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Scope of Study: This report includes a history of industrial education and of copper enameling. A questionnaire was prepared by the writer and mailed to the heads of the industrial arts departments of selected schools across the country asking for information as to how they included copper enameling in their programs; what materials did they use; how many different enamel colors were used; what mesh size; what techniques were taught in their classes; and how successful had enameling been in their cases. The results of this survey are given by the use of tables with explanations given for each table. A suggested course of study is presented along with a list of suppliers and supplies for copper enameling.

Findings and Conclusions: Copper enameling, while suitable for inclusion in a general shop program, has not had wide acceptance by industrial arts teachers at the present time. The equipment used as reported in the survey has ranged from the minimum required to some of the most elaborately equipped shops in the schools. When offered, copper enameling has been successful. Copper enameling as an area in the general shop has only been offered for a few years. Enameling at the present time is offered either by the industrial arts department or the art department. Copper is the base metal most frequently used, while silver, brass and a little steel were reported. A course of study has been suggested and included to serve as a guide for teachers formulating a course to suit their own particular needs and students.

ADVISER'S APPROVAL John B. Tate

COPPER ENAMELING: ITS SUITABILITY FOR INCLUSION IN A GENERAL SHOP PROGRAM

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By

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The objectives of industrial arts education have changed through the years as have the objectives of general education. The term manual arts connoted the training of manipulative skills and the teaching of principles of art. Industrial arts also contains these two phases, but its scope is much greater. It includes a study of the materials, processes, and products of industry. This type of study is important if the student's education is to be complete because modern industry plays a significant part in everyone's life. In the relatively recent time since enameling has become a manufacturing process it has rapidly spread throughout industry until today it is found in such fields as housing, appliances, advertising and decorative articles.

As one of the subjects in industrial arts, enameling would not be taught as it is taught in art classes or in technical classes in educational institutions. An aim in this course is to give the pupils a wide variety of experiences and to avoid great detail or complicated technical information. It is designed to acquaint the student with a basic fundamental knowledge of enameling, its use in industry and the possibilities of enameling as an advocational pursuit for the individual and in this respect to acquaint him with the tools, equipment, and materials related to enameling as an advocational pursuit.

There is a necessity, however, in studying enough of the theory involved in enameling to insure good workmanship. One must understand

the effects of heat, first upon the selection of the metal to be enameled, and second, how the effect of heat is shown in the expansion and contraction of enameled pieces during firing and while cooling. In every situation, the student should know why certain things are done in order to improve his techniques and to insure utmost safety.

Part A

Selection of the Problem

Although enameling as an art is hundreds of years old it has only recently been used in the United States as a manufacturing process with widespread application. The average American citizen does not recognize or appreciate the benefits that this increasing use of enamels means to him. Well planned activities in an enameling course can stimulate an interest in and develop an understanding of enameled materials, their care and use. A course of this type not only increases the pupil's appreciation of enameling but also offers him a possible hobby.

Purpose of the Study. This study was made for the purpose of obtaining information pertaining to the extent that enameling is being taught in our schools today and to plan in a limited way the procedures to be used in teaching a course in enameling applicable to the general shop. Teachers of industrial arts have not, as yet, organized any materials on this subject to utilize in teaching an enameling course.

Available Literature. A survey of the literature discloses that there is a dearth of material pertaining to enameling. Very few books of any kind that are devoted to enameling are available and of the books that devoted only a portion of their contents to enameling, the majority

are either out of date or so inadequate as to be totally useless. Further searching has turned up a limited number of booklets that are suitable for use in an enameling course. In organizing the material in this report, it was necessary for the writer to refer to many incomplete and fragmentary sources for the background material on enameling, both historical and practical. For the material needed to prepare the history of industrial education, no such problems were encountered although the books available were somewhat dated with there being no really modern and up-to-date sources for such material. It is hoped that the material presented in this report will be of value to industrial arts teachers.

Research Techniques. Two types of research were employed in this report. The normative survey was used to develop the chapter on history of industrial education and it was also used in portions of other chapters. The questionnaire technique was used to gather all of the information from the various schools contacted which was used as the basis for the tables and content of Chapter III. From these, conclusions were formed by the writer and entered into the report.

Related Information. The enameling course should include a wholesome amount of related information. Safety can be emphasized through visual aids, class discussions, and safety literature. Posters illustrating good safety habits while working can be displayed in the shop.

Connected with safety is the care of shop equipment. If the students know the correct way to take care of equipment, there will be fewer accidents. The student must recognize the need for tools in the construction of his project. When he recognizes the need, he will be

willing to accept his responsibility in the maintenance of the shop equipment.

Important to a basic understanding of enameling is the knowledge of the various materials used and the cost of these materials. The student should also be instructed as to where he may purchase the necessary supplies if he should desire them for his own use.

Part B

Definition of Terms Used

To assure a better understanding of the material presented in this report, it is necessary that certain terms be defined. These definitions selected from various sources are:

> Industrial Arts. Those phases of general education which deal with industry. . . its organization, materials, occupations, processes, and products and with the problems resulting from the industrial and technological nature of society. (29, page 2)

> General Education. . . . may be summed up as implying three basic purposes: (1) to transmit a way of life, (2) to improve and reconstruct that way of life, (3) to meet the needs of individuals. (29, page 3)

> General Shop. Shops that are planned and equipped to teach two or more distinct types of shopwork at the same time under one teacher are general shops. (17, page 5)

> Enamel. A vitreous composition, usually opaque, for coating the surface of metal, glass, or pottery, for ornament, protection, or as a basis for decoration. (48, page 270)

> Kiln. An electric or gas muffled furnace used for firing enamels. (4, page 199)

> Counterenamel. Enamel used on the reverse side of a piece to relieve the tension of the expansion and contraction of the enamel on the right side. (4, page 199)

Basse-taille. A type of enameling making use of transparent enamels fired over a carved or chased metal surface. (4, page 199)

Champleve. A type of enameling making use of transparent or opaque enamels fired into etched or carved areas, leaving the metal partly exposed. (4, page 199)

Cloisonne. A type of enameling in which each color is separated by thin metal ribbons or wires. (4, page 199)

Flux. A clear enamel with no oxide of metal for coloring. (4, page 199)

Gum Tragacanth. A gum from Asiatic trees which is applied in a water solution as a binder for enamels. (4, page 199)

Opaque Enamels. Enamels which cover the metal densely when brought to the fusing point. (4, page 200)

Plique a jour. A type of enameling making use of transparent enamels suspended in small openings in metal, giving the appearance of stained-glass windows. (4, page 200)

Sgraffito. A technique in enameling whereby a linear motif is produced by scratching through one enamel revealing a different colored ground. (4, page 200)

Transparent Enamel. Enamel which allows the color of the metal to be seen through it when fused. (4, page 201)

Part C

Brief History of Enameling

Enameling is another of the many areas in industrial arts that is new in that it has only recently been introduced into the industrial arts curriculum. In reality it is among the oldest of our many industries and today is enjoying a revival in interest and application in our everyday life.

Early History. Among the first known examples of enamel work are those of the fifth century B.C. Greeks who utilized enameled gold inlays

on their sculpture of that period. One example of their work is the enameled figures and flowers on the gold drapery of the Phidias statue of Zeus. Later during the fourth century B.C., the Greek goldsmiths used a thin coating of pale blue or white enamel between slightly raised outlines of gold wire to form inlaid flowers and other small designs. This process, known as cloisonne, therefore must be considered as the forerunner of all other enameling processes.

The Celts of the British Isle during the third century A.D. were the next to have done any extensive work with enameling, as is recorded by many articles of enamel used as decorations on shields and swords. The method of pouring molten enamel into sunken or gouged areas in the metal is known as champleve enamel and represents the next development in enameling techniques. Sometime during the ninth century, enameling spread from the British Isles to Byzantium where it flourished until the eleventh century. Here again the cloisonne type of enameling done on beaten gold became prevalent. During this time enamels were used as decorations for many objects for the church which was the dominating element of the time.

From Byzantium the spread of enameling is easily traced to Germany, being brought by Princess Theophano when she married Otto II of that country. Having been spread from town to town by the artist and craftsmen of the time, enameling next spread to France where shortly before 1500 A.D. the next change in enameling developed and flourished in the town of Limoges. Limoges enameling is the technique of painting with enamels on the surface of metal.

While enameling was spreading over Europe, it was also developing in Asia, particularly in China where it was introduced during the

thirteenth century. Russia was the scene of the next development in enameling techniques. Here was developed what is known today as plique-a-jour. This technique produces what is known as backless enamel in which the light can pass completely through the enameled piece. With the coming of the industrial revolution came the end of handcraft in enameling and the beginning of the many mass produced items we have today.

