock; an inside caliper is used to measure inside dimensions. The caliper is adjusted to a given dimension and then slipped over the work, or it is slipped over the work first and the distance between points is then measured.			
( ) 158. A micrometer caliper measures in thousandths of an inch.			
( ) 159. Since measurement with a micrometer depends to an extent upon the touch or feel of the mechanic and since the touch of different mechanics varies, a micrometer should be set by the person who is to use it.			
( ) 160. All micrometers read alike: The screw has 40 threads per inch: thus each turn of the screw equals one fortieth of an inch (.025), and one twenty-fifth of a turn equals one thousandths of an inch (.001). Graduations on the barrel and thimble permit the user to determine how many turns and parts of turns of the screw have been made.			
( ) 161. A vernier scale on such instruments as the caliper and height gauge permits measureing in thousandths of an inch. On the micrometer, which already permits measuring in thousandths, the vernier makes possible readings in ten thousandths of an inch.			
( ) 162. Gauge blocks are used for the accurate setting of gauges and measuring instruments, the blocks themselves being accurate to within two millionths of an inch.			
( ) 163. No two manufactured pieces can be exactly the same size. For this reason, dimension limits—minimum and maximum—are usually given for precision-made pieces. The difference between the largest and lowest limit is known as the tolerance.			
( ) 164. Fixed gauges of the go-not-go type are used to determine whether metal parts are correctly made within specified dimension limits.			
( ) 165. Thickness or feeler gauges consist of a series of blades of varying thickness. This gauge is used to check the clearance between two surfaces.			
( ) 166. Because precision manufacturing is costly and time consuming, it is wasteful to specify closer tolerances than necessary.			
PART E			
( ) 167. Bench metalwork is basic to all phases of metalworking. It includes laying out, shaping, forming, assembling, and testing work at the bench, using hand tools and instruments.			
( ) 168. For the best work, tools should be in first-class condition and they should be used only for the purpose for which they were designed.			
( ) 169. Holding work securely in a stationary position is very important in practically all metalwork operations—both hand and machine. The most common device for this purpose is the machinists' vise.			
( ) 170. Since the jaws of a vise are usually rough, copper or brass plates may be used as covers to protect the stock being clamped. Small pieces of metal also may be used to protect work from the grip of pliers.			
( ) 171. Metal to be sawed or chiseled in a vise should be clamped with the line to be cut close to the vise jaws. This will prevent the stock from vibrating when the cut is made.			
( ) 172. The machinist's hammer is used in such operations as driving punches, heading rivets, and cutting with the cold chisel.			
( ) 173. A soft hammer or mallet with a head of material such as lead, copper, leather, or wood is used where a steel hammer would dent or nick the surface of the metal or where pounding a hardened steel surface might break either the surface or the hammer.			
( ) 174. To tighten or loosen a nut or similar part with a wrench, the proper wrench should be selected. Besides the common monkey wrench, which is a general purpose tool, there are other wrenches designed to grip nuts securely, conveniently, and without damage or danger.			
( ) 175. The wrench must fit the part to be turned and it must be used in a proper manner; otherwise the wrench may slip, causing damage to the part and possibly injuring the worker.			
( ) 176. In order to avoid damage to a screw head and in order to drive a screw properly and safely, the screw driver must fit the slot of the screw. The blade of a screw driver should have a square end and the taper should not run to the end.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 177. When a screw is being driven in a small piece, the work must be held securely in a vise or laid on a bench. It is dangerous to use a screw driver on work held in the hands.			
( ) 178. Pliers are used for firmly gripping small metal pieces for purposes of pulling, twisting, and pushing. Some pliers, such as side-cutting pliers, can also be used to cut small sizes of wire.			
( ) 179. Pliers should not be used ordinarily for turning nuts and screws because such use usually results in scarring the nut or screw head.			
( ) 180. Cold chisels, which are driven with a hammer, are useful in such work as shearing off rivet heads, chipping grooves in metal, cutting holes in sheet metal, and cutting off small rods and bars.			
( ) 181. Goggles should always be worn when chipping with a cold chisel.			
( ) 182. A drift or pin punch is used to drive out cotter pins and dowel pins.			
( ) 183. The hack saw is used for cutting all metals except hardened steel.			
( ) 184. When using a hand hack saw, the worker should press down on the forward stroke and lift a little on the return stroke, making about 40 cutting strokes per minute and using the entire length of the saw blade.			
( ) 185. A blade should be used that will have at least two teeth cutting at one time.			
( ) 186. Thin metal may be cut with the jeweler's saw which is useful in cutting out designs in metal (piercing).			
( ) 187. A handle must always be fitted to a file before using it, and the particles of metal which collect in the file teeth must be cleaned out by brushing the file with a file card.			
( ) 188. Filing properly is one of the most diffcult operations in the mechanical field. As in sawing, pressure is applied on the forward stroke and the file is lifted slightly on the return stroke. The entire length of the file should be used.			
( ) 189. Twist drills with a straight shank are used in a hand drill; when used in a drill press, straight-shank drills must be held in a drill chuck fitted with a Morse taper which fits into the drill press spindle.			
( ) 190. The use of an improperly ground drill results in inaccurately drilled holes and frequently in damage to the drill.			
( ) 191. The cutting edges, known as lips, must be equal in length and there must be from 12 to 15 degrees clearance angle. The recommended lip angle is 59 degrees.			
( ) 192. A reamer, a tool which has cutting edges on the sides, is used to true and smooth holes which purposely are drilled slightly undersize. The reamer is used in the same manner as a tap.			
( ) 193. To drill holes in stone, brick, or concrete, a star drill or carbide tipped drill in a brace or electric drill is used. The star drill is struck with a hammer and is turned slightly between blows.			
( ) 194. Rectangular and irregularly shaped holes are made by forcing a broach through an opening which is slightly undersize.			
( ) 195. The bench shear is used to cut to rough metal up to ¼ inch in thickness.			
( ) 196. Outside screw threads are cut by hand with a tool known as a threading die, which is made of hardened steel and roughly resembles a threaded nut.			
( ) 197. Inside screw threads, as the threads in a nut, are cut with a tool called a tap, which is made of hardened steel and roughly resembles a screw.			
( ) 198. Hand taps must be used with great care because they are easily broken and when broken off in a hole they are difficult to remove.			
( ) 199. The hole to be tapped must be no smaller than the minor diameter of the threads to be cut; nor should it be larger than three fourth the major diameter.			
( ) 200. Portable tools, such as electric drills and grinders, are useful because they may be brought to work that is too large to be placed in a vise or in a machine.			
( ) 201. A grinder, operated either by hand or by power, is used in renewing edges on cutting tools and in removing burrs from the heads of such tools as punches and chisels.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 202. To operate a grinder safely, the tool rest of the grinder should be set as closely to the wheel as possible without touching it, and the operator must always wear goggles.			
