PLASTICS AS AN INDUSTRIAL ARTS SUBJECT

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By

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C.T.C.

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CHAPTER I

PURPOSE AND EXTENT OF THE STUDY

The idea of classes in plastics is relatively new in the field of industrial arts. This activity has been added to a number of schools throughout the United States. Oklahoma has at least a dozen schools in which plastics are used in the industrial arts shop in one form or another. Instruction in the use of plastics has been added with the primary aim of furthering education in industrial arts fields and for its values as general education in the consumers knowledges and because of its usefulness as an avocational activity.

When the writer made a search for organized material that could be used in a plastic course, it was found that only two textbooks had been written. One by Mansperger and Pepper, _Plastics: Problems and Processes_, another by Lockery, _Plastics in the School and Home Workshop_. If a choice is desired for a suitable text for a course in plastics, the writer would select, _Plastics: Problems and Processes_, because its authors designed it to be used in the school shop. Outside of these books, little has been written upon _Plastics as an Industrial Arts Subject_. The writer felt that there was a need in the field of industrial arts for an extensive study on this particular problem.

Origin of the Problem. During the winter term of 1937-38 the writer ordered some samples of plastics from a certain firm. The boys in the woodworking classes became curious about this material. After some experimental work was done by both teacher and pupils, an order for material suitable for drawer pulls, knobs, etc. was placed. The boys worked this material with great enthusiasm and prized highly the polished pulls and knobs which resulted.

During the summer of 1939 the writer was asked to make a report to the Industrial Education Society in the Oklahoma A. and M. College Summer School on the use of plastics in the school shops. This talk seemed to create enthusiasm among the group of shop teachers present and it was suggested that a study of plastics would make a good topic for a thesis. After a preliminary study of the problem the title, Plastics as an Industrial Arts Subject seemed most appropriate for this investigation.

Purpose of this Study. The most immediate value and purpose of this thesis will be to formulate a course of study which will make it possible to conduct a high school class in the use of plastics in the industrial arts shop. However, a more profound section of this report will deal with the philosophy of education and industrial arts and with the manner in which plastics as a school subject can contribute to the objectives of both general education and industrial arts education. A third phase of this inquiry deals with the scientific basis for the commercial production of plastics.

Definitions of Terms. Certain words and phrases recur frequently in a study of this character. In order for the reader and even for the person producing the report to have a consistant understanding of these words, certain and definite meanings should be ascribed to them. In most cases quoted definitions are offered and these definitions express the meaning of the words used which will apply to them throughout the thesis. Several terms are defined by the writer of this thesis since no appropriate and meaningful definitions were found in the literature reviewed. Certain terms and their definitions as used in this thesis are as follows:

Plastic. Concerned with or pertaining to molding or modeling (such as sculpture and ceramics); also, capable of being molded or receiving form (as clay, wax, etc.), capable of being brought to a definite condition or character. (The New Century Dictionary)

Modern Plastics. Generally limited to a group of synthetic, organic materials which are made plastic by the use of heat and are capable of being molded or pressed into finished parts and products. (5, page 3)

Synthetic. Pertaining to or involving synthesis; formed by synthesis, as compounds; compounded or prepared in the laboratory as an artificial product. (The New Century Dictionary)

Resin. Any of a class of uncrystallized vegetable substances produced by hardening or drying secretion exuding from certain plants; soluble in alcohol, terpentine, benzine, etc., but not in water. A term generally referring to all natural substances which, within a particular range of temperature, shows the properties just mentioned. (47, page 179)

Subject. An organized body of knowledge, as Chemistry, Algebra, or Botany, forming a subject, especially when taught in an educational institution; subject matter. (The New Century Dictionary)

Resinoid. A resinous substance; a class name applied to temporary thermoplastics or thermosetting plastics to distinguish them from natural resins. This term applies only to synthetic or man-made materials. (47, page 179)

Rosin. The resin forming the residue after the distillation of oil of turpentine grom crude turpentine. It is a brittle amber colored solid, and is used for violin bows, in the manufacture of varnish, etc. (Funk and Wagnalls New Standard Dictionary)

Industrial Arts. Is one of the Practical Arts, a form of general or non-vocational education which provides learners with experiences, understandings, and appreciations of materials, tools, processes, products, and of vocational conditions and requirements incident generally to the manufacturing and mechanical industries. (67, page 27)

Industrial Education. Industrial education is used to include the general course of the secondary school variously known as manual training, manual arts, industrial arts, and industrial education, and the vocational work of the continuation school, trade school and evening schools. (54, page 1)

Since there is no definition of "area" as it is used in relation to this subject matter, the writer has formulated one suitable for this purpose.