Enameling Today. Enameling today is no longer a handcraft as in the earlier times but has been mechanized and subjected to scientific studies to determine the best and most efficient ways of production and the best formulas for enamels for different purposes. Today enamels not only are used for decorative purposes, but also are used on cooking utensils, bathtubs, sinks, stoves and other household appliances, sanitary ware, hygienic implements, chemical apparatus, hospital and other medical appliances, signs and billboard displays, and many other items. The equipment used in the enameling industry today is much the same as when the industry was just established, but being greatly improved in speed and efficiency. The pieces to be enameled are dipped into tanks containing the enamel in a liquid form or the enamel is sprayed on them. Then they are placed on a conveyor belt that carries them through a furnace where they are heated to the fusing point of the enamels used. By the choice of the proper enamel formula, the enameled pieces can be given any of a great number of colors, made resistant to acids and other chemicals, and will stand up to a great deal of abuse while still serving the original purpose.

In this chapter it has been the writer's purpose to place before the reader explanations of various elements with which the reader should be familiar so that a clear understanding can be had of the main content of this report.

In the following chapter a brief history of industrial education will be presented for the purpose of giving the reader an understanding of its background. Reference will be made to the contributions that past leaders have made to the development of industrial arts and to the current situation in industrial arts.

CHAPTER II

HISTORY OF INDUSTRIAL EDUCATION

A realization of the fact that skill of hand is an advantage to its possessor goes back to the time when primative man taught his son all the skills and crafts that had been passed on to him or that he had learned from his own experiences, and when the exceptionally skilled worker was regarded as possessing superhuman power. (6, page 11) From that beginning much progress has been made in the field of industrial education until today we find it a highly organized field of instruction. Industrial education in some form was already included in the schools of Europe before the independence of the United States. American programs of vocational education were patterned after those of Europe. Since the passage of the Smith-Hughes Act in 1917, the industrial education program in the United States has been divided into the fields of industrial arts education and vocational industrial education.

Part A

Early History

Much of the early industrial education in Europe was connected with the home. The early church did much to influence the development of industrial education. Many of the systems of industrial education in Europe were advocated as a part of a general education program. Two significant influences affecting the establishment of industrial training in the United States were the Russian system and the Swedish Sloyd system.

In Antiquity -- Beginnings. The savage people were driven by their needs to seek food, clothing and shelter for themselves and their families. To them, skill of hand was more valuable than brute force in protecting their families and in securing food. In his efforts to protect his family and to secure for them the needed food and shelter, the savage learned the use of tools and methods and their manufacture from wood, stone, clay, bone, fiber and hides. Having learned how to provide himself with tools and means to secure food and protect his family, the savage man passed his knowledge on to his son, not by means of a school but by imitation, unconscious imitation. Having seen his father do something one way the son did it the same way.

Barbarism. When savage man learned to control the power of fire, he passed from savagery to barbarism. With this came the development of definite trades such as mining, smithing, masonry, carpentry and weaving. (6, page 12) But even in the higher civilizations such as ancient Egypt there developed no theory or system of teaching their arts except by means of conscious imitation. Models were made by the master and were copied over and over until the pupil could reproduce them without errors.

Influence of the Church. Next to instruction in the law for the ancient Jew was instruction in some trade or vocation. The custom was for the child to attend school in the morning to learn the law and to remain at home in the afternoon to learn his father's trade.

> As it is your duty to teach your son the Law, teach him a trade. He who does not have his son taught a trade prepares him to be a robber. (6, page 15)

As an outstanding example of the influence of the church on the early development of industrial education, one can point to the order of the Benedictines. From their manuscript reproduction was developed the art of book-making. To Cassiodorus (468-560), an Italian statesman and historian who became a monk in 538, goes much of the credit for developing the art of book-making to its highest achievement. In 920, the famous monastary of Cluny was established which was "the founder of a great school of building from which grew in the next century thousands of churches". (6, page 20) With its prescribed hours for labor, for reading, for worship, for rest; with its discipline and complete subjection to the will of an abbot, a monastary was a school as well as a retreat and a shrine. Thus the monasteries came to be the schools for teaching and the place of professional training. As the monasteries became centers of intellectual life, they became centers of instruction for boys, both those who came to enter a monastic life and those who came merely to be educated and protected. (6, page 21)

The Middle Ages. The chief means of industrial education during the middle ages was the apprenticeship system whereby a boy was bonded to a master craftsman for a period of years, usually seven. During this period the boy was to live with the master and was to be taught his master's craft. Part of his training was to be taught how to read and write. Most masters did teach the boys something of both. Many, however, did not and with the coming of the industrial revolution the apprenticeship system came into disfavor and died out. With the passing of the apprenticeship period, men began to seek something to take its place. In seeking a substitute, they looked to the schools for assistance.

Francois Rabelais, in his book Gargantus, proposed a new system of education in which the interest of the pupil in the world around him is cultivated by means of visits to various industries.

> To see the drawing of metals, or the casting of great ordnance, how the lapidaries did work, as also the goldsmiths and cutters of precious stone. . . to visit the alchymists, money-coiners, upholsterers, weavers, velvet-workers, watchmakers, looking-glass framers, printers, organists and other such kind of artificers. (1, page 8)

With Rabelais such familiarization of the pupil with industry was thought to have value educationally, whether the objectives were vocational or avocational.

Sir Thomas More, in his Utopia, suggested the combination of industrial training with common school education and thus was among the first to present any educational ideas that bear any resemblance to the industrial arts of today. (1, page 6)

Others, particularly Johann Amos Comenius, John Locke, and Johann Bernard Basedow believed that a part of each child's education should be devoted to instruction in the arts and crafts or to manual labor. Not for its vocational values, but for the fuller appreciation of the problems of life, the acquisition of industrious habits, for vocational guidance in later life and the avocational values that could be derived from such a study.

Rousseau, whose works have often been blamed for the French Revolution, also created an upheaval in educational thinking with his book Emile, in which he advocated the use of nature study and the manual arts to replace textbooks until such time as the pupil had real use for them. "The great secret of education is, to make the exercises of the body and the mind serve as relaxation to each other." (6, page 80)

Johann Heinrich Pestalozzi, who is today called the "father of manual training", was not the father in the sense that he organized handwork as a part of general school work, nor did he first state certain principles of handwork instruction in a rather definite and organized form, but from his many ideas and imperfectly stated principles came forth the foundations of a new method of pedagogy. A method that utilized the manual labor of the child and natural objects as a means of teaching the traditional school subjects. In the teaching of drawing he used an analysis of the subject which broke it down into its simplest forms which then were taught to the pupil in such a way as to build up from one step to the next in a definite order.

The first school that employed specially trained teachers instead of mere artisans as teachers of the manual arts was that of Christian Gotthilf Salzmann at Schnepfenthal, Germany. Salomon of Sweden later cited Salzmann's advice to teachers:

> And since it is unfortunately necessary in order to teach the child, you should yourself be able to fashion something with your hands, you will readily perceive. . . . you who devote yourselves to teaching . . . that you are bound to learn to work with the hands yourselves. . (22, page 66)

The Russian System. In the year 1830 a school of trades and industries was established in the city of Moscow, Russia. This school was later reorganized and became a technical school devoted to the education of engineers. (7, page 15) In addition to theory courses, the student received practical experience in the workshops operated by the school. The workshops were operated much the same way as the private industries of the day, and the student assumed more or less the role of apprentice.

The lack of efficient methods of instruction led to the adoption by Victor Della Vos, the director of the school, of a new system of shops devoted entirely to instruction. (7, page 15) The purpose of the instruction was not to achieve mastery of a trade, but to develop skill in the basic elements of industrial work. (1, page 159) The principles upon which Della Vos founded his system are outlined by Bennett.

1. Each art or distinct type of work has its own separate instruction shop; e.g. joinery, wood turning, blacksmithing, locksmithing, etc.

2. Each shop is equipped with as many working places and sets of tools as there are pupils to receive instruction at one time.

3. The courses of models are arranged according to the increasing difficulty of the exercises involved, and must be given to the pupils in strict succession as arranged.

4. All models are made from drawings. Copies of each drawing are supplied in sufficient number to provide one for each member of the class. The drawings are mounted on cardboard (or, for the blacksmith shop, on wooden boards) and varnished.

5. The drawings are made by the pupils in the class for elementary drawing, under the direction of the teacher of drawing with whom the manager of the shops comes to an agreement concerning the various details.

6. No pupil is allowed to begin a new model until he has acceptably completed the previous model in the course. He must receive at least a grade of three, which is considered good.

7. First exercises will be accepted if dimensions are no more than approximately correct; later exercises should be exactly to dimensions; therefore, the same marks given a student at different periods during his course do not express the absolute, but the relative, qualities of his different pieces of work.

8. Every teacher must have more knowledge of his specialty than is necessary merely to perform the exercises in the course of instruction. He must keep constantly in

> practice so that his work may be an example of perfection to his pupils. Such dexterity increases the authority of the teacher. (7, page 17)

The aims of the Russian system did not parallel those of present day industrial arts courses; the methods of teaching, however, established a system whereby mechanics arts could be introduced into the classroom without recourse to vocational objectives.