( ) 203. The cutting angle of tools should be appropriate for the material to be cut, i.e., the harder the material to be cut, the larger should be the angle of the cutting edge.			
( ) 204. All grinding should be done on the face of the wheel. Grinding on the side of the wheel spoils its shape and burns the tool quickly. Cup wheels are made for such grinding.			
( ) 205. An oilstone or slipstone is used to hone or finish the sharpening of a tool and to remove any burrs that are the result of grinding.			
( ) 206. When it is necessary to remove a rivet the head may be sheared off with a cold chisel and hammer and the rivet driven out with a drift punch. A hole the size of the rivet drilled through the rivet head will make the rivet easy to remove.			
( ) 207. A nut or screw that has become rusted often cannot be turned by means of a wrench or screwdriver. Soaking the threads with penetrating oil sometimes will remedy the trouble. If it does not, or if penetrating oil is not available, the nut or screw may be turned by driving it with a punch or hammer. Expanding a nut through heating it is another way to loosen it.			
( ) 208. If a stud or screw, broken off above the hole, cannot be turned out with a pair of pliers, it sometimes may be removed by sawing a slot in the end of the extending piece and turning it out with a screw driver. If the screw or stud is broken off even with, or below, the surface of the part into which it is screwed, it may be screwed out by driving it with a prick punch or drilling a hole into the screw and screwing it out by means of a screw extractor.			
( ) 209. Broken taps may be removed by the same procedures as listed above, except that a tap must be annealed before it can be cut. Also a tap extractor is available.			
( ) 210. Hand scrapers are used to remove high spots on metal surfaces to make them smooth and level. The operation consists of shearing or paring off thin flakes of metal, removing scratches and tool marks as well as high spots.			
PART F			
( ) 211. Machining is the term used to describe the cutting of metal to shape through use of machines such as the lathe, mill, and shaper. Metal is removed by cutting tools held in the machine. Machine-shop work consists primarily of shaping metal by use of machines.			
( ) 212. Two basic motions are used in machine tools—reciprocating motion and rotary motion. Some of the machines that use reciprocating motion are: hack saw, shaper, planer. Some machines that use rotary motion are: drill press, lathe, milling machine, grinder.			
( ) 213. The machines mentioned above are known as tool-room machines because they are used in making tools, dies, jigs, and fixtures.			
( ) 214. Operated properly, machines are not dangerous to the operator.			
( ) 215. Small, light work may be drilled in the sensitive drill—so-called because the operator can feel all the strains on the drill in the feed handle. Larger work is drilled in a back-geared drill press or in a radial drill which feeds the drill into the work automatically.			
( ) 216. Work being drilled must be held securely during the operation. If the work springs or moves while it is being drilled, the drill may bend and break, the work may be thrown from the table, and injury may result to the operator and to the machine. Commonly used holding devices are: drill vise, clamps of various kinds, V-blocks.			
( ) 217. The speed at which the drill rotates should be varied with the size of the drill and the composition of the material being drilled. The usual practice is to use a low speed for hard metals and a high speed for soft metals; the larger the drill the slower it should be revolved.			
( ) 218. Feeding the drill into the work too fast will cause the drill to break or the point to burn. The feed should be reduced when breaking through the work.			
( ) 219. When large holes are to be drilled, a smaller pilot hole should be drilled first. The pilot hole should be the size of the web of the larger drill.			
( ) 220. Besides drilling holes, a drill press may be used for reaming, countersinking, counterboring, spot facing, tapping, and spot finishing.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize		
	In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 221. If many pieces of the same kind are to be drilled, a drill jig may be used to hold the work in place and to insure drilling holes in the exact location desired.			
( ) 222. The lathe is used principally for cutting round work. The piece to be machined is held between centers, in a chuck, or on a face plate. As the piece is revolved a cutting tool is fed, either by hand or automatically, across the surface, removing metal as desired by the operator.			
( ) 223. Screw threads may be cut in a lathe by using a properly shaped cutting tool which traverses the work a given distance for each revolution of the work.			
( ) 224. A piece of metal that is to be turned between centers must have small holes center drilled in both ends which are supported by the lathe centers. If the lathe centers are not exactly aligned, a tapered cylinder will result. A lathe dog clamped to the work and inserted in the face plate causes the work to revolve.			
( ) 225. Handles on some tools and screws are made rough in order to provide a better hand grip. This process of roughening is known as knurling. It is usually done in a lathe with a knurling tool, although it may be done in other machines or by hand.			
( ) 226. The milling machine is used to cut all kinds of grooves such as the keyways on shafts or the teeth on gears. The work is clamped in position and passed under revolving cutters of the desired shape. A universal mill may be used to cut spirals and cams as well as simpler work.			
( ) 227. Indexing is the procedure used in rotating work or tools to exact fractions of a complete revolution. For example, as in milling the teeth on a gear. A divider head is used for this purpose.			
( ) 228. The shaper is a machine tool used for planing flat surfaces. The work is clamped in the shaper and the cutting tool moves back and forth over it, cutting on each forward stroke.			
( ) 229. The planer is used to machine flat surfaces too large to be planed in a shaper.			
( ) 230. Grinding is the process of removing metal through use of an abrasive wheel. Grinding machines are used to machine exact and finely finished surfaces.			
( ) 231. Grinding wheels are made of abrasive grains cemented or bonded together to form a wheel. Wheels are available to serve every conceivable grinding requirement.			
( ) 232. An abrasive is a very hard, tough material which has many sharp cutting edges or points when crushed or ground.			
( ) 233. Grinding wheels are usually run at a surface speed of 4000 to 6000 feet per minute. If a wheel is run too fast it is likely to break. If it is run too slowly it will not grind efficiently.			
( ) 234. When a grinding wheel has become clogged it will not cut and it will cause the work to heat unnecessarily. To put the wheel in good working condition it is dressed and trued with a dressing tool.			
( ) 235. An abrasive coated disc or a specially designed wheel may be used to cut off pieces of metal.			
( ) 236. Boring is the process of machining an internal round surface. It is done on a boring mill, drill press, lathe, and other machines. The cylinders of an automobile engine are bored, for example.			
( ) 237. Lapping is the fine grinding off of small amounts of metal from work, usually hardened steel that is slightly oversize. A lapping tool, called a lap, softer than the material to be finished, is coated with lapping compound and rubbed against the surface of the work.			
( ) 238. A press is a powerful machine which is used to punch holes of different shapes or to press flat sheets of metal into a certain shape or form, such as an automobile body. The sheet of metal to be punched or formed is placed between matching dies which are forced together with enormous pressure.			
( ) 239. Extruding is a process in which metal heated to a plastic condition is forced through a die. Variously shaped strips can be made by this process. Aluminum moldings are an example.			