Area. In the school shop an "area" indicates a space set aside for a particular industrial arts subject. Example: The drawing and planning area, the foundry area, the plastics area.

Delimitation. Naturally any subject dealing with plastics is limited in time to the last few years and certainly not more than ten years. The earliest article or book in the bibliography devoted to plastics is dated 1935. Likewise the extent of the use of plastics in the school shops is bound by the same time limits but extends geographically over the entire nation.

Studies of a Similar Nature. A review of the literature of the field of industrial arts reveals that very few studies similar to the one the writer is undertaking are available. In addition to making a search in the field of industrial arts education, the writer examined Readers Guide from the years 1930 to 1940, the Industrial Arts Index, and a list of graduate theses on industrial arts and art accepted by institutions of higher learning in the United States. This search showed only one similar study, Margaret Jeanne Halsey's study on the subject "A Method of Evaluating Children's Use of Certain Plastic Materials," a Master's Thesis written in 1938 at Iowa University. A number of magazine articles have appeared in Industrial Arts and Vocational Education Magazines about the use of plastics in the school shop, and the majority of these articles have been published in the past two or three years. Many articles on this subject are to be found in recent magazines of the home workshop type and in architectural and trade journals.

Expected Outcomes and Uses of Results. The results obtained from this study should be useful in the industrial arts field in that another medium for self-expression has been made available. As the result of this a group of objectives have been formulated which will prove useful in actual practice.

An investigation will show that numerous schools have attempted to introduce the use of plastics along with woodwork or metal work in their shops. The result of this coordination has developed a keen student interest in plastic materials which leads the writer to believe that plastic courses will be added to many shops in the near future.

In Chapter I the origin, purpose and extent of the study have been shown. In the second chapter an analysis of the extent to which plastics as a school subject will contribute to the objectives of general education and of industrial arts will be presented.

CHAPTER II

GENERAL EDUCATION, INDUSTRIAL ARTS AND PLASTICS

OBJECTIVES AND RELATIONSHIPS

The historical development of industrial arts as a school subject has seen the advent of many movements or transitional activities as, for example, the building of model houses, airplanes, boats, gesso-craft, mission furniture and to the recent advent of modernistic furniture.

At the present time, industrial arts seems to be facing the introduction of a new material. Its use may also be brief and experimental, or it may become a permanent member of the group of studies composing an industrial arts program in the public schools. The possibilities of its permanence and usefulness depend on the contribution plastics as a shop course can make to industrial arts objectives and to the objectives of general education. In this chapter the relationship of industrial arts to general education and the values of plastics as an industrial arts subject will be discussed.

GENERAL EDUCATION

One of the purposes of our schools is to provide all future citizens with a general education. This education refers to all activities which do not have relationship to any specific field of service. The youth today faces a 1939 civilization with new situations confronting him. Our schools should provide a good general education which must include a broad understanding of the industrial arts as well as essential vocational education.

<u>What is Education.</u> In the thought of today, education is regarded as a

method of adjustment. Education is such an essential part of life that it should be combined with the process of adaptation which characterizes every level of life. At this point the relation which exists between adjustment and education should be made more explicit. Under education, used in its widest sense, must be included all those changes, which from birth to death are brought about in the individual by the process of learning. Whether these take place in infancy, old age, in the home, at school, or in business, is of no consequence. They are all essentially alike in form and must be included under the term "education."

When education is looked at from this point of view, it is nothing more than a social process. Chapman and Counts in their book, Principles of Education, offer this definition: (17, page 11)

> Education is nothing more than an economical method of assisting an initially ill-adapted individual, during the short period of a simple life, to cope with the ever-increasing complexities of the world.