The Sloyd System. The term "sloyd" was first used to designate a form of handicrafts practiced during the long winter months by rural families of the Scandinavian countries. The purpose of this type of work was largely economic, the handicraft being performed in such materials as wood, leather, and metal which could easily be worked in the home. (7, page 54) With the advent of power machinery, sloyd was no longer profitable and fell into disuse. In an attempt to rebuild interest in home sloyd, national leaders proposed and established schools for instruction in handicrafts. The objectives of these sloyd schools were similar to sloyd in the home, the pupils making objects which could be sold readily, without regard to the educational value of such objects. Since the products of the school must be marketed, the teacher often assisted the student to the detriment of the educational process. (7, page 56) The value of sloyd as an aid to general education was not overlooked, however, and steps were eventually taken to place this subject upon a sound pedagogical basis.

Educators, using theories previously advanced in Germany and Switzerland, introduced into the public schools of Finland and Sweden what later became known as "Educational Sloyd". (7, page 53) Much of the credit for this educational sloyd movement was due Uno Cygnaeus of

Finland and Otto Salomon of Sweden.

Uno Cygnaeus. In 1858 Cygnaeus was appointed director of elementary education in Finland and commissioned to establish a national system of elementary education. Upon his return from a tour of France, Germany and Switzerland, where he studied the methods used by their educators, (1, page 106) he established a normal school in which to prepare teachers for the new educational system. (7, page 58) The elementary system proposed by Cygnaeus consisted of six years of general education divided into two years in the lower division and four years in the upper division. A nonvocational form of sloyd was offered to all children of school age. It was Cygnaeus' belief that handwork could be effectively used to further general education in the elementary school.

The system of elementary education designed by Cygnaeus was adopted by the Finnish Senate in 1866, making Finland the first nation to adopt handwork as a part of its national education system. (7, page 60) Anderson listed the objectives of the handwork in Finland as: "Develops the spirit of observation, taste, skill and the love of work". (1, page 108)

The Finnish system of sloyd, unlike the Russian system of work, was not based upon any form of scientific analysis, nor were the objectives technical or economic in nature. But they were simply a means of attaining a formal education through a useful foundation in the manual crafts.

Otto Salomon. Beginning his professional career as a teacher in a school operated by his uncle, August Abrahamson, at Naas, Salomon recognized the need for competent sloyd teachers, established courses in

teacher education for skilled craftsmen at the school. In 1874 Salomon was appointed inspector of sloyd schools for the local school district, a position he occupied for several years.

In 1877 he journeyed to Finland where he became acquainted with the work of Uno Cygnaeus, and the Finnish sloyd or manual work in the elementary schools. Being dissatisfied by some of the methods of instruction used, although the principles were in accord with his philosophy, Salomon undertook a scientific study to determine a suitable method of organizing and teaching sloyd in the elementary schools. (7, page 64)

The system as evolved by Salomon became known as "Educational Sloyd". (7, page 63) Salomon proposed a system based on tool exercises and construction principles which, unlike the Russian system, produced articles of beauty and utility. (7, page 65)

In addition, Salomon visit to Finland convinced him that to serve the needs of general education, sloyd teachers must be teachers well versed in educational principles. (22, page ix) To meet this need, Salomon discontinued the education of craftsmen and began to offer short courses in sloyd to ordinary teachers. Before long the complete facilities of the school at Naas were devoted exclusively to teacher education. (9, page x) Salomon outlined in his writings seven important principles of "Educational Sloyd".

1. The concentration on one form of sloyd.
2. The making of useful articles, and not articles of luxury, nor yet of parts of articles, e.g. joints.
3. The teaching based on educational principles, and the work methodically arranged.

4. The instruction to be given by a trained teacher, not by an artisan.

5. Voluntary and individual teaching.

6. Positions to be chosen suitable for physical development.

7. Drawing and Sloyd to be combined. (22, page x)

With the spread of the educational sloyd movement in Sweden went the fame of the training school at Naas and before long teachers from many countries came to study at the school. These teachers introduced the theory of educational sloyd into the school systems of their native lands. (1, page 185) Although educational sloyd illustrated the need for careful organization of shopwork and did much to promote school shopwork for considerations other than economic needs, it was considered to be inadequate by some educators. In its original form, educational sloyd proved to be too formal and lacked the flexibility desired by educators. For this reason when Swedish Sloyd was introduced in other nations, it was usually in a modified form. (1, page 188)

Part B

The Development of Educational Shopwork in the United States

The current system of nonvocational industrial education, industrial arts, in the United States has been evolved from the many early systems of handwork advocated by American and European educators. The early systems can no longer be identified as the result of frequent revisions of aims and subject matter necessitated by a changing dynamic industrial society. The many movements contributing to the acceptance of industrial subjects as a means of general education have not always

been in accord as to methods of teaching and subject matter to be taught. While divergent educational philosophies were responsible for some confusion during the formative period of the industrial arts movement, the final result has been a school subject which is more functional and flexible than its prototype.

Pre-Revolutionary Days. In America prior to the Industrial Revolution and the Revolutionary War, the educational thought and methods of training were the same as those in Europe. The main source of such ideas was England, the mother country to most of our earliest settlers. As early as 1641 the General Court of the Colony of New Plymouth passed an Act adopting the English Poor Law of 1601 to the needs of the Colony. (6, page 268) In 1642 the Massachusetts Bay Colony passed a comprehensive apprenticeship law because there had been:

> great neglect of many parents and masters in training up their children in labor and learning and other employments which may be profitable to the Commonwealth. (6, page 268)

A New Plymouth Order of 1671 required the officials of every town to:

> have a vigilant eye from time to time over their Brethren and Neighbors, to see that all Parents and Masters do duly Endeavor to teach their children and servants as they grow capable, so much learning as through the blessing of God they may attain at least to be able to read the Scriptures, and other profitable Books printed in the English Tongue and the knowledge of the capital Laws . . . And further that all Parents and Masters do breed and bring up their children and apprentices in some honest lawful calling, labour or employment. . . (6, page 268)

With many masters being unable to teach their apprentices to read and write and being under the law required to teach them, the masters were obliged to send their apprentices to persons who could teach them, which in many cases meant sending them to school. So it came about

that elementary schools appeared early in the colonies, and in 1647 the General Court of Massachusetts ordered that every town of fifty householders should appoint one within their number as a school teacher who should be paid either by the parents and masters or "by the inhabitants in general". (6, page 269) With the coming of the Industrial Revolution, the apprenticeship system in America broke down and was discarded as in England and Europe.

Manual Labor Movement. The Manual Labor Movement in America began during the years from 1825 to 1830 and reached its height about 1834. In less than ten years it began to decline as an educational movement, but left a type of work which grew and became permanent. (6, page 182) In early schools where manual labor was advocated, its prime purpose was to assist students to obtain an education. Early American advocates of manual labor saw in it a means of preserving the health of the students and enabling many to secure an education. Reverend Elias Cornelius, whose office was in Boston, became the headquarters for information concerning manual labor schools. In these schools the making of usable and saleable articles seemed to dominate most of the activity spent in the shop. (6, page 183)

Mechanics Institute Movement. The first important institution of this type in America was established in 1820 by the General Society of Mechanics and Tradesmen of New York City. The establishing of this school resulted from the fact that the Public School Society was unable to meet all the needs of the mechanics and tradesmen. This school was in existence for thirty-six years and in 1858 discontinued because of

the general adoption of the free public school system throughout the city. (6, page 318) The most famous of the mechanics institutes in America was the Franklin Institute of Philadelphia, named in honor of Benjamin Franklin. This institute was established in 1824 for the purpose of extending knowledge in mechanical science and the mechanic arts.

Discovery of the Russian System by Runkle. In 1876 the Imperial Technical Schools of Moscow were represented by a number of exhibits at the Centennial Exposition at Philadelphia as they had been at a number of expositions throughout Europe. Dr. John D. Runkle, while at the exposition, was greatly impressed by the Russian exhibit, as they seemed to represent the answer to his problem of a workable system of instruction in the use of tools. Upon his return to his post as President of the Massachusetts Institute of Technology, Dr. Runkle reported his findings to the Board of Directors and advocated not only that the Russian system be used in the school of engineering, but that it also be applied to general education. This discovery by Dr. Runkle and his report to the Board of Directors of the Massachusetts Institute of Technology led to the establishment of the School of Mechanic Arts in the Massachusetts Institute of Technology.

Woodward and the Manual Training School. Dr. Calvin M. Woodward, professor of mathematics and mechanics at Washington University of St. Louis, also saw the Russian exhibit in Philadelphia and believed it would be practical in the schools of the United States. Before the St. Louis Social Science Association, Dr. Woodward delivered an address which led to the establishment of the St. Louis Manual Training High

School. (1, page 62) Woodward's motive behind the establishment of the manual training high school seemed to be training in the use of hand tools for general education. The financial supporters believed that the school should be for the benefit of industry. This school became the model for establishing most of the manual training departments in the high schools of the United States. Visitors to the school were given demonstrations of the work being done and through this influence manual training schools were soon established in most large American cities. (1, page 162) Dr. Woodward promoted a program of training that would start in the kindergarten and continue through the high school.