( ) 240. Wire is made by drawing a metal rod through a series of dies, the hole in each successive die being smaller than the material entering it.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 241. Production machine tools are used in manufacturing on a mass production basis. Examples are the turret lathe and the automatic screw machine. They may be set up to cut duplicate pieces automatically or semiautomatically.			
PART G			
( ) 242. The principal means of fabricating or assembling metal parts are: riveting, fastening with screws or bolts, welding, soldering, locking (as sheet metal seams), and fitting as press or shrink fit).			
( ) 243. Hardware or standard parts such as bolts, nuts, screws, washers, small springs, and ball bearings are usually purchased from a specialty manufacturer rather than made by each manufacturer. Machines and devices are designed so as to utilize standard parts for reasons of economy and efficiency.			
( ) 244. Bolts and screws are usually used to fasten together parts in such a manner that they may be taken apart later.			
( ) 245. A bolt is used when the worker can get at both sides of the work with wrenches, turning a nut on one side and holding the bolt head on the other side. A screw, which does not require a nut, is used where only one side can be reached with a wrench or screw driver.			
( ) 246. Bolts are available in shapes and sizes to serve various purposes, e.g., stove bolts, machine bolts, studs. Screws available include machine screws, cap screws, set screws. When a bolt or screw is replaced, the proper kind should be used.			
( ) 247. Bolts and screws used in metalwork today are usually threaded according to national standards. The threads are either National Coarse, National Fine, or National Special.			
( ) 248. Screws and bolts usually have right-hand threads. To tighten them they are turned in a clockwise direction; to loosen them they are turned in a counterclockwise direction.			
( ) 249. The common washer consists of a flat circular piece of metal with a hole in the middle. The purposes of using a washer in connection with a bolt or screw are to provide a smooth bearing surface for the nut or screw head and to serve as a shim.			
( ) 250. To prevent a bolt or screw from becoming loose through vibration, a lock nut, lock washer, or castelated nut may be used.			
( ) 251. For maximum efficiency of a screwed or bolted joint, the surface upon which the bolt head, screw head, or nut rests is machined to form a perfect seat, e.g., countersunk, counterbored, or spot faced.			
( ) 252. Set screws are used to hold objects like pulleys on shafts. They are made with or without heads. The headless screws are slotted for a screw driver or contain a hexagonal hole for a wrench. Headless set screws are safer then screws with heads.			
( ) 253. Keys are commonly used to keep pulleys and gears from revolving on shafts. Part of the key fits into a slot in the shaft; the other part fits into a slot in the pulley or gear.			
( ) 254. A dowel pin is a metal pin used to keep two parts in a certain relation to each other and to keep them from moving or slipping. Sometimes tapered pins are used to fasten a pulley, collar, gear, or handle on a shaft.			
( ) 255. In metalwork, fitting means putting parts together so that they touch or join each other in such a way that one will turn inside the other, that one will slide upon the other, or else that the parts will hold tightly together so that they cannot move.			
( ) 256. When a shaft is fitted to a bearing, the diameter of the shaft should be a little smaller than the diameter of the bearing to allow space for a film of oil between the surfaces and to allow the shaft to expand from heat caused by rubbing.			
( ) 257. A shim is a thin sheet of metal, wood, or paper placed between two surfaces to keep them a certain distance apart or so that the shim is a support.			
( ) 258. Parts of machinery are often pressed together—a pulley pressed on a shaft, for example. This is done on an arbor press.			
( ) 259. Riveting is a process of fastening metal pieces together permanently. The rivet is placed through a hole in the pieces to be fastened together permanently. The rivet is hammered into the form of a head. Structural steel work, boilers, and airframes are examples of riveted construction.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
PART H			
( ) 260. Sheet metal work deals with laying out, cutting, shaping, and assembling thin sheet stock such as galvanized sheet steel, tinplate, copper, black iron, and aluminum. A person who specializes in sheet metal work is called a sheet metal worker.			
( ) 261. The thickness of sheet metal is designated by gauge numbers which range from 000 to 36. The larger the gauge number the thinner the metal.			
( ) 262. To make an article out of sheet metal usually requires the making of a pattern or templet which indicates lines to be cut, allowances for seams, and places and direction metal is to be bent. Patterns are usually drawn on paper.			
( ) 263. To make a sheet metal pattern requires an understanding of geometric principles.			
( ) 264. When scratching layout lines on sheet metal, care must be taken to mark only the lines to be cut, because scratches mar the surface of the metal and, in the case of coated sheets, the base metal is likely to become rusted where scratch-awl marks cut through the coating.			
( ) 265. Sheet metal 20 gauge and thinner is usually cut by hand with snips. Heavier sheet metal is cut with a bench shear, power shear, hack saw, cold chisel, squaring shear, or oxy-acetylene cutting torch.			
( ) 266. Slivers of sheet metal along a cut edge are sharp and dangerous; such irregularities should be filed off before the piece is handled.			
( ) 267. To punch a hole in sheet metal with solid or hollow punches, the sheet is placed over a block of lead or wood, the punch is placed on the sheet, and the punch is struck with a hammer. Thin sheet metal may be punched with a hand punch similar to the kind used in punching paper.			
( ) 268. Sheet metal may be bent in a vise, over the surface or edge of variously shaped stakes, or in a bar folder or cornice brake. Curved parts are formed in a forming machine.			
( ) 269. To stiffen the metal and to protect users, the edges of many sheet metal articles are single or double hemmed, bent over a wire, or otherwise built up.			
( ) 270. Such metals as sheet copper, brass, aluminum, monel metal, and silver may be shaped by hammering the metal into molds, over stakes, or on a sand bag. The process is known as raising, and the appearance of the raised article is distinguished by the hammer marks.			
( ) 271. Sheet metal articles such as aluminum, copper, or pewter trays are often shaped by spinning in a lathe. A sheet metal disc is revolved and pressed over a mold of the desired shape.			
( ) 272. Sheet metal workers use several kinds of hammers for special purposes, e.g., a setting hammer for setting down seams, planishing hammers for smothing and shaping.			
( ) 273. Operations such as grooving, turning, beading, and crimping are done on hand-powered bench machines in most sheet-metal shops. Power machines are used for these operations in sheet-metal manufacturing plants.			
( ) 274. The most common means of fastening sheet-metal pieces together are seaming, soldering, and riveting. Sometimes self-threading screws are used.			
( ) 275. Seams such as the locked seam, grooved seam, and double seam hold the pieces together securely without other fastening. To be watertight, however, all seams are usually soldered.			
( ) 276. Successful soldering is dependent upon (1) having the pieces of metal to be joined clean, (2) having the pieces in mechanical contact with each other, (3) using the proper kind of solder and flux for the particular metal, (4) heating the pieces to be joined to a temperature which will melt the solder and permit it to run freely, (5) having work placed on a surface that will not conduct heat too rapidly, and (6) heating the pieces in such a manner as to cause the solder to flow into the seam.			