It is not sufficient for one to live on the level of real manhood, each person must live for a purpose. With this in mind, it is certain that either education must continue to be made more effective, or else the individual must be satisfied with a simpler civilization. The biological equipment of the individual cannot be altered, the average life of man cannot be extended much beyond seventy. These limitations create the necessity of a more clearly conceived ideal of conscious effort in the service of education.

General Education. General education at the secondary school level has the same purpose as general education at the elementary school level. Everyone must have education to live intelligently in a modern community.

"General" means belonging to every individual. The chief obligation of general education is to meet the demand that each individual by education carry out efficiently his share of the work of the world.

General education is quite as essential for those who attend secondary schools for a year or two as for those who attend institutions of higher education. This education may be administered in some degree to those who leave school earlier.

One meets great difficulties when attempting to state concisely the all-inclusive purpose of general education. One of the truly great definitions of general education was prepared by the Committee on Science in General Education, a division of the Progressive Education Association. The committee agreed on the following definition for general education: (20, page 1)

> The purpose of a general education is to provide rich and meaningful experiences in the basic aspects of living, so directed as to promote the fullest possible realiziation of personal potentialities, and the most effective participation in a democratic society.

By "rich and meaningful experiences" the authors had in mind the activities that are designed to involve the interests of the individual. They proposed to study the youth in his relationships to life. The "basic aspects of living" referred to in the statement are classifications of human living. In the second part of the definition, the authors advocate education as a provision for personal development and social effectiveness. Perhaps the basic ideal of our American tradition of democracy is the high regard in which the individual is held.

It is obvious that general education is not the same as it was a generation ago. What then are some of the problems of general education?

Judd declares: (38, page 226)

> The only sure formula which can be adopted by educators is one that emphasizes the importance of cultivating adaptability to the highest degree. If the individuals can be prepared to adjust themselves to new situations, they will be far better equipped for the future than they will be if they are taught by the long established traditional formulas.

In fact, already there is a decided need and justification for this philosophy of general education to continue through high school graduation. Education which is general in motive must also be resolved into specific divisions. Definite goals are frequently established by proposing a full list of objectives.

Specific Objectives of Education. During the last two decades many proposals have been made as to the aims of education. An earlier proposal is probably even now more widely known than any other statement of educational objectives. In order to determine the main objectives that should guide education, many committees, commissions and individuals have made proposals. The Commission on Cardinal Principles of Secondary Education submitted the following as the chief objectives of education: (10, page 5)

1. Health.
2. Command of fundamental processes.
3. Worthy home membership.
4. Vocation.
5. Citizenship.
6. Worthy use of leisure.
7. Ethical character.

Normally the youth is a member of the family, of a vocational group, and of various other civic groups, and is being called upon to engage in the activities that enrich the family life, to render vocational service and to promote the common welfare. It follows that worthy home membership, vocation and citizenship demand attention as three of the leading objectives.

Aside from the specific duties, every individual should have some time for the cultivation of personal and social interests. This leisure if well used will strengthen his powers, enlarge and enrich his life, thus, better qualifying him to meet greater responsibilities. In view of these considerations education for the worthy use of leisure is increasing in importance.

To be of service and to benefit from leisure, one must be in good health. The health of an individual is essential to the existence of the race and to the defense of the nation. Therefore, health education is very essential to the individual.

The various processes such as reading, writing, oral and written expression, etc., are needed as tools in the business of life. The command of these fundamental processes is without doubt an indispensable objective.

Finally the objectives already named are dependent upon ethical character which is conduct founded upon right principles. Good citizenship, vocational excellence and the worthy use of leisure unite closely with ethical character. Therefore character is meaningless apart from the will to discharge the duties of life, and there is no guarantee that these duties will be rightly performed unless good principles are substituted for impulses. Consequently, ethical character is involved in all of the objectives and at the same time it should require consideration in any program of national education.

Another list of characteristics of a good education was proposed in 1924 by Bobbitt and later used by the National Education Association.

The ten titles and a brief analysis are listed here with no further comment: (7, page 7)

1. Language (Social intercommunication).
2. Health (Physical fitness).
3. Citizenship.
4. General social activities (Meeting and mingling).
5. Spare-time activities (Amusement and recreation).
6. Mental fitness.
7. Religion.
8. Parental.
9. Unspecialized or non-vocational practical activities.
10. Vocational activities.

