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A study of content material for art metalwork in the junior high school.

Emil E. Keiler

University of Massachusetts Amherst

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A STUDY OF CONTENT MATERIAL
FOR ART METAL WORK in the JUNIOR HIGH SCHOOL

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A STUDY OF CONTENT MATERIAL
FOR
ART METALWORK IN THE JUNIOR HIGH SCHOOL

by

Emil E. Keiler

A problem presented in partial fulfilment of
the requirements for the Master of
Science Degree
Massachusetts State College
1946

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CHAPTER I

THE INTRODUCTION

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THE INTRODUCTION

What Suggested this Study -- In a General Metal Shop, Art Metalwork is one of the activities used to round out a general study of the metals field. That it is a valid subject to be taught in this field of activity is shown by the fact that Art Metalwork is included as a center of activity in a number of state studies in the Industrial Arts curriculum. The Pennsylvania state study of Industrial Arts lists Art Metalwork as a center of activity in the Metals area. The Connecticut state study in Industrial Arts lists Art Metal under General Metalwork. The New York state course for Industrial Arts also includes Art Metalwork as a center of activity in General Metalwork. The United States Office of Education in its bulletin suggests, "Metalworking may include sheet metal, art metal, bench metal, forging, gas and electric welding, casting and machine tool work." (1) A desire to establish the content material for a study of Art Metalwork in a General Metal shop on a learning unit basis revealed a scarcity of material set up in this manner in the courses of study available. That this type of set-up is desirable is revealed in one of the most outstanding studies ever attempted in the field of Industrial Arts. "No matter what the course of study, no matter what the methods

(1) Proffitt, M. M., Industrial Arts, Its Interpretation in American Schools, United States Office of Education, Bulletin 1937, No. 34, p. 46-47.

of teaching employed--no matter what text-book or no text-book, may be used--no shop teacher can escape organizing his work on the basis of some plan of 'fundamental learning units.' The effort to determine what these units are in the various shop subjects constitutes the objective of this study."(2) This study, however, does not cover Art Metalwork, although it does include a few of the learning units in the Sheet Metalwork analysis. To validate the work being done in this section and to teach only what are considered the most important units, the need was felt for a study of what is being done by others in this field and what they consider the most important units of study to be. A study of this kind will serve as an analysis of what should be taught in Art Metalwork, not based on one person's opinion, but verified by the judgment of others on the basis of their experience as teachers of Industrial Arts. What are others in Art Metal teaching in the way of manipulative learning units, what metals are they using, and what technical and related learning units are they teaching? To obtain the answer to these questions would help to establish the desired learning unit content for work in the Art Metalwork center. Everyone, of course, will not be teaching the same units. Because of limitations of shop space, time element, equipment, or money to purchase the

(2) Selvidge, Robert W., Standards of Attainment in Industrial Arts Teaching, American Vocational Association, 1931, p. 5.

necessary equipment and supplies, variations exist in what can be taught, let alone what is considered important by the various teachers. To establish a list of learning units for both manipulative and technical and related work as the content material to aid in carrying out the teaching of Art Metalwork is the purpose of this problem. In order to validate the work being done in this center of General Metalwork, and to teach only what are considered the most important units, the purpose of this study is to obtain from instructors of Industrial Arts work their judgment of what they consider the most important units to teach. By obtaining the opinion of others who are teaching Art Metalwork, a cross check will be obtained which will add more value to such a list than if it were composed by an individual.

Its General Value -- A survey of this type will be of value to anyone teaching in the Metals area, be it in a General Metals Shop, a Comprehensive General Shop, a Unit Shop, or an Arts and Craft Shop. "A general unit shop offers a variety of Industrial Arts experiences, but they are usually limited to the use of a certain medium, such as wood, metal, textile, etc.. The General Metals Shop will include the working of metal in all its various forms." (3) "A Comprehensive General Shop is found to be most effective in schools in which only

(3) Fales, Roy G., Industrial Arts for Junior and Senior High Schools, New York State Dept. of Education, Albany, N. Y. 1940, p. 32.

one instructor of Industrial Arts work is employed. Up to the present time, the backbone of this shop has been woodworking. During the past decade, metalwork has increased in popularity very rapidly." (4) "It has long been the practice to define unit shops as those which are equipped for teaching in a single field such as woodwork, metalwork, forging, foundry, or printing." (5) "Divisions common to the arts and crafts general shop are Tooled Leatherwork, Weaving, Painting, Carving, Making Jewelry, Art Metal." (6) It can be used as the basis for a unit course in Art Metalwork. To those teaching in a General Metal shop, it will indicate the units of work in the Art Metalwork center which will be of greatest value to a well rounded experience in this area. Teachers in a General Shop will find much of value which they can use in developing the metals center of this shop. To those teaching Arts and Crafts, the Art Metalwork will form an important unit. Taken as a whole, Art Metalwork has much to offer to anyone teaching any of the courses which use metal as a medium, and a study of this kind will reveal the most important units which should be taught.

Pupils find Art Metalwork a very satisfying experience.

(4) Fales, Roy G., op. cit., p. 32.

(5) Proffitt, M. M., op. cit., p. 51.

(6) Newkirk, Louis V., and Stoddard, George D. The General Shop, p. 33.

The elementary skills can be developed faster and with more satisfactory results than with some of the other materials used in Industrial Arts work where a greater variety of tools is used and their use calls for more skill in accomplishing a satisfactory piece of work. "Metal work, when employing thin sheets, is often less difficult, however, than woodwork."(7)

Scope of this Study -- The scope of this study is to cover the work which is usually presented to Junior High School pupils on the 7th, 8th, and 9th grade levels. What part of the material is taught in any one shop or in any particular grade is not within the scope of this study, but rather we shall consider what is most important to be taught in the Junior High School as a whole. Once it has been established what should be taught in the Junior High School in the Art Metal center, then it is possible to compare this with what is now being taught and make any changes deemed advisable. Also, this study may contribute the basic units for adding Art Metalwork to the General Metals area if this is not already a center in this type of shop, or the addition of an Art Metalwork center in a General Shop when establishing a new course. The scope of this study covers not only the manipulative units of learning, but also the more desirable metals to use in giving a broader experience and also the technical and related learning units which apply to the manipulative work being done.

(7) Proffitt, M. M., op. cit., p. 50.