( ) 277. The equipment needed in most soldering is a soldering copper and a source of heat, such as a soldering furnace or blow torch. The soldering copper must be large enough to carry adequate heat and small enough so that the heat may be controlled. An electric copper may be used.			
( ) 278. The faces on the point of the soldering copper must be clean and coated with solder (tinned) before it can be used for soldering.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 279. The most common solder is an alloy consisting of half lead and half tin.			
( ) 280. The purpose of flux in soldering is to help clean the metal, to keep the metal from oxidizing during the soldering process, and to help the solder to flow.			
PART I			
( ) 281. Metals which flow freely when molten may be cast into desired shapes by pouring the molten metal into molds. The process is known as casting or founding. It is done in a foundry, e.g., iron foundry, brass foundry.			
( ) 282. Molds for casting metal are commonly made of sand or plaster. When many castings are to be made from one mold, as in die casting, the mold is made of metal.			
( ) 283. Molds must be free from moisture when the metal is poured in; otherwise steam will form and cause an imperfect casting and possibly cause an explosion.			
( ) 284. In order to allow the molten metal to flow into all parts of a mold, the mold must be vented to permit air, gas, and steam to escape.			
( ) 285. The mold into which the metal is poured must be made from a sample or full-scale model known as a pattern. Patterns are made of wood, metal, wax, or plaster.			
( ) 286. In order that a pattern may be lifted from a mold, the sides of the pattern must be tapered. The taper is called draft.			
( ) 287. Cast iron and most other metals take up more space when hot than they do when cold. For this reason, patterns must be made larger than the finished article to allow for shrinkage.			
( ) 288. When molding articles that have holes or hollows, a core is placed in the mold so the metal will flow around it. Cores are usually made of sand and oil. They are molded in a core box and baked in an oven prior to insertion in the mold.			
( ) 289. When castings have solidified and cooled they are taken from the mold and placed in an irregularly shaped barrel (called a rattler) to clean off molding sand and to shake out cores. A cold chisel is used to chip off burrs and irregularities.			
( ) 290. Metals such as bronze and white metal are often shaped by a process known as die casting. The metal is in either a fluid or plastic state and it is forced into a die under high pressure. Die-cast articles have a smooth surface and require no finishing unless they are to be plated.			
PART J			
( ) 291. Historically the first metalworking process was forging, which means beating metal into shape. The process is important today, but most of it is done by machine (drop forge) instead of by hand, although hand forging is still done by ornamental iron workers and maintenance mechanics.			
( ) 292. The process of forging refines the grain of metal in such a way that forgings are tougher than castings or machined pieces. For this reason such parts as crankshafts are usually forged to shape before machining to finished dimensions.			
( ) 293. The principal equipment for hand forging is a coal or gas forge, an anvil, tongs for holding the heated metal, and hammers, chisels, forming tools, and punches.			
( ) 294. A drop hammer is a large, powerful machine which has a heavy weight that acts as a hammer. The weight has a die fastened to its bottom. The hot metal is laid upon another die which is fastened on the base or anvil. The weight then drops on the metal and hammers it into both dies. The object thus formed is a drop forging.			
( ) 295. In forging iron or steel, the metal should be hammered only when it is bright red hot or hotter. The work can be damaged if it is hammered at an improper heat.			
( ) 296. To stretch or draw out an iron or steel rod or bar, it may be heated white hot and then hammered over the horn of an anvil.			
( ) 297. To thicken or upset the end of an iron or steel rod or bar, the end to be upset is heated white hot, placed on an anvil, and the other end struck with a hammer or the heated end rammed against the anvil.			
( ) 298. Wrought iron and mild steel up to and including ¼ inch in thickness can be bent cold. Thicker pieces must be red hot or hotter.			
( ) 299. When bending a metal bar at an angle, an allowance must be made to compensate for the shrinkage in the length of the piece. The rule for allowance is to add an amount equal to one half the thickness of the metal for each right-angle bend made.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 300. Circular bends may be made over an anvil or around some cylindrical piece such as a rod or pipe. A common procedure when bending metal bars cold is to use a pipe or rod with a slot in one end, inserting the end of the bar in the slot and slowly bending around it.			
( ) 301. Metal bars are often twisted to give them additional stiffness, to alter their position for fastening purposes, and for ornamental reasons. Mild steel square bars up to ½ inch and strap iron up to ¼ inch in thickness and 1½ inches in width usually can be bent cold. To prevent stock from bending out of line when twisting, it may be twisted inside a section of pipe of the proper size.			
( ) 302. Scrolls are used in ornamental iron work to lessen the monotony of straight lines. Scrolls are usually formed cold, using a variety of devices such as bending forks, jigs, and bending machines.			
( ) 303. In most ornamental iron work the appearance is improved by shaping or marking the ends of metal pieces. This is commonly done by forging, filing, grinding, or hammer marking.			
( ) 304. Wrought iron or steel may be welded by heating the pieces to welding heat, placing the pieces together, fluxing the joint, and hammering. This process, which requires much skill, has been almost entirely replaced by gas and electric welding.			
PART K			
( ) 305. Welding is the process of fusing metals together. Oxy-acetylene and electric arc are the two principal kinds of welding, both processes supplying entense and concentrated heat which melts the metal and the filler rod which fills the space in the joint.			
( ) 306. Both edges of the base metal and the end of the filler rod must be molten simultaneously if a weld is to be sound.			
( ) 307. Shipbuilding, automobile and farm equipment manufacture, and the refining and transportation of oil and gas are major industries which require employment of many welding operators. In cities and even rural communities there is work for welders in the repair and maintenance of machinery.			
( ) 308. Stock to be welded must be clean, and the space between the pieces must be such that the weld metal can flow freely and make a sound joint.			
( ) 309. A flux is used to increase fluidity of the molten metal and to prevent the heated metal from becoming oxidized. In arc welding, the filler rod (electrode) is usually coated with flux.			
( ) 310. In oxy-acetylene welding, acetylene and oxygen are supplied to a welding torch where they are mixed and burned.			
( ) 311. In arc welding, a heavy current is required, often as great as 400 amperes for a single welding machine.			
( ) 312. Both AC and DC machines are used, but the DC machine is generally considered superior to the AC for most work. With either machine, the work is connected to one side of the electrical circuit and the electrode to the other. When the electrode is brought in contact with the work a hot arc is created.			
( ) 313. Because of the strength of welded joints, welded construction makes it possible to save much weight in many manufactured products and consequently decrease costs and sometimes improve performance and appearance of the product. Welded ships are an example.			
( ) 314. The infra-red and ultra-violet rays from the welding flame or arc are injurious to the eyes; therefore, the welders' goggles or helmet must be in place before an arc is struck or a torch lighted—whether you are watching or welding.			