Dissatisfaction with Manual Training. Soon after the manual training movement began to spread, it was realized that some improvement should be made. In 1884, the first organization for the study and promotion of industrial education was established. This was the Industrial Education Association of New York City. (1, page 167) In 1906, the National Society for the Promotion of Industrial Education was organized at a meeting in the Engineer's Club of New York City. (7, page 517) One of the important pieces of work undertaken by the Society was in connection with vocational-education surveys of cities. The first of these was in Richmond, Virginia, in 1914; the second in Minneapolis, Minnesota, in 1916. (7, page 521) The most outstanding work of the National Society, however, was done in helping to secure the passage of a law providing federal aid for vocational education. (7, page 521)

Part C

The Current Situation

The history of industrial arts since the first World War has, as yet, not been published by any person as was the earlier history of manual and industrial education. As with Bennett's book, History of Manual and Industrial Education, all available books stop in their discussion with the passage of the Smith-Hughes Act of 1917. Any information covering the period since 1917 has to be obtained from articles in various industrial education magazines.

Trends in Industrial Arts. Some trends, problems, concepts and changes that have occurred in industrial arts can be learned by reading and studying articles written in industrial education magazines during the past several decades. Since about 1910, when the writings of James E. Russell and Fredric Bonser were a major influence in changing the name of school shop instruction for general education purposes from manual training to industrial arts, there have been several periods of development.

These periods have been described by William E. Warner, Ohio State University, in an article written in 1939. (85) In this article, Warner divided the period from 1910 to 1939 into a number of tentative categories, which he termed ages of emphasis or trends. The age of skills and handicrafts was first. This period was emphasized by the manual training idea. With the awakening of psychology came an age of standards and tests. In this age work was done by such men as Selvidge, Newkirk and Varnum. The Smith-Hughes Act of 1917 brought an age of light and darkness. The newly established vocational program took away

many of the leaders of industrial arts. The industrial arts program was without leadership and backing from about 1917 to 1933.

The depression of the 1930's was given credit for much of the new interest developed in industrial arts. Emphasis was placed on worthy use of leisure time. Industrial arts was taken into the lower grades of the public schools. This expansion would not have been made possible had not the depression years influenced the marketing of smaller and cheaper machines for the school shop. An age of professional consciousness followed. Warner felt that an era of much confusion prevailed in some states and in certain professional organizations concerning organized sponsorship of vocational education and industrial arts. An age of scholarship followed and emphasis was placed on comparative academic status for the industrial arts teacher. Warner gives the following statistics concerning industrial arts teacher education in the United States:

> One hundred eighty colleges, institutions, and universities are now actively concerned in the training of various types of shop teachers on the baccalaureate level. Master's degrees are now possessed by approximately 1,500 shop teachers in the United States and there must be at least 100 doctorates that have majored in areas of education that relate to the subject. (85)

Warner lists as the last trend in the period just prior to 1939 an age of philosophy and research where more attention is focused toward research and philosophy.

Since 1940, the war years brought a period of emphasis on training an individual for immediate employment in industry. This period was one of temporary duration and only lasted until about 1946. From 1946 to 1950 the heavy enrollment of returning war veterans resulted in

large enrollments in schools of industrial arts. As this boom period began to subside, it was again energized by another influx of returning war veterans, this time returning from the Korean War and again provided with an educational training allowance. When the history of industrial arts for the first half of the twentieth century is published, there is little doubt that much progress will be evident both in methods of teaching and in teacher preparation.

Part D

History of Federal Acts Pertaining to Vocational Education

The federal government has passed a number of acts giving aid to education. Some of these acts contained provisions for aid to vocational education in particular. Most acts giving federal aid to education carry certain control measures governing spending of the funds. The establishment of state agricultural colleges, experiment stations and vocational training programs of less than college level in agriculture, home economics, distributive education and trades were greatly influenced by these federal acts.

Acts Prior to 1918. Prior to the Smith-Hughes Act of 1917 a number of acts were passed giving federal aid to states for practical education. The Morrill Act of 1862 was the first of this series giving aid to practical education. It provided 30,000 acres of land for each state for purposes of establishing agricultural and mechanical colleges. The second Morrill Act of 1890 provided $25,000 annually plus ten $1,000 increments to each state. In 1907 the Nelson amendment to the Morrill Act provided $25,000 annually to each state to be used for

training teachers of agriculture and mechanical arts. The Smith-Lever Act passed in 1914 provided $4,580,000 annually for agriculture and home economics extension services. These funds were allocated on the basis of rural population and were to be matched by the state or local government, or both. Agricultural experiment stations were provided for in the Hatch Act of 1887 and the Adams Act of 1906. The Smith-Sears Act of 1918 provided for rehabilitation training for disabled war veterans.

Passed in 1917, the Smith-Hughes Act was one of the most important bills providing aid to practical education. Promotion of vocational training in home economics, agriculture, and trade and industrial subjects was the aim of this bill. Also provided for in the bill was the training of teachers of vocational subjects. The sum of $500,000 was appropriated for the year ending June 18, 1918, for the purpose of training teachers of agriculture, home economics and industrial subjects. This amount was to be increased to $1,000,000 by 1921 and to remain at that figure thereafter. This money was to be allocated on the basis of the population of states to population of the United States proportionately.

The sum of $500,000 was appropriated for payment of salaries of teachers, supervisors, and directors of vocational agriculture for the year ending June 30, 1918. This amount was to be increased by $250,000 per year until 1926 and to be maintained at $3,000,000 annually thereafter. This money was to be distributed on the basis of proportion of state rural population to United States rural population. The appropriation for vocational trade, home economics and industrial subjects

was the same as for agriculture and was to be distributed on the basis of proportion of state urban population to the urban population of the United States.

To receive benefits under the Smith-Hughes Act, each state must accept by legislative action and the funds must be matched by state or local government or both. Students receiving training under the Smith-Hughes Act had to be fourteen years of age or older. The training given must be less than college level.

Acts from 1918 to 1946. The Smith-Bankhead Act of 1920 provided for rehabilitation of civilians disabled in employment. In 1925 the Purnell Act granted to each state $60,000 annually for agricultural experiment stations. The Capper-Kercher Act of 1928 added an additional sum of $980,000 and $500,000 annually to the Smith-Lever Act of 1914 to be matched by the states. In 1929 the George-Reed Act, a temporary act of five years duration, was passed. It provided $500,000 plus $500,000 annual increments for four years to be divided equally between agriculture and home economics. The George-Ellzie Act of 1934 was another temporary act of three years duration. It provided $1,000,000 for each of the three services of agriculture, home economics, and trade and industry. All these appropriations were made in addition to the money provided under the Smith-Hughes Act of 1917.

In 1936 the George-Deen Act, a permanent act replacing the George-Ellzie and the George-Reed Acts, was passed. This act provided the sum of $12,000,000 annually to be matched by state or local money, or both, on a fifty per cent basis the first year and on a one hundred per cent basis at the end of six years. One-third of the annual appropriation

was to go to each of the services in existence and the new service of distributive education was created. The act also provided $1,000,000 for the training of teachers of vocational subjects to matched on a dollar for dollar basis by the states. Ten war-training acts were passed from 1940 to 1945 which provided funds for accelerated training programs that did not have to be matched by the states.

George-Barden Act. Passed in 1946, the George-Barden Act is now the act under which the vocational educational programs are operating. The George-Barden Act is an amendment to the George-Deen Act of 1936 and provided funds that had to be matched by the states one hundred per cent. The sum of $10,000,000 annually was appropriated for agriculture with no state to receive less than $40,000 annually. The sum of $8,000,000 annually was to go to home economics with no state to receive less than $40,000, this sum to be distributed on the basis of rural population. Trade and industrial education was to receive $8,000,000 annually to be distributed on the basis of total state non-farm population to total non-farm population of the United States with no state to receive less than $40,000 annually. The sum of $2,500,000 annually was appropriated for distributive education, distributed on the basis of total state population with no state to receive less than $15,000.

With its vast funds of money from the Federal Government, vocational education has the task of preparing skilled labor for industry. Industrial arts in turn has the task of introducing the young people of today to a knowledge of industry and aiding them in their search for a position in industry. To do this, industrial arts cannot continue to use just the old tried and true ways, but must always be searching for

new and better ways of teaching, just as industry is always looking for new and better ways of doing its job. One of the methods that industrial arts has for doing this is to change its curriculum by the introduction of new subject matter areas such as copper enameling. The following chapter reports the results of a survey of selected schools in regard to copper enameling.