The technical units are a necessary part of the carrying out of the manipulative experience. In drilling a hole, it is necessary to know how to tell the size of drills in order to choose the correct one after the desired size is known. The drills on hand may be any one of the three systems of labeling drills, and therefore an interpretation of the system on hand must be made in order to select the desired size. The related units give a greater appreciation of the information obtained on one job to a general application to other jobs. "The fundamentals should be taught with illustrations of applications."

(8) The complexity of the Industrial age in which we live virtually requires the American public schools to provide a rich enough range of experiences to give a spread of technical knowledges needed by everyone in order to cope with the environment in which he lives." (9) "Adequate provision should be made for the acquisition of common technical knowledges and manipulative functions. The study of how several metals are used from the standpoint of costs, characteristics, and appreciations constitutes a basis for technical, consumer knowledges and appreciations." (10)

"In the metals field, work has been confined largely to

(8) Fryklund, Verne C. "Adapting the Course of Study," Education Vol. 58. No. 3 (Nov. 1937), p. 177.

(9) Collicott, J. G., and Skinner, B. O., A Prospectus for Industrial Arts in Ohio, 1934., pp. 56-57.

(10) Ibid., p. 86.

iron and sheet steel, to the neglect of other common metals such as copper, lead, tin, zinc, aluminum, pewter, brass, bronze, and other important alloys which have recently been introduced, such as stellite and monel metals." (11) That there is need for an investigation of this area is brought out in the Ohio Prospectus, "Contact should be made with as great a number of materials as possible. Provision must also be made for contacts with as many other common metals such as the new alloy steels, copper, brass, aluminum, nickel silver, monel metal, lead, pewter, zinc, and silver. Each of these opens up a whole new field of experience, study and appreciation. New processes are required, new tools utilized, and a new wealth of information is available." (12)

Since the purpose of this study is to establish and evaluate the learning units in an Art Metal course for the Junior High School, a list of learning units which might be suitable for this level was compiled with the assumption that the system was using the 6-3-3 plan, although it can also be used as a basis of selection for the 6-2-4 plan. The article, "A Suggested Ideal Shopwork Program" bases its program upon the 6-3-3 plan. "It assumes an organization of Junior High Schools, Grades 7, 8, 9, and Senior High Schools,

(11) Proffitt, M. M., op. cit., p. 44.

(12) Collicott, J. G., and Skinner, B. O., op. cit., p. 84.

Grade 10, 11, 12." (13) To give as much emphasis upon an enrichment of the Industrial Arts program by giving breadth to the work experience, a list of technical and related work units is included. These technical and related units are based upon an analysis of the manipulative units. While this analysis is not exhaustive of the possible content, it covers the main points of the work and may be suggestive of further possibilities should the time element so demand.

(13) Trybom, J. H., "A Suggested Ideal Shopwork Program,"
Industrial Education Vol. XXVI, No. 3, (May, 1934),
p. 145.

CHAPTER II

STATEMENT OF THE PROBLEM

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STATEMENT OF THE PROBLEM

Why the Learning Unit Content -- There is a growing need for a more definite list of learning units for Art Metalwork together with the technical and related units which give generalization of application and breadth of understanding and appreciation. "A great deal of work has been done by teachers in attempting to analyze and list the learning units involved in the various trade and industrial arts subjects. These efforts have been somewhat isolated, and there has been little opportunity to exchange ideas and receive the criticisms and suggestions of others.

"The value of such a list of learning or teaching units is obvious. It gives very definite objectives which are quite apparent to both teacher and pupil, and it becomes a relatively simple matter to develop tests to determine the progress of the pupil in learning them.

"Such a list also furnishes a basis for the analysis of jobs to determine whether they contain the elements we wish to teach, and what the learning units are in the job.

"Such original lists should be reasonably complete, and probably would contain a greater number of units than would be taught in any one school; but the teacher should select from such a master list the particular learning units which he wishes to teach to his classes." (1)

(1) Selvidge, Robert W., Standards of Attainment in Industrial Arts Teaching, American Vocational Association, 1931, pp. 5-6.

It was proposed to obtain verification of a suggested list of learning units, selecting the most important units, and to obtain any other suggested units deemed desirable to be included. It was proposed to obtain this verification by making a survey which made use of a questionnaire asking that judgment be passed upon the suggested units, the most important ones checked, and that any other units considered important be added. It was proposed to obtain the recommendations of shop teachers for this type of work, together with the recommendations of teachers of Industrial Arts in teacher training institutions.

Courses of Study Examined -- Courses of study giving content material are almost wholly unavailable. Those which are in print are usually very sketchy and of little value in developing a list of learning units because of the general treatment of the subject. The state of Connecticut bulletin is good as far as it goes, but it concerns the entire area of General Metals and the Industrial Arts curriculum as a whole, and therefore it lists only a limited number of units in Art Metalwork. The New York State Education Department course for Industrial Arts for Junior and Senior High Schools lists Art Metal to be taught as a center in the General Metal or Comprehensive General Shop courses. Learning units are not given, but "it is suggested that the operations, processes, and jobs to be performed by the pupils should be shown in logical

outline." (2)

The best reference to a study of the content of Industrial Arts work is the cooperative study conducted by Prof. Robert W. Selvidge of the University of Missouri under the auspices of the Committee on "Standards of Attainment in Industrial Arts Teaching" for the American Vocational Association. This study covers an analysis of learning units in Woodworking, Sheet Metalwork, Elementary Electricity, Auto Mechanics, Printing, and Mechanical Drawing. This study lists the teaching units under three main headings: 1. "The things you should be able to do; 2. The things you should know; 3. What you should be." (3) Under each heading is listed the various learning units covered. The first involves manipulative skill, knowledge of procedure and construction processes. The second group involves information concerning qualities and characteristics of materials and other matters of general interest in the field. The third group involves attitudes and habits which affect the success of the individuals.

Assumptions Made in this Study -- In order to have a common ground for evaluating the questions and to make this survey

(2) Fales, Roy G., Industrial Arts for Junior and Senior High Schools, New York State Dept. of Education, Albany, N. Y. 1940, p. 48.

(3) Selvidge, Robert W., Standards of Attainment in Industrial Arts Teaching, American Vocational Association, 1931, pp. 18-22.

as comprehensive as possible, certain assumptions were made. When answering a questionnaire, one naturally applies the question to one's own situation. This may or may not be helpful for the purposes of the questionnaire. In this particular questionnaire where it is desirable to find out what should be taught rather than what is being taught, it is desirable to eliminate local limitations. Therefore, the assumptions made were as follows:

1. No time element need be considered in covering either the manipulative learning units or the technical and related work.