( ) 315. The hazards of welding—from the electric current, from the hot metal, from flying scale, and from injurious light rays—require rigid adherence to all safety precautions.			
( ) 316. Welding in a flat position (downhand) is relatively simple; vertical and overhead welding are difficult skills. About 200 clock hours of intensive training is required to develop minimum employable skills to arc weld steel in all positions. The skills are lost if not used regularly.			
( ) 317. Defective welds are indicated when the pattern of the weave is irregular, when blow holes are present, and when fine cracks are visible.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 318. Bronze welding (brazing) is similar to welding except that brass (known as spelter) is used as the filler rod and the base metal is not melted. The process is sometimes called hard soldering.			
( ) 319. Sheet steel articles such as children's toys, lockers, and office furniture are frequently fabricated by a process known as spot welding. The pieces of metal are placed between two electrodes and pressed together. The current passing through the pieces produces sufficint heat to fuse them at that spot.			
( ) 320. Steel may be "cut" with an oxy-acetylene cutting torch. The oxy-acetylene flame heats the metal to a temperature at which is will oxidize quickly and then a stream of oxygen, directed toward the place to be cut, burns through the metal. The process is called flame cutting or burning.			
( ) 321. By welding it is possible to add a coating of extremely hard metal on surfaces which are subjected to excessive wear. For example, a hard-surfaced plow share.			
PART L			
( ) 322. Wrought iron or steel pipe is used in the home to run water, steam, gas, and electric wires. Copper pipe is considered superior to steel pipe for water lines.			
( ) 323. Pipe fitting means measuring, cutting, threading, and putting pipes and fittings together. A plumber installs water pipes; a steam fitter, steam pipes; a gas fitter, gas pipes; and an electrician, conduit—the name given to pipes that carry electrical wires.			
( ) 324. In machines, pipes are used to carry oil, gasoline, and a variety of fluids. They are installed and maintained by appropriate mechanics, e.g., hydraulic lines in an airplane by an airplane mechanic.			
( ) 325. There are two main classifications of pipe: welded and seamless. The shaping and welding of welded pipe is usually done by a rolling process; seamless pipe is made from a solid rod of metal which is rolled and pushed over a long mandrel.			
( ) 326. Pipes made of thin metal—chiefly brass, copper, aluminum—are called tubing. Tubing is fitted similarly to pipes.			
( ) 327. The size of pipe is denoted by its internal diameter. The hole is usually somewhat larger than the nominal size.			
( ) 328. Because pipe is round, it must be held in a special vise (called a pipe vise) when it is being cut or threaded. Also a special wrench (pipe wrench) is used to screw pipes and fittings together.			
( ) 329. Pipe may be cut with a hack saw. The general practice, however, is to use a pipe cutter which is fastened over the pipe and revolved around it. The cutter is tightened with each revolution until the pipe is cut off and, after cutting, the rough edge of the inside hole is reamed so it is smooth.			
( ) 330. When a pipe or tube is bent the outer part is stretched while the inner part is squeezed together. For this reason the pipe or tube tends to flatten when bent. To prevent this, the pipe may be tightly packed with fine, dry sand during the bending.			
( ) 331. Pipes are most often connected by means of threaded fittings such as elbows, tees, couplings, plugs, and caps. Copper pipes, however, may be soldered to the fittings.			
( ) 332. Pipe threads are tapered so as to make the joints tight. Red lead is smeared on pipe threads before pipe and fittings are screwed together, so as to make the joints gastight and to keep the metal from corroding.			
( ) 333. Pipe threads are almost always right-hand. When the ends of two pipes in a fixed position are to be joined, a fitting called a union is used.			
PART M			
( ) 334. Metal articles are finished in various ways for the purpose of protecting the surfaces from becoming tarnished or corroded and for the purpose of improving appearance.			
( ) 335. Rusty metal, covered with grease or paint, may be cleaned by boiling it in a solution of caustic soda and water.			
( ) 336. Metal must be clean, dry, and free from rust and grease before it can be painted or plated.			
( ) 337. Rust and dirt may be removed with a wire brush, either by hand or with a brush on a grinder. If a grinder is used, goggles must be worn and the work should be held against the lower edge of the brush.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)
( ) 338. Red lead and zinc chromate paints are used to keep iron, steel, and other metals from becoming rusted. For example, red lead on structural steel.			
( ) 339. Iron and steel articles such as lawn furniture and ornamental iron work may be painted, enameled, or lacquered. Cast iron parts, however, should be filled before painting if a smooth surface is desired.			
( ) 340. Metal articles may be given an antique appearance by applying different chemicals.			
( ) 341. Metals are electroplated with another metal to improve appearance or to increase wear. The process consists of separately suspending in an electrolytic solution the article to be plated and an anode of the plating metal and causing a direct current to flow through the solution from the anode to the article.			
( ) 342. Crackle lacquer, used on commercial products such as radio panels and typewriters, provides an attractive appearance and effectively conceals many small irregularities in the surface. The lacquer is applied just as ordinary paint and the article is then baked in an oven.			
( ) 343. Clear lacquer or wax provides a transparent protective covering for metal. This finish is often used on brass to keep its appearance bright and on steel when it is desired to retain the coloration of the oxides resulting from heating.			
( ) 344. Ornamental iron work can be given a distinctive appearance by hammer marking the surface with a ball-peen or cross-peen hammer or with punches of various kinds.			
( ) 345. To polish is to change a rough, uneven, dull surface with irregular scratches to a surface with very fine, uniform, parallel cuts or grooves which cannot be seen with the naked eye.			
( ) 346. Hand polishing means to rub the surface of the metal by hand with an abrasive cloth or with steel wool, beginning with coarse abrasive and continuing with finer grades successively until using the finest grade.			
( ) 347. Grains of abrasive glued to cloth makes an abrasive cloth—emery cloth, for example.			
( ) 348. Machine buffing consists of holding the work against a cloth buffing wheel to which has been applied a buffing compound such as lime, tripoli, or rouge. The process is also done by hand rubbing.			
( ) 349. Spot finishing may be done by applying emery flour to the surface and then rubbing the spots lightly with the end of a revolving dowel held in a drill press.			
( ) 350. Burnishing is a process of making a surface shiny by rubbing it with a hard, smooth tool and pressing out minute high spots.			
( ) 351. Relief designs may be placed on sheet metal articles by a process called chasing or repousse. The design to be embossed is traced with tools of various shapes which are tapped lightly with a hammer.			
( ) 352. Identifying marks are placed on tools and machine parts by stamping, stenciling, and etching or, in the case of cast articles, by molding the marks as a part of the pattern.			
( ) 353. Etching is done by coating the metal surface with melted wax or asphaltum, scratching through this coating the marks to be etched, and then applying an acid which eats out the design.			
( ) 354. Through the use of hard, sharp engraving tools, designs may be encised on metal surfaces. This process is known as engraving.			