CHAPTER III

CURRENT STATUS OF COPPER ENAMELING IN SELECTED SCHOOLS ACROSS THE COUNTRY

The purpose of this study is to provide accurate up-to-date information on the status of copper enameling in selected schools across the country, to show that copper enameling is a suitable area for inclusion in a general shop program and to provide those who are planning to add copper enameling to their program with a course of study for enameling and a list of supplies and suppliers. To convey its full intent, one must first learn something of the techniques which are employed to developing this study.

Part A

The Research Techniques Reported

There are two main forms of research techniques which may be employed in developing a study such as this. The first is the normative survey or the use of the library in finding what material has already been written on the subject. The second is used only after the first method has been exhausted and it serves to supplement information obtained by the use of the first method. It is the questionnaire form which is sent directly to the source of the information needed.

Reference Material Used. To be able to compile information concerning the history of the subject, considerable reading and study were undertaken by the writer. Information was carefully chosen for its

validity and clearness of thought. This was recorded in a note form and then compiled in a chronological order. Information was obtained at the same time for use in preparing the set of instruction sheets that make up the following chapter.

The Questionnaire Form. In obtaining information to supplement that obtained from the normative survey, the questionnaire form of research was employed by the writer. Due to the expense and time involved in going directly to the source to obtain the needed information, the writer had to resort to the questionnaire which, with an accompanying letter, was sent to the industrial arts teacher at the selected schools asking that they complete the forms with data pertaining to their individual situations. In the Appendix are copies of the letter and the questionnaire form which were sent to each of the selected schools. The findings of this chapter as a whole and of this report in part will be based upon the information compiled from data contained in the returned questionnaires.

The Questionnaires Validity. With the constantly changing needs of society comes the need for education and industrial arts to review and revise their programs to meet the ever changing demands placed upon them by society. To be able to do this effectively, information is needed as to the prevailing conditions in the field which the questionnaire purports to ascertain. However, as this is the first study to the writer's knowledge in this particular area, there were no paths by which the writer could be guided in preparing the questionnaire, except by what could be drawn by analogy from parallel studies in other areas of

industrial arts. While the survey itself is not essentially forward looking, it reveals practices and conditions in a number of schools polled by the writer.

The next part of this chapter will deal with the findings made by the writer from the information received from the various schools across the country.

Part B

Status of Copper Enameling Reported

The following materials will deal with the schools responding to the questionnaire, the number and sizes of classes, techniques and materials used, length of time offered and successfulness of the course, and in which department enameling is presently being taught.

Basis of Selection. In undertaking a problem of this nature it was necessary to have information that pertained to the teaching of enameling, its success, techniques and materials as actually employed by teachers engaged in teaching enameling in some form. To this end it was felt that some control should be exercised in the selection of the schools to which the questionnaires were sent; accordingly it was decided to make a survey of all published material possible, listing every school that was mentioned as having some form of enameling included in their curriculum. Using this list and the bulletin Directory of Secondary Day Schools, a second list was compiled and questionnaires were sent to each school in a district in which one or more schools was known to be teaching or to have taught enameling. Of the 183 schools contacted, 105 responded to this inquiry. This represented a 57.4 per cent return on a questionnaire which was strictly voluntary on the part of those contacted.

Enameling as Now Offered. Out of the 105 responses to the questionnaire mailed out to selected schools across the country, forty-two, or 40 per cent, reported that they are now teaching copper enameling in some form. Of the remaining sixty-three replies, eighteen, or 17.1 per cent, have considered copper enameling as a possible addition to their curriculum with one reporting that they desire to add copper enameling but are unable to do so because the Board of Education will not allot the money needed for equipment. Two of the eighteen now have programs ready to begin with the fall semester, and one school is trying to rearrange the schedule of its assistant principal so that he can begin teaching a class in enameling. Only two schools, or 1.9 per cent, of the total replies have dropped enameling from their curriculum; of these, one has been reclassified as an elementary school, whereas the other dropped enameling because of space limitations and a restricted curriculum. Of the 105 responding to the questionnaires, sixty, or 57.1 per cent, now have or are planning to add enameling to their programs; two, or 1.9 per cent, have dropped enameling from their programs; and forty-three, or 41 per cent, report that they are not teaching enameling now and have not considered teaching it in any way.

Success of Enameling Courses. Of the forty-three usable replies to the question of successfulness of enameling as now taught, thirty-four, or 79 per cent, said that enameling was successful for them; eight, or 19 per cent, said that enameling was not successful for a number of reasons that ranged from the fact that students were just unable to follow instructions and therefore could not turn out good work, to the fact that other areas held more interest for the students.

The majority said that most of their trouble was due to the desire on the part of students to hurry and finish something quickly instead of planning their work and working slowly to obtain good results. One reported that since this was the first semester that enameling was offered, it was too soon to know how successful it was, or in her words, "time will tell". The remaining sixty-two out of the 105 respondents to the questionnaire did not give any replies to this item on the questionnaire.

Length of Time Offered. From Table I it can be seen that enameling is a comparatively new area to be added to the curriculum of most schools with the median being in the range of from one to three years with a frequency of twenty-five; this was followed by the range of one year or less, which included all of the new courses added during this school year 1955-56, with a frequency of nine. These two ranges included 80.9 per cent of all the schools now offering enameling in some form as reported in response to the questionnaires. It can readily be seen that enameling is just now beginning to be considered for inclusion in the curriculum of our schools.

TABLE I

DISTRIBUTION OF TIME TAUGHT

Time Interval	Frequency
Less than one year	9
1 to 3 years	25
3 to 5 years	4
5 to 10 years	3
10 years or more	2
Not reporting: 63	

Amount of Class Time Per Week. The amount of class time per week as reported by thirty-eight of the respondents to the questionnaire varied from as little as thirty minutes per week to what seems to be an impossible high figure of twenty-five hours per week. As Table II shows

TABLE II

CLASS TIME DISTRIBUTION IN HOURS WEEKLY

Hours	Frequency
1/2	2
1	3
1 1/2	2
2	3
3	1
4	1
5	12
6	2
6 1/2	1
7	1
8	1
10	1
15	1
25	1
Varies	3
Others	3

the median was five hours weekly with a frequency of twelve, followed by the ranges of one and two hours per week with a frequency of three each.

Three respondents reported that the amount of time devoted to enameling varied as the demand required. In addition, three reported that the time devoted to enameling ranges from one period per semester to nine hours per semester, with one reporting that he taught enameling for one hour during each nine weeks unit during the semester.

Departments Teaching Enameling. Fifty-three schools responded to this part of the questionnaire with a total of sixty-seven departments reported to be offering enameling in some way. Of the fifty-three schools replying to the question, "In what department is enameling included?", twenty-six reported the Art Department taught the only enameling that the school offered; four reported that the Arts and Crafts Department taught the only enameling courses; while ten schools reported that the Industrial Arts Department taught the only enameling offered in their programs. However, many schools reported that they had two departments offering enameling, either as a separate course or as part of another course. In this category were six schools in which both the Art and the Industrial Arts Departments were teaching enameling, and eight schools in which both the Art and the Arts and Crafts Departments were teaching enameling. Although the greatest number of offerings, thirty-nine, was reported in the Art Department (sixteen in the Industrial Arts and twelve in the Arts and Crafts Departments), this is because enameling has only recently been recognized as a manufacturing process and added to the industrial arts program, whereas it has been recognized and taught for many more years as an art medium thus accounting for the difference in the number of offerings in each department.

Of the fifty-three schools reporting enameling as being part of their program, thirty-two reported what course or courses that enameling was included with. Art metal was mentioned nine times; general shop was mentioned five times; being closely followed by craft and jewelry courses, each of which were mentioned four times. As can be seen from Table III, enameling was taught in conjunction with metalwork courses

for a total of eighteen times, or 56.2 per cent of the total courses named. Enameling as a separate course was mentioned twice with both schools reporting that it was taught as a separate course in the Art Department. With the exception to the two courses, enameling was reported to have been taught in conjunction with another; it served to supplement or to extend the course.

TABLE III

COURSES WHICH INCLUDED ENAMELING

Course	Frequency
Art Metal	9
Metal Crafts	2
Ornamental Metal	1
General Metal	1
Metals	1
Jewelry	4
General Shop	5
Ceramics	3
Crafts	4
Enameling	2

Metals Used. While copper was the base metal reported most frequently, forty-three times, silver or fine silver was also reported in many instances for a total of fourteen times. Two schools also reported using brass, one reported the use of steel tiles, and one indicated that another metal other than copper or silver was used but failed to say what metal it was.