As the purpose is to find out what should be taught, we should not at this point be limited by the great time variation found in various schools. Otherwise each respondent would try to fit the units into his time allowance and this would affect the results of the survey.

2. Cost of materials and equipment need not be considered for our purposes.

There is no great uniformity in making budget allowances for materials and equipment for the teaching of Industrial Arts. Therefore, if each respondent answered this questionnaire in the light of his own situation and limitations in regards to cost, again there would be a wide variation in the basis for the replies.

3. Assume that none of this work is taught in any other area of your Industrial Arts Program.

Large communities are most likely to have Unit Shops or

General Unit Shops, while smaller communities often have Comprehensive General Shops. Because of the variation in what is being taught under these various shop set-ups, it is desirable to confine all of the units suggested in the questionnaire to be taught in the Art Metal shop. If there is a Sheet Metal or General Metal shop in the system, some of the units might be taught there, and because of this fact, would be omitted in this questionnaire. Therefore, by not considering any other area where these units might be taught, we will consider them in the light of their own importance in Art Metalwork rather than if they have been taught previously.

4. Consider that you recommend SHOULD be taught rather than what you are now teaching.

There are so many possible qualifying factors in what a shop teacher may be teaching and what he feels is important and should be teaching, that we shall try to eliminate as many of these factors as possible. By stating what he feels SHOULD be taught, an instructor starts from the same point as the others answering the questionnaire. Time, shop area, equipment, and budget allowances for supplies all are qualifying factors to what we are teaching. If we can disregard these factors, then we have a free reign to say what we feel should be taught, without considering these limiting factors.

Composition of Questionnaire -- For the purposes of this

survey, the questionnaire was made up for Art Metalwork learning units, most suitable metals to use in teaching Art Metalwork, and the technical and related learning units which should accompany the manipulative learning units.

The manipulative learning unit list was based upon the various operations necessary in making a wide variety of projects to give a broad experience. Some of the units are of an elementary nature and some are definitely more advanced. The suitability of these learning units was determined by an examination of a number of textbooks and workbooks on metalwork and such courses of study as were available. (4)

The units for the survey of the various kinds of metals were composed of the common metals available and most often suggested for use in Art Metalwork. There are many other metals available. Some of these are used in the Sheet Metalwork center or Bench Metal center, and therefore were not included in this survey. Some metals are too valuable or too

-
- (4) Payne, Arthur F., Art Metalwork, Peoria: Manual Arts Press, 1929, p. 176.
Manzoni, Peter, Metalcraft for Amateurs, Boston: Beacon Press, Inc., 1935, p. 136.
Smith, Robert E., Units in Etching, Spinning, Raising, and Tooling Metal, Wichita: McCormick-Mathers Pub. Co., 1939, p. 56.
Smith, Robert E., Units in Sheet Metal Work, Wichita: McCormick-Mathers, 1939, p. 47.
Dragoo, A. W. and K. L., General Shop Metal Work. Bloomington, Illinois, 1939, p. 68.
The Dixon Manual for Metal Artists. Newark: William Dixon Inc., 1937, p. 10 / 20 plates.

hard for use on the Junior High School level. Suggestions for other metals to be recommended for use in Art Metalwork were requested.

An analysis of the manipulative learning units and the metals used resulted in a list of technical and related units which will give the necessary information for the manipulative learning units. "Such enrichment of the Industrial Arts instruction gives the pupil a broader vision, and much more extensive information than he would acquire if his activities were restricted to the experiments, constructions, and observations in the school shop." (5)

Selection of Mailing List -- This questionnaire was sent to selected colleagues throughout the country. They were selected because of their position or professional interest as evidenced by their contributions to the professional literature. The mailing list included shop teachers in the Junior and Senior High Schools, and also professors in the Industrial Arts Department of teacher training institutions. This cross section was included to check how teacher trainer recommendations compared with what shop teachers in field recommended in order to better check what we SHOULD be teaching. This will also show whether the teacher trainers are far in advance of what is being taught, or whether the shop teachers

(5) Lease, L. J. "Enriching the Teaching of Industrial Arts Subjects." Industrial Education. Vol. XXXVI, No. 1. (Jan., 1934), p. 35.

are keeping up professionally with the latest recommendations of the teacher training institutions.

Where the Replies Came From -- Ten replies were received from teacher trainers in the Industrial Arts Departments of state teacher training institutions in California, Arizona, Missouri, Nebraska, Illinois, Colorado, Indiana, Pennsylvania, Rhode Island, and New York. These replies came from institutions which had particularly fine offerings in their Industrial Arts Departments as evidenced in a study now being made of Industrial Arts Departments in teacher training institutions throughout the country. Twenty-two replies were received from shop teachers located in Illinois, Washington, D. C., New York, Indiana, New Jersey, Iowa, and Massachusetts. The combined replies represent a total of sixteen states which give a good cross section of the Art Metalwork being done throughout the country.

CHAPTER III

ANALYSIS OF THE RESULTS OF THE QUESTIONNAIRE

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Selection of Manipulative Learning Units by Teacher Trainers --
The teacher trainers in the Industrial Arts Departments of teacher training institutions were asked to check the fifteen manipulative learning units which they considered most important to be taught in Art Metalwork on the Junior High School level. The results of this selection are shown in Table I.

An analysis of the results shown in Table I indicates a noticeable unanimity in regard to the elementary fundamentals to be taught inasmuch approximately one-third of the units received unanimous approval. Developing and transferring patterns and designs, cutting metal, sawing with the jewelers saw for both outside cuts and piercing, filing to shape and filing burrs, soldering, and finishing were the units receiving 100% approval. Centerpunching and drilling, riveting, and annealing received approval in 90% of the replies which indicates a high ranking of importance for these units. Bending and seaming, planishing, and peining, using both the ball and cross peining hammers, and beating into molds using hammers and mallets received 80% of the checks. Chasing and etching received 70% of the checks. At this point, there appears a natural break with the remaining units receiving 50% approval or less. These units and the per cent checks received are embossing or repousse 50%, raising with stakes 40%, spinning 40%, dapping and engraving 30% each, and fluting received no checks at all. Other units suggested were foundry 10% and methods of holding material 10%. It is significant that fluting received no checks. This unit was suggested in a number of the books surveyed in obtaining the original list

TABLE I

Manipulative Learning Units Selected by the Teacher Trainers

Per cent	Manipulative Units
100	1. Developing and transferring patterns and designs.
100	2. Cutting metal
100	3. Sawing with jewelers saw -- outside cuts and piercing
100	4. Filing to shape and burrs
90	5. Centerpunching and drilling
80	6. Bending and seaming
90	7. Riveting and seaming
100	8. Soldering
80	9. Planishing
80	10. Peining -- ball and cross peining
80	11. Beating into mold -- hammer and mallet
40	12. Raising with stakes
90	13. Annealing
70	14. Chasing
50	15. Embossing or repousse
30	16. Dapping
30	17. Engraving
70	18. Etching
0	19. Fluting
40	20. Spinning
100	21. Finishing

TABLE I (Continued)

Per cent	Manipulative Units
	22. What other units do you recommend?
10	Foundry
10	Methods of holding material

of manipulative units.