The political framework of a people determine in a large measure its educational system. In America a sincere reliance is placed on the ideal of democracy in politics and education.

Education in a Democracy. Interest in the objectives of educational institutions has not been confined to a few exceptional leaders. Plain citizens, parents, taxpayers, and even the young learners themselves have in mind some notion as to the reasons why they support and participate in the means of education.

The National Education Association Policies Commission offers this statement on education in a democracy: (31, page 41)

> The general end of education in America at the present time is the fullest possible development of the individual within the framework of our present industrialized democratic society.

The attainment of this end is to be observed in individual behavior. The term education implies the existence of some person other than the learner, a person who is interested in the outcome and who desires to encourage one type of conduct. Education seeks to encourage the mastery of such knowledge, and the development of such habits as will result in a socially desirable way of living. The way of living that is encouraged by the education of American people is a closer approximation to democratic ideals. Some of the desirable elements of information, such as skill, habit, interest and attitudes will surely promote individual development and encourage a democratic way of living among the people of this country.

Although the earlier statements included eight cardinal objectives of education, in one of the most recent reports of the Educational Policies Commission, these four great groups of objectives are listed: (31, page 47)

1. The objectives of Self-realization.
2. The objectives of Human Relationships.
3. The objectives of Economic Efficiency.
4. The objectives of Civic Responsibility.

Each of these educational objectives is related to each of the others. The classification will be more helpful if it is thought of as a series of four objectives from which the purposes of education may be studied.

Self-Realization. Conduct in this field is centered on the personal development, growth and learning of the individual. A democracy should be concerned with giving to each individual an opportunity to shape his own destiny and should be interested in developing in each individual strong qualities of initiative, accountability and self-direction. In a democracy self-realization is of supreme importance because success in this role determines one's success in every other phase of life's activities.

Human-Relationship. The second objective deals with the more intimate connections of the individual with his friends, his neighbors and the members of his own family group. Educationally the home is the most powerful, and it is probably the oldest of all social institutions. Good homes and good communities are the basic units of a democracy. During the school period the youth weaves a texture of knowledge, habits, inspiration and mutual respect which aids him in helping to hold society together. There is an important relationship between the youth's inner life and his contact with many fellow citizens.

Economic Efficiency. The next aspect of the activities of the member of a democratic society includes the economic sphere, the creation and satisfaction of material wants. Here the education of the individual as a producer, a consumer and an investor, should be considered. The importance of such education is realized by its providing the indispensable material basis for comfort, safety, and even life itself.

Civic Responsibility. Finally, there are the activities of the educated citizen. They involve dealing with the government, local, state, and national; his relationships with the peoples of other nations, and other contacts in large scale collective enterprises.

If the purposes of general education as just proposed are accepted, it must include a form of practical education involving a study of and activities with the many industrial materials, products and services of our modern industrial civilization. This kind of education is achieved in the industrial arts classes.

INDUSTRIAL ARTS IN GENERAL EDUCATION

The democratic tendencies of the eighteenth and early nineteenth centuries instilled the movement of giving the industries a place in general education. The general education of every public school pupil is not complete unless he develops understandings and appreciations of the manufacturing industries and the involved relationships of manufacturers, workers, and consumers. It is possible for pupils to develop these concepts through industrial arts courses in the school program.

<u>What is Industrial Arts?</u> Among the first new problems after the Civil War was the need for skilled mechanics. Up to this time most all workers came from Europe. As the need for practical education became more urgent, the insistence on the establishment of schools for training of mechanics increased. This demand coincided with a movement among certain educators to liberalize the school curriculum. They were discussing means of making education more democratic. The agitation was slowly increasing in influence during the decade of 1870 to 1880.