Enamels: Kinds, Colors and Mesh. Out of 105 replies to the original questionnaire, forty-three indicated whether they used opaque or transparent enamels or a combination or both. Of the forty-three replies,

thirty-eight used both opaque and transparent enamels while only five used opaque enamels alone and none reported using transparent enamels alone. Of those using both opaque and transparent enamels, twenty-seven reported on the number of colors of each that they used. As can be seen in Table IV, the number of opaque colors ranged from as few as four to a

TABLE IV

NUMBER OF DIFFERENT ENAMEL COLORS USED

Opaque		Transparent	
Number	Frequency	Number	Frequency
4	1	2	1
6	1	3	1
8	3	4	2
10	7	5	2
12	5	6	2
14	1	8	5
15	4	10	6
20	3	12	1
25	1	14	1
41	1	15	3
		18	1
		24	1
		35	1
Average 14		Average 10	
Median 10		Median 10	

high of forty-one with the median being ten colors with a frequency of seven. The average number was fourteen colors as reported on the questionnaire. The group ten to fourteen with a total frequency of thirteen includes both the median and the average for the opaque colors and represents 48 per cent of the cases reported. For the transparent colors the number reporting was the same, twenty-seven, with the median number being ten and the average also being ten. Of the total cases reported on transparent enamels, forty-one per cent, or eleven of the

twenty-seven, are included in the groups eight to ten.

The mesh size of the ground enamels that was reported the most often, with a total of twenty-six schools reporting it, was the 80 mesh size. The mesh size that was next most popular was the 120 mesh with a total of thirteen schools reporting that they used it. Five schools also reported the use of 100 mesh; three reported 150 mesh size; and one school reported the use of a 200 mesh size for their ground enamels. In addition, two schools reported that they ground their own enamels from the lump or frit form with the use of a morter and pestle. With the commercially available enamels being sold in the lump and 80 and 120 mesh size, the most popular of the forms available is the 80 mesh which is preferred two to one over the finely ground or 120 mesh size.

Techniques Employed. Of the many techniques that have been developed for use with enamels that reported most often was "Sgraffito" which was reported twenty-five times out of the thirty-one usable replies received on the returned questionnaire. Next in popularity was "Cloisonne", which was reported nineteen times; this was followed by "Basse-Taille" with twelve reports; and "Champleve" and "Plique a Jour" with ten reports each out of thirty-one replies. Also mentioned were "Limoge", "Mayolica" and "Grisaille". The use of gold and silver foil under transparent enamels and "liquid gold" over both opaque and transparent enamels were also reported by a few in addition to the above mentioned techniques.

Class Sizes Reported. Table V shows the frequency and sizes of the classes as reported by forty-two of 105 schools that returned usable

questionnaires. While the data as presented can be of little use because of confusion as to whether or not the class size as given in a number of instances are average class sizes or the total of all classes taught by one instructor, it can be used to show what can happen when a great deal of care and foresight are not used when preparing a questionnaire of this type.

TABLE V

CLASS SIZES AS REPORTED

Sizes	Frequency
Less than 10	6
10 to 20	7
20 to 30	7
30 to 40	4
40 to 50	4
50 to 60	3
60 to 70	0
70 to 80	0
80 to 90	2
90 to 100	2
150	2
200	4
300	1

The purpose of this chapter was to report what has been done and is being done by our schools today in regard to enameling as revealed by the survey prepared by the writer. The following chapter will present a course of study based in part on this survey and upon the extensive reading and study done by the writer in preparing the survey.

CHAPTER IV

A COURSE OF STUDY IN COPPER ENAMELING FOR THE INDUSTRIAL ARTS GENERAL SHOP

In industrial arts, the content material of a course must be selected from those trades, industries, and crafts which bear the closest relationships to the needs experienced by every boy and girl. For example, a course in enameling is more meaningful to the student than a course in weaving. To construct a course so that it will fulfill the requirement of meaningful experiences, the content must be carefully selected and organized. It is the purpose of this chapter to present such content material for a course in copper enameling for the high school general shop.

Part A

General Organization

This course is designed to acquaint the student with the basic fundamental knowledge of copper enameling and the use of the tools, materials and equipment related to this type of work. There is a necessity in studying enough of the theory and related information involved to insure good workmenship and safety. In this report copper enameling is to be taught on a general shop basis, taking into consideration that the student will also complete other subjects in the same shop, each course continuing for either six or nine weeks.

Class Enrollment. During a single period of instruction, there will be approximately thirty students in the class. Of this group, ten will be enrolled in a copper enameling section.

Time Allotted. The length of the period per day would be fifty-five minutes, but the course is flexible enough so that it can be adjusted to any school curriculum.

Class Organization. The pupil personnel system is an essential aspect of the general shop and can be used in a class of this size. The various officers in this form of organization are the class superintendent, the safety engineer, the tool foreman, and the sanitary engineer. These should be willing to accept responsibility and should possess desirable characteristics of leadership, honesty, and initiative. The following duties are only a few of those that the teacher may select for the officers to perform. They are as follows:

1. Class superintendent. He is responsible for the care of class attendance records and observes the efficiency of the other officers.

2. Safety engineer. The safety engineer records and reports all accidents to the instructor. He is also responsible for seeing that all members of the class observe the safety regulations at all times, and he cautions pupils about hazards in the shop.

3. Tool foreman. The tool foreman inspects the tool panels before and after class and presents a daily report of the condition of the tools to the instructor.

4. Sanitary engineer. This officer is responsible for the cleanliness of the shop at all times and supervises the class during the clean-up period.

Organization is an essential part of good teaching. The success of any course depends upon how effectively it is planned. In fact, organization is not only a function of administration but is also a method of teaching. Although organization is an important factor, it is necessary to employ several techniques in teaching.

Part B

Methods of Teaching

In all fields of education it is necessary for teachers to be well versed in the many methods of teaching. Industrial arts is no exception, but one technique that works particularly well in this curriculum is the project method. Learning through doing should be stressed. In this course, the project method will be emphasized. However, the following techniques will be used in teaching this course in copper enameling.

Demonstration. In industrial arts, this method is used in teaching the occupational skills. This method is essential in making the first approach to the subject matter of the manipulative core of a course of study.

Project Method. Pupil planning, performance, and evaluation are direct outcomes of this method of teaching. This method consists of pupil-centered activities. Because it is a large-unit plan of teaching, it shows the student a series of integrated facts and experiences. (24, page 311)

Visual Aids. Visual aids are used to supplement other methods of instruction. These aids include films, slides, charts and models.

Visual aids naturally stimulate the students' interest, and thus motivate learning. A second reason for their use is that the students remember the lessons better because visual aids clarify the ideas that have been presented by the teacher.

Field Trips. Field trips to various industrial concerns should be planned because it will give students a better understanding of the industrial environment.

Testing. As a guide to pupil problems and achievements, testing is a valuable device. It also indicates to the teacher the effectiveness of his teaching.

Other teaching techniques may be employed depending upon the pupils' needs. It should be remembered, however, that a successful job of teaching depends upon various methods being used to present the subject. Several methods of instruction plus well-developed units of instruction should greatly aid the teacher in accomplishing his objectives.

Part C

Units of Instruction

A course of study should vary somewhat with the community, depending upon local needs. The students should see the need for experiences, and these experiences should be sound in nature rather than abstract. The lessons are constructed so that they begin with the less complex and advance to the more complex as the student progresses.

The course of study in this chapter is to be used in assisting the instructor to conduct the lessons in an enameling course. It is assumed that the time will be arranged for the instructor to meet in a formal

class situation with the enameling group.

Enameling. While the manufacturing and fabrication of enameled objects has never been one of the major industries of this country, enameling is today being utilized more and more in the production of many items that are found not only in our homes but also in almost every walk of life.

Objectives of Enameling. While no one person can prepare a set of objectives for every course in enameling, the following are suggested for consideration as a possible starting point from which the instructor and his class can procede to develop the objectives that best fit their needs and situation.

1. Develop some skill in use of tools and equipment used in enameling.

2. Use these skills in making projects that will give personal satisfaction.

3. Learn the characteristics, sources, and uses of the materials being used.

4. Acquire information about the role of enameling in the industrial environment.

5. Improved aesthetic appreciation.

6. Increased avocational interests and pursuits.

7. Promote safety habits in the use of enameling tools and equipment.

8. Identify the common enameling techniques.

Some Manipulative Experiences That Should Be Covered in Enameling. There are some experiences that are common to all areas of the general shop and these should be given first consideration. All the many possible areas of the general shop require the use of tools and equipment, much of which is powered. Instruction should be given in:

1. Safety rules and practices, health precautions, proper dress and first aid.

2. Principal parts of tools and machines.

3. How to keep the tools in good repair and working order (sharp and adjusted).

4. How to use the tools safely and properly.

5. How to keep the machines in good repair and working order (sharp and adjusted).

6. How to use the machines safely and properly.

Some of the basic manufacturing processes that may be covered in an enameling program are: (48, page 58)

I. Designing a project

- A. Utility
- B. Beauty
  1. Shape
  2. Color
- C. Working properties of the metal being used that will affect design.