Teacher Trainers' Recommendations for Manipulative Units --
In order to determine the most important manipulative learning units, the fifteen units receiving the highest number of checks are shown in Table II.

From Table II it may be noted that these units cover a well balanced distribution of the fundamentals processes, more advanced processes, and modes of decoration. The development of the patterns and designs, the cutting to shape, both straight and irregular cutting, finishing by filing to shape and smoothing burrs cover the fundamental processes of getting out the stock. Centerpunching and drilling prepares for riveting, bending and seaming, and then soldering develops the project into shape. Decorative treatment of the metal is given by the planishing, peining, chasing, and etching units. Annealing is a necessary process to soften the metal after beating into the mold with the hammer and mallet, so this process follows in logical order. The unit on finishing is necessary in order to complete a project to best advantage. It is of value to note that each unit received at least 70%

TABLE II
Manipulative Learning Units Recommended by the Teacher Trainers

Per cent	Manipulative Units
100	1. Developing and transferring patterns and designs
100	2. Cutting metal
100	3. Sawing with jewelers saw -- outside cuts and piercing
100	4. Filing to shape and burrs
100	5. Soldering
100	6. Finishing
90	7. Centerpunching and drilling
90	8. Riveting
90	9. Annealing
80	10. Bending and seaming
80	11. Planishing
80	12. Peining -- ball and cross peining
80	13. Beating into mold -- hammer and mallet
70	14. Chasing
70	15. Etching

of the checks which shows the importance attached to each one of these units.

Selection of Four Most Suitable Metals by Teacher Trainers --
In order to determine which metals are most suitable to use in Art Metalwork, the teacher trainers were asked to check

the four metals they considered most important to use. Seven metals were suggested and they were asked to recommend any other metals they considered important.

Table III shows the metals selected and the percentage of checks each received.

TABLE III
Most Suitable Metals Selected by the Teacher Trainers

Per cent	Kinds of Metal
40	1. Aluminum
70	2. Brass
100	3. Copper
10	4. Gar-alloy
60	5. Nickel silver
90	6. Pewter
40	7. Silver
	8. What other metal do you recommend?
10	Tin
10	Wrot Iron

The selections made by the teacher trainers of the most suitable metals shows a wide range of choice. Copper was checked by 100% while gar-alloy received only 10% of the checks. Gar-alloy, being a formula of the Brodhead-Garrett Co., distributors of Industrial Arts supplies, may not be considered a standard metal and therefore this could account

for the low rating it received. In between these choices came pewter with 90%, a surprisingly high score, brass with 70%, nickel silver 60%, and aluminum and silver with 40% each. It is significant that aluminum received only 40% approval. Tin and wrought iron were suggested as added metals to be recommended for use by 10%. As these two metals are usually used in other centers of the General Metal shop, they were not included in the original check list.

The Four Most Suitable Metals Recommended by the Teacher Trainers -- By selecting the four metals receiving the highest percentage of checks, we have the metals considered most suitable for use on the Junior High School level.

Table IV shows the results of these recommendations.

TABLE IV

Four Most Suitable Metals Recommended by the Teacher Trainers

Per cent	Kinds of Metal
100	1. Copper
90	2. Pewter
70	3. Brass
60	4. Nickel silver

From Table IV may be obtained the metals which the teacher trainers feel should be used on the basis of making use of only four metals. There is no doubt of the desirability of using copper with 100% agreement, pewter follows a close second with 90%. A drop occurs at this point and the next

two metals, brass and nickel silver received 70% and 60% checks respectively. There is a natural break at this point from the other metals not recommended. It is surprising that aluminum is not included in this list in the light of its tremendous use industrially and for household uses and also because of the tremendous uses made of it during the war.

Technical and Related Learning Units Checked by Teacher Trainers -- The teacher trainers were asked to check the technical and related learning units which they considered most important. They were asked to check 12 out of the 21 suggested and to add any others they considered important. The results of this selection are shown in Table V.

It is very noticeable in this table that there is a wider distribution of checks and therefore lack of agreement on which units are most important. This does not mean that there is direct conflict in which units should be taught, but rather that there is more choice (12 units out of 21 suggested) and therefore fewer units received unanimous checks than was the case with the manipulative units. Soldering and finishing were the only two units receiving 100% checks. The kinds of files, sizes, shapes and cuts, and the fluxes, kinds and uses received 90% of the checks. Four units, standard gauges, sizes and weights of metal and their costs, kinds and sizes of drills and sharpening, hammers and mallets, weights, shapes, uses and materials, consumer value and judging of finished projects, received 80% of the checks. Four units, information on common metalworking tools, molds and stakes, chasing tools, and etching acids and resists received 70% of

TABLE V

Technical and Related Learning Units Selected by
Teacher Trainers

Per cent	Technical and Related Units
70	1. Names, selection, care and use of the common metalworking tools and equipment
80	2. Standard gauges, sizes and weights of metal and costs
40	3. Sizes of jewelers saw blades
90	4. Kinds of files, sizes, shapes and cuts
80	5. Kinds and sizes of drills--sharpening
60	6. Kinds of rivets, sizes, heads and materials
80	7. Hammers and mallets, weights, shapes, uses, materials
70	8. Molds and stakes, sizes, shapes and uses
100	9. Solders, kinds and uses
90	10. Fluxes, kinds and uses
70	11. Chasing tools, kinds, shapes and uses
30	12. Embossing or repousse hammers and mallets
50	13. Dapping dies and punches, uses
50	14. Engraving tools and uses
70	15. Etching acids and resists
10	16. Fluting, wooden stakes and fluting irons
40	17. Spinning, equipment needed, forms, tools, lubricants
100	18. Finishing, buffing tools and compounds, chemicals