Amont the leaders of this movement were two prominent men, Dr. John D. Runkle, President of Massachusetts Institution of Technology, and Professor Calvin M. Woodward, of Washington University, St. Louis. President Runkle was seeking a practical method of teaching the mechanical processes of industry to students in engineering. Professor Woodward was interested in having all boys taught shop work as a means to their better education regardless of their chosen vocation. Dr. Runkle later set up a plan to give instruction in shop practice just like laboratory courses in chemistry or physics were taught. Woodward likewise started instruction in shopwork subjects in St. Louis. His work was so successful that he immediately adapted it to his plan for making handwork a part of general education. This new work was called Manual Training by Woodward. (48, page 193)

All of the earlier manual training courses were modeled on that of Woodward's school and hence were an adaptation of the "Russian System." (48, 193) The essential features of the Russian System was, in brief, that of analyzing workshop operations into their elementary processes of arranging these in a graduated series and making them the object of systematic drill by the student. This system was not designed to train for mastery of any particular trade, but rather it cultivated skills in "the elements which underlie all industrial pursuits." The present type of such work, called industrial arts, is quite different from the courses developed at the St. Louis Manual Training school.

General influences entered during the years between 1880 and 1900 which seemed to modify the original type of industrial work in the secondary schools. These aided in making such work more adequate and tended to meet the needs and interests of American boys.

Between 1900 and 1915 there was a renewed agitation by industrial leaders and certain school men to adopt real vocational education for the industries. This movement proved to be the most significant of all those affecting the history of practical education since 1880. One definite result was the Smith-Hughes Act which provided for a federal subsidy for vocational industrial education. Also there resulted a greatly enriched industrial arts quite different in content and method from anything that had gone before. Its purpose was to provide general education in the industrial arts.

Whatever the value of industrial arts as it appears in public schools as a phase of industrial education, it is unquestionably valuable as a phase of the general education for boys who have to live and work in an industrial environment.

Mays in a summary of the factors of industrial arts states: (48, page 209)

> The subject of industrial arts, while it has certain very significant vocational values, is properly regarded as an important phase of the program of general education rather than a program of specific trade training.

There are many problems which should be made the basis for student investigations in the industrial arts field. Such studies will help in the development of a scientific attitude and method of attacking problems, and will extend greatly the knowledge of industrial materials, processes, and products.

Many writers on the meaning of industrial arts have formulated definitions of this subject. Bonser offered this definition of industrial arts: (8, page 5)

> Industrial arts is a study of the changes made by man in the forms of materials to increase their values, and of the problems or life related to these changes.

The State Advisory Committee for Industrial Arts in Oklahoma Schools proposes this definition for industrial arts: (From an unpublished report)

> Industrial arts, as a school subject, may be defined as a study of the processes, tools, and machines by means of which the materials of nature are changed by man to make them more valuable and pleasing. It includes an understanding of the native qualities of raw materials and of the natural forces, together with a knowledge of the methods and practices of utilizing and changing these materials and forces. It is also concerned with the social and economic problems incident to these changes.

One would expect to find the best meanings for industrial arts in a recent bulletin from the Office of Education which is devoted entirely to this subject. Its contributions will be analyzed briefly.

<u>Interpretation of Industrial Arts in American Schools</u>. Industrial arts is a phase of general education that concerns itself with the materials,

processes and products of the manufacturer. The students' learning comes through experiences with tools and materials and through the study of resulting conditions of life. Industrial arts has general values that apply to all levels of education. Proffitt shows this relation in his statement concerning the four general values of industrial arts: (19, page 1)

1. Gains knowledge
2. Grows in appreciation.
3. Increases in ability.
4. Develops attitudes.

The student gains knowledge of the materials to meet the needs of society. The youth also learns of the processes used to meet the changing needs and conditions, and of the industrial workers and the working conditions.

The youth grows in appreciation of the values of occupations as a background for a wise choice of a career. This voluntarily brings about the appreciation of good designs and a better understanding of industrial processes.

Through creative and constructive experiences the student learns of the sources of industrial and related information, to handle tools and materials effectively, to make good use of his leisure and to express with material things his individual interests. The youth develops better attitudes concerning safety practices, and consideration for workers in all fields. Furthermore he develops a greater respect for property and learns better cooperation.

Exploration and guidance leading to a choice of a career is provided for in the junior high school. Industrial arts is looked upon today as an essential element in the educational program of all boys and all girls.