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize		
	In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)

Statements of Things to Be Learned (To be rated according to relative importance)	Emphasize		
	In Ind. Arts	In Other Courses	Out of School
(1)	(2)	(3)	(4)

APPENDIX E

TYPICAL LETTER REQUESTING HELP IN CHECKING LIST

November 1, 1950

Dear Professor Blank:

As is usual in the preparation of a thesis, I have come to the point where I need help.

Under the auspices of Boston University, I am attempting to discover just what content of general metalwork measures up to criteria of general education. From textbooks, bulletins, courses of study, and journal articles I have derived a list of statements which seem to represent the general education content of general metalwork. At present the list includes 295 such statements, prepared in the form of a check list.

In order that the final report will represent broader judgment than mine alone, I am writing to see if you would be willing to pool your thoughtful opinions with those of other leaders in industrial arts.

It would be unfair to ask you for a yes-or-no answer until you know the size of the undertaking. However, would you go so far now as to say whether you would be willing to look at the check list and then let me know if you are willing to cooperate in the study? The enclosed card will facilitate your reply.

Sincerely yours,

Kenyon S. Fletcher

APPENDIX F

DETAILED SUMMARY OF PERCENTAGE REACTIONS OF EACH AND ALL JURIES TO EACH ITEM IN THE CHECK LIST

In column (1) of the following table, the items of the check list are given by number.

In column (2) is given the rank order of the item in importance in general education, as determined by the combined responses of all jurors who participated in the study.

In column (3) is given the per cent of general educators who checked the item as important.

In column (4) is given the per cent of industrial arts supervisors and teacher trainers who checked the item as important.

In column (5) is given the per cent of general metalwork teachers who checked the item as important.

In column (6) is given the per cent of all sixty-six respondents who checked the item as important.

In column (7) is given the per cent of all sixty-six respondents who checked the item for emphasis in industrial arts courses.

In column (8) is given the per cent of all sixty-six respondents who checked the item for emphasis in courses other than industrial arts.

In column (9) is given the per cent of all sixty-six respondents who checked the item for emphasis out of school (or left to be learned outside the influence of the school).

Appendix F. (continued)

Item	See page 224 for explanation of data in each column.							Item	See page 224 for explanation of data in each column.						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Part A. General Information									36	49	55	64	67	62	57	40	9
									37	25	80	73	88	80	79	49	14
1	1	100	100	96	99	91	84	29	38	21	75	86	88	83	81	47	9
2	10	85	91	96	91	85	69	19	39	24	75	86	83	81	74	53	10
3	15	90	91	88	90	85	64	24	40	22	75	91	83	83	81	54	10
4	18	75	91	92	86	80	61	22	41	29	65	82	88	78	75	45	11
5	31	65	73	79	72	63	43	26	42	30	70	82	79	77	69	49	9
6	32	65	59	75	66	56	47	26	43	28	75	77	83	78	69	47	12
7	19	85	77	96	86	77	66	41	44	20	65	95	92	84	82	35	9
8	22	95	82	75	84	67	74	32	45	31	65	82	83	77	74	41	13
9	12	95	77	100	91	78	66	39	46	36	55	82	79	72	73	34	10
10	20	90	73	88	86	71	65	19	47	14	80	95	83	86	78	59	9
11	3	95	95	92	94	83	69	22	48	7	80	100	88	89	86	64	12
12	7	95	95	88	93	82	70	24	49	38	50	77	83	70	68	21	12
13	28	80	82	75	79	72	38	22	50	17	80	91	83	85	74	70	15
14	26	85	91	71	82	76	38	22	51	42	55	73	75	68	64	16	9
15	16	80	86	96	87	80	59	22	52	5	85	100	96	94	91	58	22
16	11	90	86	96	91	85	77	24	53	16	85	91	79	85	80	54	18
17	17	70	95	96	87	87	26	33	54	4	90	100	92	94	88	60	36
18	2	95	95	96	95	75	83	47	55	3	100	86	96	94	88	47	30
19	23	90	82	79	84	63	68	39	56	9	85	91	88	89	83	28	34
20	29	80	73	79	77	55	65	38	57	10	85	91	88	89	85	31	30
21	14	100	86	83	90	50	84	39	58	2	95	100	92	96	92	68	49
22	5	100	95	83	93	40	91	42	59	39	60	77	71	69	66	6	11
23	24	100	73	75	83	31	82	35	60	45	50	68	75	64	61	3	10
24	30	90	73	67	77	29	76	29	61	47	45	77	67	63	60	6	8
25	27	80	95	63	79	61	60	29	62	51	25	45	42	37	33	5	6
26	6	95	91	92	93	70	87	18	63	15	75	95	88	86	80	41	26
27	13	100	82	88	90	73	70	22	64	1	100	100	96	99	91	61	35
28	21	95	86	71	84	49	81	33	65	34	65	86	71	74	71	36	11
29	25	95	73	79	82	37	79	36	66	35	45	86	88	73	70	27	13
30	4	95	95	88	93	75	85	35	67	37	55	82	75	71	65	52	8
31	8	100	77	96	91	50	88	47	68	18	75	100	79	85	79	68	15
32	9	85	95	92	91	62	87	33	69	41	50	82	75	69	62	56	8
									70	50	30	77	67	58	47	27	7
Part B. Mechanical Knowledge									71	43	50	77	75	67	57	42	6
									72	8	85	95	88	89	80	58	20
33	23	75	86	83	81	81	33	9	73	6	90	86	96	91	83	70	15
34	27	75	82	79	79	80	32	9	74	46	50	73	67	63	57	29	7
35	33	75	73	75	74	76	41	7	75	12	85	91	83	86	60	76	12