TABLE V (Continued)

Per Cent	Technical and Related Units
20	19. Sandbags and engravers pitch pans
80	20. Consumer value of projects, judging finished projects
30	21. Opportunity for commercial use of skills and knowledge acquired
10	Metals, kind, characteristics, etc.
10	Making equipment for Art Metalwork

the checks. The remaining units received the following percentage of checks, sizes of jewelers saw blades 40%, kinds of rivets, sizes, heads and materials 60%, dapping dies and punches, and engraving tools and uses 50% each, spinning 40%, embossing hammers and mallets, and commercial use of skill and knowledges acquired each received 30%, sandbags and engravers pitch pans 20%, and fluting stakes and irons 10%. Metals, kinds and characteristics, and making equipment for Art Metalwork were suggested units outside of the original list. This list shows a wide distribution of checks but they fall into a pattern following the recommendations for the manipulative learning units which it supplements.

Twelve Most Important Technical and Related Learning Units Recommended by the Teacher Trainers -- The results of the selection of the twelve most important technical and related learning units are shown in Table VI.

In spite of the scattered checks for the various units

TABLE VI
Technical and Related Learning Units Recommended by
Teacher Trainers

Per cent	Technical and Related Units
100	1. Solders, kinds and composition
100	2. Finishing, buffing tools and compounds, chemicals, preserving polishes
90	3. Kinds of files, sizes, shapes and cuts
90	4. Fluxes, kinds and uses
80	5. Standard gauges, sizes and weights of metal and their costs
80	6. Kinds and sizes of drills--sharpening
80	7. Hammers and mallets, weights, shapes, uses, materials
80	8. Consumer value of projects and judging of finished projects
70	9. Names, selection, care and use of the common metalworking tools and equipment
70	10. Molds and stakes, sizes, shapes and uses
70	11. Chasing tools, kinds, shapes and uses
70	12. Etching acids and resists

in the selecting process for the technical and related units, the units recommended as being the twelve most important received 70% approval or better. While soldering and finishing were the only units receiving 100% approval, the other

units fell into groups which showed their importance. Kinds of files, and the fluxes both received 90% of the checks, standard gauges of metal etc., kinds and sizes of drills, hammers and mallets, and consumer value and judging finished projects received 80% of the checks, while name, selection and related information on tools and equipment, kinds of molds and stakes, chasing tools and etching acids information received 70% approval. It is significant to note that the last two manipulative units recommended and the last two technical and related units recommended are the same. This would indicate that the related work is taught parallel to the manipulative work and also that the same percentage of teacher trainers (70%) considered them of equal importance.

Manipulative Learning Units Selected by Shop Teachers -- The choice of the shop teachers in selecting the fifteen most important manipulative learning units are shown in Table VII.

There are five units which received 100% approval of the shop teachers as being necessary units to include in the Art Metalwork. These were developing and transferring patterns and designs, cutting metal, riveting, soldering, and finishing. Filing to shape and filing burrs, centerpunching and drilling, and beating into molds with hammers and mallets each received 95.4% approval. Bending and seaming received 90.9% approval. This means that nine out of fifteen selected units received over 90% approval which is a high degree of agreement. Sawing with the jewelers saw received 86.3% of the checks, etching received 81.8%, planishing and peining 72.7% each, raising

TABLE VII

Manipulative Learning Units Selected by the Shop Teachers

Per cent	Manipulative Units
100	1. Developing and transferring patterns and designs
100	2. Cutting metal
86.3	3. Sawing with jewelers saw, outside cuts and piercing
95.4	4. Filing to shape and burrs
95.4	5. Centerpunching and drilling
90.9	6. Bending and seaming
100	7. Riveting
100	8. Soldering
72.7	9. Planishing
72.7	10. Peining--ball and cross peining
95.4	11. Beating into mold--hammer and mallet
50	12. Raising with stakes
72.7	13. Annealing
35.9	14. Chasing
27.2	15. Embossing or repousse
13.6	16. Dapping
35.9	17. Engraving
81.8	18. Etching
22.7	19. Fluting
35.9	20. Spinning

TABLE VII (Continued)

Per cent	Manipulative Units
100	21. Finishing
	Other units recommended
4.5	Use of wood and metal hammers for different effects
9	Casting
4.5	Jewelry repair

with stakes 50%, chasing, engraving, and spinning received 35.9%, embossing 27.2%, fluting 22.7%, dapping 13.6%. Other units suggested were casting 9%, and use of wood and metal hammers for different effects, and jewelry repair 4.5%.

Recommendations of Shop Teachers for Manipulative Learning Units -- From the selections of the shop teachers of the manipulative learning units they considered most important, the fifteen receiving the highest percentage of checks would indicate the recommendations of the shop teachers. Table VIII shows the units recommended.

From Table VIII it will be noted that one-third of the units received 100% approval. The other units received a high rating of approval also. It will be noted that there is a definite break between the last units in the list. The 12th, 13th, and 14th are tied with 72.7% approval and the 15th unit drops to 50%. This last unit is one which calls for considerable skill and judgment and its ranking in last place of the recommended list might indicate its desirability as an advanced unit only. The recommended list would give a well

TABLE VIII

Manipulative Learning Units Recommended by the Shop Teachers

Per cent	Manipulative Units
100	1. Developing and transferring patterns and designs
100	2. Cutting metal
100	3. Riveting
100	4. Soldering
100	5. Finishing
95.4	6. Filing to shape and burrs
95.4	7. Centerpunching and drilling
95.4	8. Beating into mold--hammer and mallet
90.9	9. Bending and seaming
86.3	10. Sawing with jewelers saw, outside cuts and piercing
81.8	11. Etching
72.7	12. Planishing
72.7	13. Peining--ball and cross peining
72.7	14. Annealing
50	15. Raising--with stakes

rounded experience in Art Metalwork with the layout and cutting units, the forming and fastening units, the beating metal units, the decorative units, and the finishing units all being included.

Selection of the Most Suitable Metals by the Shop Teachers --
The shop teachers were asked to check the four metals they considered most suitable for Art Metalwork in the Junior High School. The results of this selection are shown in Table IX together with the percentage of checks each metal received.