The Office of Education Bulletin includes these statements concerning the values of industrial arts in the junior high school: (19, page 41)

> Industrial arts, as a part of general education, in these years (a) provides information regarding industry and workers; (b) reveals employment opportunities offered by industry; (c) satisfies the boys and girls desires to create useful things; (d) develops hobby and handy-man interests and abilities; (e) contributes to the taste and judgment of the prospective consumer; (f) develops interest and ability in home repairs and maintenance; (g) affords practice in safety related to the school, home, and industry; (h) gives opportunity for cooperative effort in groups; and (i) illustrates and vitalizes the academic subjects.

These same interests prevail in the fifth and sixth grades of the elementary schools. One of the important problems is to organize an industrial arts program in these elementary schools giving the girls opportunities comparable to those of the junior high school.

Senior high schools provide industrial courses of advancement which lead toward a future vocational career. The greater the number of courses obtainable strengthens the degree of the vocational ability of the student. The value of industrial arts as a contribution to general education of all youth is being recognized and there is an increasing tendency to provide industrial arts experiences for girls.

The Committee submitted the following concerning industrial arts in senior high schools: (19, page 61)

> Industrial arts as a part of general education contributes to this end by: (a) developing an appreciation of design and quality in manufactured products; (b) providing practice in the use of materials and tools for recreation and home utilization; (c) sampling a variety of industries, through advance school courses, in preparation for entrance as a beginner in the skilled trades or into college courses in engineering and architecture.

The activities which may be included in a more general program may be a continuation on a more advanced level than is found in the junior high school. Others will represent new activities involving more complex projects than could be offered in the junior high school.

Industrial arts, a function of complete living, should not be restricted to the programs of the elementary and secondary schools. Due to needs and interests of college students it is suggested that offerings be arranged in higher institutions. It has been acknowledged that industrial arts is an essential part of general education and should be offered in college as well as in the elementary school or high school.

Industrial Arts in General Education. The primary purpose of the American public schools is to provide for an education. Living in a democracy this education must be life itself. Social changes affect the life of every individual so profoundly that your schools must provide a general education which give a cultural development.

Profitt states in Industrial Arts, Its Interpretation in American Schools that: (19, page 1)

> Industrial arts is a phase of general education that concerns itself with the materials, processes and products of manufacture, and with the contributions of those engaged in industry. The learnings came through the pupil's experiences with tools and materials and through his study of resultant conditions of life. It is a curriculum area rather than a subject or a course, being comparable in this respect to the language arts.

Industrial arts has general education values that apply to all levels. Through largely manipulative, industrial arts provides a content which is informational, technical and social in character. It gives opportunity for observation, discussion, reading, experimentation, and creation of many things, therefore satisfying many of the impulses inherent in the individual. In a consistent and continuous program of industrial arts, the values are cumulative in effect. The pupil gains knowledge of the interaction of tools and materials, and this in relation to society. The youth develops an ability to plan, to construct, and to evaluate the work that has been undertaken. From these experiences grows an appreciation of industrial progress, materials, and the labor involved in the production of things which make modern society possible.

The pupil develops attitudes of consideration for and cooperation with others. The youth's conceptions of safety, respect for property, and dignity of labor assume new meanings and have a genuine significance in life.

Siepert, writing an article for an industrial arts number of the magazine Education, made this comment: (61, page 235)

> John R. Runkle, a pioneer advocate of industrial arts teaching in the United States, based his proposed system of handwork upon the theory that such a course could be arranged and taught systematically as a valuable part of general education for all pupils, regardless of their future study or business pursuits.

The methods that Runkle devised were those appropriate to the various mechanic arts at that time. During a period of more than sixty years, many new and sometimes different viewpoints concerning both objectives and methods of teaching industrial arts have appeared. Siepert tentatively stated items which will indicate a line of procedure for teaching industrial arts: (61, page 236)

> Industrial arts is an important element in general education because it provides an opportunity for personal experience and learning by doing.
>
> Industrial arts is a part of general education because more than in any other subject, the individual pupil rather than a class is the unit of teacher consideration.

Industrial arts is a part of general education because it provides opportunity for practical consumer education.

Industrial arts is a part of general education because it assists in making provisions for the leisure time of the present industrial era.