(continued on next page)

Appendix F. (continued)

Item	See page 224 for explanation of data in each column.							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
76	40	55	82	71	69	51	59	8
77	11	85	95	83	88	75	70	12
78	19	70	91	92	84	77	45	18
79	26	65	95	79	80	71	49	15
80	44	60	73	67	67	59	35	12
81	13	85	91	83	86	82	37	26
82	48	45	77	67	63	54	33	9
83	32	60	86	79	75	69	51	15

Part C. Metals and Metallurgy

84	11	80	77	92	83	69	70	23
85	5	95	77	96	89	69	75	23
86	26	70	82	71	74	65	48	14
87	44	45	55	75	58	49	36	7
88	32	50	68	83	67	57	51	11
89	52	50	32	54	45	34	34	8
90	18	70	82	88	80	73	64	16
91	12	80	77	92	83	69	67	18
92	15	70	86	88	81	78	52	18
93	50	30	55	63	49	44	33	6
94	21	60	86	83	76	76	38	12
95	49	30	64	63	52	46	27	9
96	13	85	73	88	82	79	43	18
97	28	50	82	88	72	70	30	16
98	53	15	50	54	40	38	14	5
99	33	40	82	79	67	66	24	12
100	24	55	86	83	75	75	27	15
101	35	45	77	75	66	66	24	16
102	34	55	82	63	67	63	23	10
103	45	35	68	71	58	56	36	13
104	17	70	82	88	80	78	38	18
105	22	60	77	88	75	75	35	16
106	47	35	73	63	57	52	21	13
107	27	70	73	79	74	65	41	16
108	43	25	82	75	61	56	33	15
109	51	25	68	54	49	46	22	12
110	36	45	73	79	66	63	31	12
111	42	45	77	63	62	58	27	11
112	40	35	82	71	63	61	21	9

Item	See page 224 for explanation of data in each column.							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
113	37	35	77	83	65	64	18	15
114	38	35	82	75	64	61	26	12
115	48	25	64	71	53	50	9	10
116	39	35	77	79	64	64	10	10
117	16	60	91	92	81	81	26	12
118	25	55	86	83	75	75	22	12
119	19	60	86	92	79	78	20	14
120	23	60	86	79	75	75	41	12
121	41	40	73	75	63	63	21	12
122	46	20	73	79	57	57	13	9
123	4	90	95	96	94	91	29	20
124	7	80	95	83	86	86	40	15
125	20	80	82	75	79	74	55	14
126	2	90	100	96	95	94	69	24
127	30	55	77	83	72	64	53	10
128	6	80	95	88	88	81	67	12
129	3	95	95	92	94	92	69	18
130	10	70	95	88	84	84	46	15
131	8	75	91	88	85	83	44	15
132	1	95	100	92	96	91	76	18
133	9	80	95	79	85	83	51	14
134	14	80	91	75	82	79	51	14
135	31	50	82	71	68	68	29	12
136	29	60	77	79	72	71	18	19

Part D. Assembly and Fabrication

Note: In this part and in following parts of the check list, data apply to industrial arts and not to other areas of learning. Data are not needed in columns (7), (8), and (9).

137	2	70	95	92	86			
138	4	85	77	83	87			
139	16	45	77	75	66			
140	22	30	73	75	59			
141	7	60	77	88	75			
142	15	50	77	75	67			
143	20	40	73	75	63			

(continued on next page)

Appendix F. (continued)

Item	See page 224 for explanation of data in each column.							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
144	8	55	82	88	75			
145	21	45	73	67	62			
146	29	25	64	67	52			
147	12	50	82	79	70			
148	10	55	77	83	72			
149	11	55	82	75	71			
150	30	25	64	63	51			
151	1	85	91	92	89			
152	9	45	82	92	73			
153	5	70	91	71	77			
154	14	65	73	67	68			
155	28	30	73	58	54			
156	3	80	82	88	83			
157	18	40	77	79	65			
158	13	40	77	92	70			
159	24	40	64	67	57			
160	27	35	59	67	54			
161	26	35	64	67	55			
162	23	35	64	75	58			
163	6	70	86	71	76			
164	25	35	68	67	57			
165	19	45	77	71	64			
166	17	65	77	54	65			

Part E. Metal Finishing, Ornamentation, and Preservation

Item	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
167	20	60	77	92	76			
168	1	95	95	92	94			
169	18	75	77	83	78			
170	15	70	82	88	80			
171	28	55	77	79	70			
172	23	60	82	79	74			
173	21	60	86	83	76			
174	5	85	95	88	89			
175	4	90	91	88	90			
176	3	85	95	92	91			
177	7	80	86	88	85			
178	6	90	95	79	88			
179	2	90	91	96	92			