II. Planning

- A. Make a bill of materials and calculate cost
- B. Make a plan of procedure

III. Measuring and Layout

- A. Measure and divide spaces with a rule

B. Measure and construct circles and arcs

C. Make a simple layout on metal

IV. Cutting

A. With hand tools, such as hack saws, cold chisels, jeweler's saw, and tin snips

B. With power tools, such as band saw and jig saw

V. Drilling, reaming and punching holes

A. Drilling holes with hand drill

B. Drilling holes with a drill press

C. Ream holes by hand or with a drill press

D. Punch holes with solid or hollow punch by hand

VI. Shaping and forming metal

A. Form to shape by hand when cold

B. With sheet metal machines

C. By spinning

D. Annealing

VII. Smoothing metal and enamels

A. With files, scrapers and burnishers

B. With grinding wheels and stones
1. Dry or wet for metal
2. Wet under running water for enamels

C. With abrasive materials

VIII. Assembling metal parts

A. With rivets

B. By soldering, either soft or hard (silver)

IX. Decorating the surface of metal (other than by enameling, prior to enameling)

A. By etching

B. By overlay (can be used after or with enameling)

C. By peening and planishing

D. By chasing, doming, fluting

E. Spot finishing

F. Design stamping

X. Cleaning the metal prior to enameling

A. With acid pickle

B. Soap and water

C. Household abrasives and detergents

D. Steel wool

E. Handle cleaned pieces by edges or on the back

F. Affects of grease and dirt on enamels

XI. Decorating the surface of metal with enamels

A. Opaque enamels
1. Simple one-color dusting
2. Multi-color dusting over stencils
3. Wet-inlay, simple and multi-colored
4. Champleve
5. Cloisonne
6. Sgraffito
7. Combined with lumps and threads

B. Transparent enamels
1. Simple one-color dusting
a. Over plain surfaces
b. Over decorated surfaces (including opaque enamels)
2. Multi-color dusting over stencil
a. Over plain surfaces
b. Over decorated surfaces (including opaque enamels)
3. Wet inlay, simple and multi-colors
a. Over plain surfaces
b. Over decorated surfaces (including opaque enamels)
4. Champleve
5. Cloisonne
6. Combined with lumps and threads

C. Counter enamels
1. To relieve stress and strains
2. To cover bare metal on backs and bottoms of pieces

XII. Firing the enameled pieces

A. Kiln and kiln equipment

B. Proper temperatures

C. Moving unfired enameled pieces into the kiln

D. Steps in firing by appearances
1. "Wet spots"
2. Dull red color
3. "Wet all over" but grainy in texture
4. Flows together, has an "orange peel" appearance
5. Mirror-like surface and dull cherry-red color

E. Cooling
1. Away from unfired enameled pieces
2. Weights on the backs of flat objects to prevent warpage.

XIII. Defects in the enameled surface

A. Salt and pepper effect

B. Steel wool and other contaminations

C. Holes

D. Unevenness

E. Cracks

XIV. Finishing the enameled piece

A. Cleaning off the fire scale

B. Polishing exposed metal

C. Lacquering exposed metal

D. Jewelry findings

E. Frames, plaques, etc.

Informational Topics. The student develops knowledge and appreciation of enamels and metalwork when the major areas of information in these fields are covered in classwork. The teacher will be wise to make liberal use of text and reference books, movies and strip films,

field trips, and commercial publications, for this will help increase student interest. (48, page 62)

He can deal with:

I. History of enameling

A. Early history of enameling

B. Modern day uses of enamels
1. Commercial
2. Decorative

II. Sources of raw materials

A. Where raw materials come from
1. For enamels
2. For the metals

B. How they are mined and extracted
1. Enamels
2. Metals

III. Processing of the raw materials

A. Grinding and refining
1. Raw material for enamels
2. Metals
a. Copper
b. Silver
c. Gold
d. Tin
e. Platinum
f. Lead

B. Melting and compounding
1. Enamels
2. Metal and alloys

C. Further processing after melting and compounding
1. Enamels
a. Grinding and washing
b. Some left in lump form
c. Production of threads
2. Metals and alloys
a. Rolling to thickness
b. Cutting to size and shape

IV. Characteristics of metals and enamels

A. Metals

1. Comparison of color, cost, working qualities
2. Properties of metals
3. Common kinds and shapes

B. Enamels
1. Comparison of color, cost, durability
2. Properties of enamels
a. How they can be altered to suit conditions of use
b. Colors, how produced
3. Common forms

V. Consumer uses of enamels

A. Home uses

B. Personal uses

C. Industrial uses

D. Institutional uses

VI. Occupational information

A. In the field of metalworking
1. Number and kinds of workers in each area
2. Types of jobs
3. Kinds of manufacturing concerns
4. Opportunities

B. In the field of commercial enameling
1. Number and kinds of workers in each area
2. Types of jobs
3. Kinds of manufacturing concerns
4. Opportunities

C. Custon enameling

VII. Enameling as an avocation

A. Sources of hobby supplies

Part D

Equipment

In the justification of any industrial arts subject, the economy factor has to be considered invariably. Therefore, this report does not include an exhaustive list of equipment. The equipment included

in this study is to give the reader a general idea or understanding of the type of equipment used in an enameling course. The tools and materials appearing in this report are typical of those used in an enameling course. In fact, many of the tools that are used in other industrial arts subjects in the general shop may be utilized in the enameling class.

Enamels -- Opaque, assorted colors, about eight
Transparent, assorted colors, about six or eight

Enamel flux

Gum tragacanth, powdered

Pre-cut copper shapes or sheet copper

Assorted jewelry findings

Asbestos gloves

Asbestos pads

Atomizer, nose and throat type

Brass or copper wire screening, 80 mesh

Ceramic triangles, star stilts or trivets, nichrome wire mesh

Enameling fork

Kiln

Long spatulas

Mica, sheets 4 x 4 inches square

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Although enameling is a relatively new industrial arts activity, its many materials and processes make it very adaptable to the realization of the aims and objectives of industrial arts. There are many occupations in the enameling industries with which the student may become acquainted through a course in enameling. Since an industrial arts activity should have some manual activity along with the lecture periods, there must be a suitable work area available. This work area should be equipped to permit the students to practice some of the elementary procedures and techniques. Equipment in these work areas should be in sufficient quantities and of a quality to enable the students to produce acceptable work. An important factor that should be considered in the selection of equipment is its ability to withstand abuse.

Summary. This study includes a brief history of the progress of industrial arts from the early development to the present time. The European influences and the early development in America that have been responsible for the present status of industrial arts have been presented.

Of the schools responding to the questionnaire mailed to them, 57.1 per cent have or are planning to add enameling to their program. Reporting on the successfulness of enameling, 79 per cent said that they considered their programs to be successful with those replying

with a "no" giving as their reasons the inability of the students to follow instructions, and the attractiveness of other areas to their students, while the majority reported that haste on the part of the student was their biggest problem.

Enameling for the majority of the schools was still relatively new having been taught for periods of one to three years. A few schools did report that they had taught enameling for ten years or more while at the other extreme about one-fifth of the schools reporting had just added enameling to their programs. The amount of class time devoted to enameling per week also shows a great deal of variation ranging from as little as thirty minutes weekly up to a high of twenty-five hours weekly. The greatest number reported that enameling when taught was offered for five hours a week.

Only two schools reported that they taught enameling as a separate course, while the rest reported that enameling was included either in the general shop or as a part of a metalworking course. The greatest number reported that enameling was taught in conjunction with art metal, with general shop and jewelry being favored in that order. Ceramics and crafts were also mentioned in addition to the metalworking courses.

Opaque enamels were favored over the transparent enamels with from ten to twelve opaque colors being used and from eight to ten transparent colors. The mesh size that was reported most often was 80 mesh, being followed by 120 mesh; both mesh sizes being available commercially. A few did report, however, that they ground their own enamels as they needed them.

Recommendations. It is recommended that an enameling course be included in the high school general shop because of the widespread use of and interest in enameling today. This may be included as either a separate area or with an art metal or jewelry area now being taught in the general shop program. It is as true for the enameling course as it is for other subjects that a planned course of study be followed. It is also necessary that the instructor become fully acquainted with the material which he is going to teach. The course of study as included in this report may be used as a guide for those who wish to include enameling in the industrial arts curriculum. Of course, modifications would have to be made in accordance with the needs of the individual students and the community in which the class is being taught. It is further recommended, however, that the content matter remain simplified so that the course will be consistent with the exploratory aspects of the general shop.