TABLE IX

Most Suitable Metals Selected by the Shop Teachers

Per cent	Kinds of Metal
100	1. Aluminum
54.5	2. Brass
90.9	3. Copper
18.1	4. Gar-alloy
31.8	5. Nickel silver
63.6	6. Pewter
40.9	7. Silver
	Other metals recommended
4.5	Tin
4.5	Nu-gold

As a result of the selection of the most suitable metals to use in Junior High School, it is evident that all of the metals listed are used to some extent. Aluminum with 100% and copper with 90.9% checks are definitely most popular with the shop teachers. Pewter and brass show quite a drop in percentage of checks compared with aluminum and copper, with pewter receiving 63.6% checks and brass receiving 54.5% of the checks. The percentages of the other metals checked are

silver, 40.9%, nickel silver 31.8%, and gar-alloy 18.1%. Two other metals suggested were tin and nu-gold. Tin is a metal commonly used in the Sheet Metal center and therefore was not included in this list. Nu-gold is a novelty metal, which, although interesting as such, does not have a very wide recognition. Gar-alloy, not being a standard metal but an alloy of the Brodhead-Garrett Co., did not receive a very high rating.

Recommendations of Shop Teachers for Four Most Suitable Metals--
By considering the metals receiving the four highest percentages as the recommendations of the shop teachers, these recommendations are shown in Table X.

TABLE X

Four Most Suitable Metals Recommended by the Shop Teachers

Per cent	Kinds of Metal
100	1. Aluminum
90.9	2. Copper
63.6	3. Pewter
54.4	4. Brass

This table readily shows the popularity of aluminum and copper by the percentage of checks each received. Pewter and brass, the next two metals recommended, show a considerable drop in percentage of checks, but still rank over 50% approval. These four metals comprise the most suitable metals recommended by the shop teachers.

TABLE XI

Technical and Related Learning Units Selected by the Shop Teachers

Per cent	Technical and Related Units
100	1. Names, selection, care and use of the common metalworking tools and equipment
95.4	2. Standard gauges, sizes and weights of metal and their costs
31.8	3. Sizes of jewelers saw blades
90.9	4. Kinds of files, sizes, shapes and cuts
86.3	5. Kinds and sizes of drills--sharpening
77.1	6. Kinds of rivets, sizes, heads and material
81.8	7. Hammers and mallets, weights, shapes, uses and materials
90.9	8. Molds and stakes, sizes, shapes and uses
95.4	9. Solders, kinds and composition
95.4	10. Fluxes, kinds and uses
18.1	11. Chasing tools, kinds, shapes and uses
9.0	12. Embossing or repousse hammers and mallets
4.5	13. Dapping dies and punches, uses
18.1	14. Engraving tools and uses
63.6	15. Etching acids and resists
9.0	16. Fluting, wooden stakes and fluting irons

TABLE XI (Continued)

Per cent	Technical and Related Units
27.2	17. Spinning, equipment needed, forms, tools, lubricants, speeds
90.9	18. Finishing, buffing tools and compounds, chemicals, preserving polishes
9.0	19. Sandbags and engravers pitch pans
72.7	20. Consumer value of projects and judging of finished projects
50	21. Opportunity for commercial use of skills and knowledges acquired
	Other Units Recommended
4.5	Information concerning metals used
4.5	Casting materials

Selection of Technical and Related Learning Units by the Shop Teachers -- The shop teachers were asked to select the twelve units which they considered most important. The results of this selection are shown in Table XI.

In Table XI it will be noticed that there is less unanimity than in some of the previous tables. There are fewer units which have the same percentage of approval. The first unit, that on the common tools and equipment, is the only one to receive unanimous approval. Standard gauges of metal, etc., solders, and fluxes were second in percentage of approval

with 95.4%. The units on files, various kinds of molds and stakes, and the finishing units ranked third with 90.9% approval. The unit on drills received 86.3% approval, hammers and mallets 81.8%, kinds of rivets, etc. 77.1%, consumer values, 72.7% and etching acids and resists 63.6%. There is a break to the next unit on opportunities for commercial use of skills to 50%, but the break is even more pronounced to the remaining units. Sizes of jewelers saw blades received only 31.8% approval, spinning unit 27.2%, chasing tools and engraving tools 18.1% each, embossing hammers and sandbags and engravers pitch pans 9% each, and dapping dies and punches 4.5% which is the lowest on the list. Two units were added by the shop teachers for consideration, information concerning metals used and casting materials.

Recommendations of Shop Teachers for Twelve Most Important Technical and Related Learning Units -- From the selection of technical and related learning units made by the shop teachers, the twelve units with the highest percentage of approval were considered to be the recommendations of the shop teachers. These units are shown in Table XII.

Table XII gives the recommendations of the shop teachers for the technical and related learning units which should be taught in the Junior High School as related content material for the manipulative learning units recommended. From this table it may be seen that over half of the units received at least 90% approval while the other half went down to as low as 63.6%. In the upper half the units were grouped, while the lower half consisted of scattered approval. The unit on tools

TABLE XII

Technical and Related Learning Units Recommended by the Shop Teachers

Per cent	Technical and Related Learning Units
100	1. Names, selection, care and use of the common metalworking tools and equipment
95.4	2. Standard gauges, sizes and weights of metal and their costs
95.4	3. Solders, kinds and composition
95.4	4. Fluxes, kinds and uses
90.9	5. Kinds of files, sizes, shapes and cuts
90.9	6. Molds and stakes, sizes, shapes and uses
90.9	7. Finishing, buffing tools and compounds, chemicals, preserving polishes
86.3	8. Kinds and sizes of drills--sharpening
81.8	9. Hammers and mallets, weights, shapes, uses and materials
77.1	10. Kinds of rivets, sizes, heads and materials
72.7	11. Consumer value of projects and judging of finished projects
63.6	12. Etching acids and resists

received 100% approval, gauges of metals, solders, and fluxes were grouped for 95.4% approval. Kinds of files, molds and

stakes, and the finishing units were grouped for 90.9% approval. Kinds and sizes of drills, information on hammers and mallets, kinds of rivets, consumer values, and etching acids and resists complete the approved units with scatter percentages of approval. These information units parallel quite closely the manipulative learning units approved which would indicate that related information should be taught with the manipulative units. It is significant to note that the unit on consumer values is included in the approved list, although the unit on vocational implications is not on the approved list. This unit, however, received 50% approval and was next on the list in percentage of approval. This would indicate considerable doubt whether to include the vocational implications or not.