Item	See page 224 for explanation of data in each column.							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
180	12	65	86	92	81			
181	13	65	82	96	81			
182	33	55	77	71	68			
183	8	65	95	88	83			
184	29	55	73	83	70			
185	37	35	77	83	65			
186	34	50	82	71	68			
187	17	60	86	92	79			
188	19	65	82	88	78			
189	31	40	77	88	68			
190	26	45	77	92	71			
191	40	30	73	79	61			
192	35	55	77	75	69			
193	25	60	73	83	72			
194	43	35	68	67	57			
195	39	45	68	71	61			
196	24	35	86	96	72			
197	27	35	86	92	71			
198	38	25	77	92	65			
199	41	25	77	75	59			
200	9	75	82	88	82			
201	16	70	86	83	80			
202	14	65	95	83	81			
203	35	55	73	71	66			
204	22	60	82	83	75			
205	11	65	91	88	81			
206	36	45	82	71	66			
207	10	75	95	75	82			
208	32	55	82	67	68			
209	42	40	73	58	57			
210	44	50	68	50	56			

Part F. Pipe Work

Item	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
211	4	70	86	88	81			
212	23	65	73	71	63			
213	31	35	64	58	52			
214	1	95	82	92	90			
215	30	25	73	63	54			
216	7	55	91	88	78			

(continued on next page)

Appendix F. (continued)

See page 224 for explanation of data in each column.

Item (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
217	14	45	77	88	70			
218	9	55	82	88	75			
219	19	45	77	79	67			
220	21	55	73	71	66			
221	24	40	73	71	63			
222	5	65	91	88	81			
223	22	35	77	83	65			
224	25	30	77	75	61			
225	16	55	77	75	69			
226	15	40	86	83	70			
227	29	20	73	71	55			
228	11	50	86	83	73			
229	17	50	82	75	69			
230	6	70	86	88	81			
231	8	65	82	79	75			
232	2	75	91	88	85			
233	26	35	77	63	58			
234	18	45	82	79	69			
235	27	30	77	67	58			
236	13	60	77	75	71			
237	28	30	77	58	55			
238	10	65	82	75	74			
239	20	35	91	75	67			
240	3	75	91	83	83			
241	12	65	77	75	72			

Part G. Hand Work

Item (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
242	7	75	86	79	80			
243	9	70	77	83	77			
244	4	95	82	88	88			
245	11	85	77	63	75			
246	1	95	91	88	91			
247	8	70	82	83	78			
248	2	100	91	83	91			
249	6	95	86	75	85			
250	3	95	91	88	91			
251	17	55	68	58	60			
252	10	65	82	79	75			
253	12	50	77	79	69			
254	15	50	77	71	66			
255	13	60	73	71	68			
256	16	35	77	75	62			
257	14	55	77	71	68			
258	18	35	68	75	59			
259	5	90	91	85	88			

Part H. Sheet Metal Work

Item (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
260	1	90	91	83	88			
261	12	60	86	71	72			
262	13	55	77	79	70			
263	14	60	68	83	70			
264	21	45	73	67	62			
265	20	50	73	71	65			
266	2	80	82	92	85			
267	16	55	73	75	68			
268	10	55	82	83	73			
269	18	50	73	79	67			
270	3	80	91	79	83			
271	7	70	86	79	78			
272	17	55	73	75	68			
273	19	45	77	75	66			
274	9	60	77	88	75			
275	15	50	77	79	69			
276	4	65	91	88	81			
277	6	65	95	79	80			
278	8	60	91	83	78			
279	11	60	77	83	73			
280	5	65	91	88	81			

Part I. Welding

Item (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
281	1	85	100	92	92			
282	3	65	86	79	77			
283	6	50	73	79	67			
284	5	55	77	79	70			
285	2	60	91	83	78			
286	9	35	77	75	62			
287	7	35	77	79	64			

(concluded on next page)

Appendix F. (concluded)

Item	See page 224 for explanation of data in each column.							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
288	8	40	73	75	63			
289	10	25	68	67	53			
290	4	50	91	79	73			

Part J. Foundry Work

291	1	80	95	96	91			
292	3	45	82	75	67			
293	4	50	77	75	67			
294	6	50	73	75	66			
295	10	25	77	79	60			
296	12	25	73	75	58			
297	13	20	73	71	55			
298	7	40	77	71	63			
299	8	35	77	71	61			
300	9	30	73	79	61			
301	11	30	73	71	58			
302	2	50	82	75	69			
303	5	40	86	75	67			
304	14	30	82	50	54			

Part K. Machine Work

305	1	95	100	96	97			
306	12	30	82	82	65			
307	2	90	95	92	92			
308	16	25	77	75	59			
309	14	30	77	75	61			
310	9	35	86	88	70			
311	11	40	77	83	67			
312	17	25	77	75	59			
313	6	80	82	83	82			
314	3	70	95	92	86			
315	4	70	86	96	84			
316	15	30	77	71	59			
317	13	40	73	75	63			
318	10	40	86	79	68			
319	5	70	95	83	83			
320	7	60	85	83	76			
321	8	60	82	79	74			

Item	See page 224 for explanation of data in each column.							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

Part L. Layout and Measuring

322	1	95	100	92	96			
323	2	95	91	88	91			
324	10	60	68	67	65			
325	12	45	68	58	57			
326	5	65	86	79	77			
327	3	80	82	88	84			
328	6	60	86	75	74			
329	7	60	86	75	74			
330	11	35	82	67	61			
331	4	65	86	83	78			
332	9	45	82	83	70			
333	8	55	82	79	72			

Part M. Forge Work

334	2	80	100	92	91			
335	13	65	91	67	74			
336	1	90	100	92	94			
337	4	80	86	83	83			
338	8	75	82	83	80			
339	7	75	91	75	80			
340	15	70	68	71	70			
341	12	50	91	88	76			
342	18	55	73	75	68			
343	5	65	91	92	83			
344	17	50	77	79	69			
345	10	80	77	79	79			
346	6	80	86	79	82			
347	11	60	91	83	78			
348	14	60	77	75	71			
349	19	55	77	54	62			
350	20	55	73	58	62			
351	21	40	77	67	61			
352	16	60	73	75	69			
353	3	80	91	83	85			
354	9	70	95	75	80			