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APPENDIX A

List of Questionnaire Respondents

Arizona:
- Tucson
  - Catalina Junior High School
  - Mansfield Junior High School
  - Spring Junior High School
  - Safford Junior High School

Colorado:
- Denver
  - Baker Junior High School
  - Byers Junior High School
  - East High School
  - Englewood Junior High School
  - Grant Junior High School
  - Griffith High School
  - Horace Mann Junior High School
  - Morey Junior High School
  - Petersburgh Junior High School

Illinois:
- Winnetka
  - New Trier Township High School

Iowa:
- Cedar Falls
  - Cedar Falls High School
  - McKinley High School
  - Wilson High School

Missouri:
- Springfield
  - Jarrett Junior High School
  - Pipkin Junior High School
  - Reed Junior High School

New York:
- Canisteo
  - Central High School

Ohio:
- Akron
  - Buchtel High School
  - Central High School
  - East High School
  - Garfield High School
  - North High School

Akron (continued)
South High School
West High School

Cincinnati
Anderson Township High School
Bloom Junior High School
Deer Park High School
Indian Hill Junior High School
Harriet Beecher Stowe School
Walnut Hills High School
Washington High School
Western Hills High School
Withrow High School
Woodward High School

Cleveland
John Adams High School
Jane Addams Vocational High School
Addison Junior High School
Central Junior High School
Collinwood High School
Cuyahoga Heights High School
East Technical High School
Edison Occupational High School
Empire Junior High School
Glenville High School
Nathan Hale Junior High School
Hart Junior High School
Myron T. Herrich Junior High School
William Dean Howells Junior High School
Thomas Jefferson Junior High School
Lincoln High School
Monticello Junior High School
Rawings Junior High School
James Ford Rhodes High School
Roosevelt Junior High School
Shaker Heights High School
South High School
West High School

Columbus
Barrett Junior High School
Crestview Junior High School
East High School
Franklin Junior High School
Hamilton High School
Mifflin High School
North High School
Roosevelt Junior High School
South High School
Upper Arlington High School

Ohio: (continued)
- Dayton
  - Dunbar High School
  - Fairmont High School
  - Fairview High School
  - Northridge High School
  - Oakwood Junior-Senior High School
  - Van Buren Junior High School
  - Colonel White Junior High School
  - Wilbur Wright High School
- East Cleveland
  - W. H. Kirk Junior High School
- North Olmsted
  - North Olmsted High School

Texas:
- El Paso
  - El Paso High School
  - Jefferson High School

Washington:
- Seattle
  - Ballard High School
  - Cleveland High School
  - Eckstein Junior High School
  - Garfield High School
  - Hamilton Junior High School
  - Madison Junior High School
  - Meany Junior High School
  - Pacific Pre-Vocational High School
  - Queen Anne High School
  - Roosevelt High School
  - Washington Junior High School
  - West Seattle High School

Wisconsin:
- Eau Claire
  - Eau Claire High School

APPENDIX B

Sources of Supplies

1. American Art Clay Company, 4717 West Sixteenth Street, Indianapolis 24, Indiana.
2. Artex Manufacturing Company, 4038 Huron Avenue, Culver City, California.
3. Bergen Arts and Crafts, 128 Main Street, Hackensack, New Jersey.
4. Charles Harris, Cathedral Station, Box 215, New York 25, New York.
5. Eastern Handicraft Supply Company, Inc., 151 Spring Street, New York, New York.
6. Ernest Linick & Company, 5 South Wabash Avenue, Chicago 3, Illinois.
7. Evanston Ceramic Supply, 807-809 Main Street, Evanston, Illinois.
8. Illini Ceramic Service, Inc., 163 West Illinois Street, Chicago 10, Illinois.
9. Jack D. Wolfe Company, Inc., 62 Horatio Street, New York 14, New York.
10. Kap Pak Products, Inc., 156 W. Walton Place, Chicago 10, Illinois.
11. Natural Ore Glazes, Central City, Colorado.
12. Stewart Clay Company, Inc., 133-137 Mulberry Street, New York 13, New York.
13. The Buell Kilns, Oaks Hobby Club, P. O. Box 302, Royal Oaks, Michigan.
14. The Copper Shop, Division of Immerman and Sons, 1812 East 13th St., Cleveland 14, Ohio.
15. The Old Viking Shop, 1236 Delaware Street, Denver 4, Colorado.
16. The Potters Wheel, Inc., 11447 Euclid Avenue, Cleveland 6, Ohio.
17. Thomas C. Thompson Company, 1539 Deerfield Road, P. O. Box 127, Highland Park, Illinois.
18. Van Howe Ceramic Supply Company, 1248 South Broadway, Denver, Colorado.

APPENDIX C

Letter of Inquiry and Questionnaire Sent to Selected High Schools Across the Country

OKLAHOMA INSTITUTE OF TECHNOLOGY
OF THE
Oklahoma Agricultural and Mechanical College
SCHOOL OF INDUSTRIAL ARTS EDUCATION
AND ENGINEERING SHOPWORK
Stillwater, Oklahoma

33-C College Courts
Stillwater, Oklahoma
February 10, 1956

Dear Sir:

I am completing a Master's degree research project under the direction of John B. Tate, Assistant Professor, Department of Industrial Arts Education and Engineering Shopwork, Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma. It is entitled "Copper Enameling: Its Suitability for Inclusion in a General Shop Program". This research is to determine the size of classes in which copper enameling is taught, if copper enameling is offered separately or as part of another class or course, kinds of enamels and techniques used, favorite projects of the students, and the success of the course as it is now offered in a number of schools.

It is recognized that in many cases the information called for cannot be supplied by you but can be furnished by some other teacher in your school. It is requested that the enclosed questionnaire and this letter be passed on to the person best able to answer it.

As the success of this research project depends upon the information that is supplied by the questionnaire, its prompt completion and return in the enclosed self-addressed envelope will be appreciated even if you can state nothing more than the fact that enameling is not taught in your school.

Sincerely yours,

Bruce D. Crumpton, Graduate Student
School of Industrial Arts Education
and Engineering Shopwork

Approved:

John B. Tate

John B. Tate, Adviser

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE
Stillwater, Oklahoma

The following questionnaire is for the purpose of obtaining information needed to complete a Master's degree research project entitled "Copper Enameling: Its Suitability for Inclusion in a General Shop Program". Please fill it out as completely as possible and return promptly in the enclosed stamped and addressed envelope.

PLEASE PRINT
Name_____Position_____

School_____Location_____

1. Is enameling being taught in your school at the present time? Yes____ No____

2. Has it been taught in the past? Yes____ No____

3. How long has it been offered? Less than a year___, 1 to 3 years___, 3 to 5 years___, 5 to 10 years___, 10 or more___

4. Has enameling ever been considered, to your knowledge, for inclusion in your school program? Yes____ No____

5. In what department has it been taught? art dept.____, arts and crafts____, industrial arts____, manual arts____, shop____.

6. If taught in the Industrial Arts department, was it included in the General Shop program? Yes____ No____; Art Metal program? Yes____ No____; Was it offered as a separate course? Yes____ No____; As part of another course? Yes____ No____; if offered as part of another course, what course? _____

7. Has enameling been successful in use? Yes____ No____

8. Number of students taking enameling or courses that include enameling? Less than 10 ____; 10 to 20 ___; 20 to 30 ___; 30 to 40____; 40 to 50____; 50 to 60____; 60 to 70____; 70 to 80____; 80 to 90____; 90 to 100____, 150____, 200____, _____.

9. How much time is devoted to enameling? _____ hours weekly.

10. What materials do you use for your base metal? Copper___, silver___, other_____.

11. How many different colors of enamels do you use? Opaque_____, Transparent_____. What mash of enamel do you use? 80 ____, 120 ____, other _____

12. What technique do you teach your students? Basse-Taille ____, Champleve' _____, Cloisonne' _____, Plique a jour ____, Sgraffito ____, other _____

13. Please list on the back of this questionnaire the equipment that you consider to be essential for teaching enameling in any form. Indicate what equipment you now have by the use of a check mark opposite the appropriate items.

14. List some of the common faults or mistakes encountered by your students. Use the back of this sheet or attach additional sheets if necessary.

15. List some of the more popular projects undertaken by your students. Do you have any photographs of student work? Yes____ No____ Would it be possible to secure copies of these photographs? Yes____ No____

VITA

BRUCE DOUGLAS CRUMPTON

candidate for the degree of

MASTER OF SCIENCE

Report: COPPER ENAMELING: ITS SUITABILITY FOR INCLUSION IN A GENERAL SHOP PROGRAM

Major: Industrial Arts Education

Biographical:

Born: August 11, 1929, at Kingsport, Tennessee.

Undergraduate Study: Tennessee Polytechnic Institute, Cookeville, Tennessee, 1948-1951, 1953-1954.

Graduate Study: Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma, 1954-1956.

Experiences: Enlisted in the United States Naval Reserve April 8, 1950. Called to active duty September 24, 1951. Served as Fireman aboard the U.S.S. Tringa (ASR 16). Released from active duty June 23, 1953.

Member of Phi Delta Kappa, Iota Lambda Sigma, Student Industrial Arts Association, Oklahoma Industrial Arts Association, American Industrial Arts Association, American Vocational Association.

Date of Final Examination: July, 1956.

Report: COPPER ENAMELING: ITS SUITABILITY FOR INCLUSION IN A GENERAL SHOP PROGRAM

Author: Bruce Douglas Crumpton

Adviser: John Bruce Tate

Typist: Dorothy Watkins