Combined Recommendations of the Teacher Trainers and Shop Teachers for the Manipulative Learning Units -- The number of checks of the teacher trainers and the shop teachers were added together to find the percentage for each unit. The fifteen units receiving the highest percentage ratings were considered to be the recommendations of the teacher trainers and the shop teachers. The results of these recommendations are shown in Table XIII.

From Table XIII it may be seen that there is substantial agreement on what manipulative units should be taught in the Junior High School Art Metal course. All units received at least 75% approval except in the 15th unit where a tie took place and so both units were included in the table. These last two units dropped down to 46.6 approval which makes a decided break. The reason for this is the difference of

TABLE XIII

Combined Recommendations of the Teacher Trainers and the Shop Teachers for the Manipulative Learning Units

Per cent	Manipulative Learning Units
100	1. Developing and transferring patterns and designs
100	2. Cutting metal
100	3. Soldering
100	4. Finishing
96.8	5. Riveting
93.7	6. Filing to shape and burrs
93.7	7. Centerpunching and drilling
90.6	8. Sawing with jewelers saw--outside cuts and piercing
90.6	9. Beating into mold--hammer and mallet
87.5	10. Bending and seaming
78.1	11. Etching
78.1	12. Annealing
75	13. Planishing
75	14. Peining--ball and cross peining
46.6	15. Raising with stakes
46.6	16. Chasing

opinion between the teacher trainers and the shop teachers in the last unit to recommend. In both cases, these units were last on the recommended list. The teacher trainers

approved chasing and the shop teachers did not. The shop teachers approved raising with stakes and the teacher trainers did not. This caused the decided break in the approval percentages for these units on chasing and raising with stakes.

These recommendations by the teacher trainers and the shop teachers may be considered the basic content material for the manipulative learning units to be taught in the Junior High School. That this may cover more ground than can be taught in some shops may readily be assumed. Each teacher will naturally select the units which will fit the local conditions, but as was brought out in the Selvidge study, a list of learning units set up on this basis "is intended to be used as source material from which selections are to be made to fit the requirements of the particular teaching situation. It appears, therefore, that the list of units in any subject may be incomplete from the standpoint of an exhaustive analysis of the related trade or industry, and still complete enough for the use of the school shop teacher; or, on the other hand, the list may be entirely too comprehensive, from the standpoint of the teacher who is concerned only with the first semester beginning students, and still practically useful as a source from which to select what is needed." (1)

(1) Selvidge, Robert W., Standards of Attainment in Industrial Arts Teaching, American Vocational Association, 1931, p. 15.

Combined Recommendations of the Teacher Trainers and Shop Teachers for the Four Most Suitable Metals -- The combined preferences of the most suitable metals to use of the teacher trainers and the shop teachers were used to obtain the recommendations for the four most suitable metals to use. The results are shown in Table XIV.

TABLE XIV

Recommendations of the Teacher Trainers and the Shop Teachers for the Four Most Suitable Metals

Per cent	Most Suitable Metals
93.7	1. Copper
81.2	2. Aluminum
71.8	3. Pewter
59.3	4. Brass

This table shows that copper is easily the favorite metal to use. That aluminum has no higher approval than 81.2% is surprising because of the fact that there were four selections to be made of only seven metals suggested. Its wide use industrially would suggest a higher rating than this. Aluminum did receive a high rating from the shop teachers (100%) but the teacher trainers rated it only 40%. The two groups show more disagreement over this one item than over any unit in either the manipulative or technical and related units. The teacher trainers rated pewter highly with a score of 90% while the shop teachers rated it at 63.6%. The combined report rated it 71.8%. Brass was rated at 70% by the teacher trainers and only 54.5% by the shop teachers. The combined report rates it

at 59.3%. Nickel silver was rated fourth by the teacher trainers at 60% but appeared in fifth place of the shop teacher selection with 40.6% rating.

Combined Recommendations of the Teacher Trainers and Shop Teachers for the Technical and Related Learning Units --

Combining the selections of the teacher trainers and those of the shop teachers and taking the twelve highest units resulted in the combined recommendations of the two groups. The results of these recommendations are shown in Table XV.

It is interesting and valuable to note that approximately two-thirds of the teachers answering the questionnaire are in agreement as to which units should be taught. The lowest recommended unit in Table XV is 65.6%. The lowest unit approved by the teacher trainers was 70% and that of the shop teachers 63.6%. Another important fact to note is that the teacher trainers and shop teachers both approve the same units with one exception, and in each case this exception is the last approved unit. The teacher trainers did not include the kinds of rivets etc. in their recommendations. This the shop teachers did. The shop teachers did not include chasing tools etc. in their recommendations which the teacher trainers did. With these exceptions, the two groups are in accord with the technical and related learning units which they recommend be taught in the Junior High School. They do, however, place different emphasis upon each unit recommended as shown by the different percentages in the rating of each unit.

TABLE XV

Technical and Related Learning Units Recommended by
the Teacher Trainers and the Shop Teachers

Per cent	Technical and Related Units
96.8	1. Solders, kinds and compositions
93.7	2. Fluxes, kinds and uses
93.7	3. Finishing, buffing tools and compounds, chemicals, preserving polishes
90.6	4. Names, selection, care and use of the common metalworking tools and equipment
90.6	5. Standard gauges, sizes and weights of metal and their costs
90.6	6. Kinds of files, sizes, shapes and cuts
84.3	7. Kinds and sizes of drills--sharpening
84.3	8. Molds and stakes, sizes, shapes and uses
81.2	9. Hammers and mallets, weights, shapes, uses and materials
75	10. Consumer value of projects and judging of finished projects
71.8	11. Kinds of rivets, sizes, heads and material
65.6	12. Chasing tools, kinds, shapes and uses

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary of the Findings as a Result of the Survey -- In summarizing the finds of this survey, these results are to be noted: there is a very close relationship between the recommendations of the teacher trainers and the recommendations of the shop teachers in the manipulative units considered suitable for use in the Junior High School Art Metal course. Their differences lie chiefly in the advanced units. These differences are primarily in the units which received the scattered checks rather than in the fundamental units to be taught. In the kinds of metals to use for the manipulative work, there was a marked difference of opinion of the value of aluminum as a suitable metal, the shop teachers recommending it 100% and the teacher trainers by only 40%. Both agree on the suitability of copper, both agree on the use of pewter and brass but with varying emphasis, and there is a marked difference of opinion on the value of nickel silver as a suitable metal to use, 60% of the teacher trainers approving it, while only 31.8% of the shop teachers approved it. The teacher trainers and the shop teachers are in quite close agreement as to what should be taught for technical and related units, but here again they vary somewhat in their percentage of approval.

Conclusions in Regard to Manipulative Learning Units -- As a result of the questionnaire on what manipulative learning units SHOULD be taught, the following were recommended by the

teacher trainers and shop teachers as comprising the fifteen basic units to be taught in the Junior High School in grades 7, 8, and 9; (last two were tied and were both included).

1. Developing and transferring patterns and designs
2. Cutting metal
3. Soldering
4. Finishing
5. Riveting
6. Filing to shape and burrs
7. Centerpunching and drilling
8. Sawing with jewelers saw--outside cuts and piercing
9. Beating into mold--hammer and mallet
10. Bending and seaming
11. Etching
12. Annealing
13. Planishing
14. Peining--ball and cross peining
15. Raising with stakes
16. Chasing

Conclusions in Regard to Four Most Suitable Metals-- As a

result of the questionnaire on which four metals were the most suitable to use on the Junior High School Level, the following were recommended by the teacher trainers and the shop teachers

in the given order:

1. Copper
2. Aluminum
3. Pewter
4. Brass

Conclusions in Regard to Technical and Related Learning Units--

As a result of the questionnaire on what technical and related learning units SHOULD be taught, the following were recommended by the teacher trainers and shop teachers as comprising the twelve basic units to be taught in the Junior High School in grades 7, 8, and 9:

1. Solders, kinds and compositions
2. Fluxes, kinds and uses
3. Finishing, buffing tools and compounds, chemicals, preserving polishes
4. Names, selection, care and use of the common metal-working tools and equipment
5. Standard gauges, sizes and weights of metal and their costs
6. Kinds of files, sizes, shapes and cuts
7. Kinds and sizes of drills--sharpening
8. Molds and stakes, sizes, shapes and uses
9. Hammers and stakes, sizes, shapes and uses
10. Consumer value of projects and judging of finished projects
11. Kinds of rivets, sizes, heads and material
12. Chasing tools, kinds, shapes and uses

Limitations of this Study--While the sampling of replies to the questionnaire was not large, the discrimination with which the mailing list was composed helped to make up for this lack of numbers. The sampling covered a large number of states and all of the teachers have had considerable experience. A broader sampling of numbers would aid to verify the findings.

Suggestions for Further Study -- In the assumptions made for this study, mention was made that "no time element need be considered in covering either the manipulative learning units or the technical or related work." This was done because of the great variation of time devoted to Industrial Arts work. A study of how much time is devoted to this work with suggestions for developing some time standards would be valuable. Budgetary allotments for supplies, new equipment, and replacements vary widely with no suggested standards to aid in determining a fair amount based upon the number of pupils and the type of shop and program. A study along these lines would be helpful to many in making a comparison of their allowances with some standard. A study of visual aids in carrying out a course in Art Metalwork would help to put across a maximum of content material in a minimum of time and to do it more efficiently. Any of these suggested studies would be helpful to a large number of Industrial Arts teachers.

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APPENDIX

Warren Junior High School
West Newton 65, Mass.

Dear Colleague:

I am writing to ask your professional co-operation in filling out the enclosed survey to aid me in collecting data for a Master's thesis which is entitled "A Study of Content Material for Art Metalwork in the Junior High School."

In order to have a common ground for evaluating the questions and to make this survey as comprehensive as possible, certain assumptions are made. These are:

1. No time element need be considered in covering either the manipulative learning units or the technical or related work.
2. Cost of materials and equipment need not be considered for our purposes.
3. Assume that none of this work is taught in any other area of your Industrial Arts program.
4. Consider what you recommend SHOULD be taught rather than what you are now teaching. (The time element and cost of materials and equipment certainly limit us now!)

Enclosed is a stamped self-addressed envelope for your convenience. I want to express my appreciation and thanks for your co-operation.

Yours very truly,

SURVEY OF LEARNING UNITS FOR ART METALWORK

(Check in the circle the 15 units you consider most important)

1. Developing and transferring patterns and designs ()
2. Cutting metal ()
3. Sawing with jeweler's saw -- outside cuts and piercing ()
4. Filing to shape and burrs ()
5. Centerpunching and drilling ()
6. Bending and seaming ()
7. Riveting ()
8. Soldering ()
9. Planishing ()
10. Peining--ball and cross peining ()
11. Beating into mold--hammer and mallet ()
12. Raising--with stakes ()
13. Annealing ()
14. Chasing ()
15. Embossing or repousse ()
16. Dapping ()
17. Engraving ()
18. Etching ()
19. Fluting ()
20. Spinning ()
21. Finishing ()

What other units do you recommend? _____

Signature _____

SURVEY OF METALS RECOMMENDED

What metals do you recommend for Art Metalwork? (when available)
(Check in the circle the 4 metals you consider most suitable)

- | | | | |
|--------------|-----|---------------------------------------|-----|
| 1. Aluminum | () | 5. Nickel silver | () |
| 2. Brass | () | 6. Pewter | () |
| 3. Copper | () | 7. Silver | () |
| 4. Gar-alloy | () | 8. What other metal do you recommend? | |

SURVEY OF TECHNICAL AND RELATED UNITS

(Check the 12 learning units you consider most important)

1. Names, selection, care and use of the common metalworking tools and equipment
2. Standard gauges, sizes and weights of metal and their costs
3. Sizes of jewelers saw blades
4. Kinds of files, sizes, shapes and cuts
5. Kinds and sizes of drills--sharpening
6. Kinds of rivets, sizes, heads and material
7. Hammers and mallets, weights, shapes, uses and materials
8. Molds and stakes, sizes, shapes and uses
9. Solders, kinds and composition
10. Fluxes, kinds and uses
11. Chasing tools, kinds, shapes and uses
12. Embossing or repousse hammers and mallets
13. Dapping dies and punches, uses
14. Engraving tools and uses
15. Etching acids and resists
16. Fluting, wooden stakes and fluting irons
17. Spinning, equipment needed, forms, tools, lubricants, speeds

18. Finishing, buffing tools and compounds, chemicals, preserving polishes
19. Sandbags and engravers pitch pans
20. Consumer value of projects and judging of finished projects
21. Opportunity for commercial use of skills and knowledges acquired

What other units do you recommend? _____

Approved by:

Albert W. Purvis

Date

May, 1946