Industrial arts is a part of general education because it affords the background for exploratory and tryout experiences helpful and occupational guidance.

Industrial arts, like any other subject, found in the general education program, calls for adequate equipment.

Industrial arts, perhaps more than most of the subjects commonly considered a part of general education, calls for more than one method of teaching.

The best way of acquiring knowledge, and of being able to apply that knowledge, likewise finds appropriate use in industrial arts. Industrial arts has every right to be considered a part of general education since it has long provided for active pupil participation.

To achieve these objectives, many materials have been used as media of expression in industrial arts subjects. Every medium used must be relatively inexpensive, within the working ability of the pupil and appealing in its finished form. Wood, metal, paper and many others have been used. Recently a new material has been made available, this material is known commonly as "plastics".

PLASTICS, INDUSTRIAL ARTS AND GENERAL EDUCATION

A decade ago people knew very little about plastics, but in the past few years plastic materials have developed so rapidly that they can be seen almost everywhere. Due to the rapid progress of plastics the individual should know more about this product. The writer is attempting to show the close relationship of plastics to general education through its use in the field of industrial arts.

<u>A New Craft Material</u>. Man is always looking for better materials to use for building and construction. Each new discovery has been a forward movement in useful arts. From the Stone Age to the Bronze Age was a big step in progress. The discovery of glass, alloys, the production of steel, each brought new convenience and beauty. Each made possible new and interesting material for the architect and designer.

Today may be the "Plastic Age." Certainly plastics have entered our life as a useful material whose future is unpredictable. The limitation of the various materials points to the use for which each was intended. A few plastics are limited in color but nearly all are obtainable in hard or soft form. Some are very resistant to heat and acids, and are readily applicable for electrical and industrial work.

It is only recently that a new plastic material has appeared. This new plastic has the qualities that are necessary for fine decorative work. It is harder than most woods yet it can be fabricated with woodworking tools.

The interesting feature to the craftsman and shop students is its range of color. It is well described by a statement from an address by A. S. Zimmerman at the Franklin Institute in November 1938: (69, page 3)

> The cast resinous materials are made in so many colors that it is appropriate to say that they rival the colors of the rainbow, from transparent water white material, which is clear as a crystal, to a black that is as opaque and beautiful as jet. There is also beautiful jade in many shades and there are all the colors of the semi-precious stones, onyx, and mottled effects....transparent, translucent and opaque colors, all alive and vivid. Amber, ivory, Brazilian onyx, coral, quartz, tortoise shell ....all compete with each other in their endeavor to show that this man-made material knows no limits of color....
>
> It is possible to produce some very interesting two-color effects in this material by double casting. For example, a square rod of one color is cast in the

center of a round rod of another color. This makes it practical to obtain some very interesting patterns in contrasting colors by proper tooling and change of tool edge. When the forming tool cuts into the inside color of a two-color tube, a pattern is exposed, changing in contour or design as the forming tool is change in shape.

Here it is possible not only to duplicate articles formerly made of wood, but also one can develop with it entierly new designs, either used alone, or in combination with wood or metal. Since the color goes through the material every piece will take the same high lustre, therefore, paint and applied surface finishes are unnecessary.

Plastics in Modern Design. Any attempt to list all the uses of this material in modern design would be useless since these uses cover a very broad field. Clocks, book ends, salt and pepper sets, paper weights, all offer possibilities in the gift field. Handles and drawer pulls, overlays and inlays for cabinet work comprise another field. Household furnishings can be delightfully modernized. Trim handles and accessories for toasters, gas stoves, refrigerators, colorful wall switch plates, etc., are examples of common uses of plastics in modern design.

Seven Classifications of Plastics. To become acquainted with the purposeful use of plastics one must know something of the ramifications there are in the plastic industry. Some one company alone may have more than 200 varieties but broadly speaking, plastics may be grouped into 7 classifications:

1. Cast plastics.
2. Molding materials.
3. Laminated products.
4. Liquid products of the heat hardenable type.
5. Synthetic resins for air drying finishes.
6. Wood adhesives for bonding plywoods and veneers.
7. Special resinous materials for calendering fabrics.

There are two general practices in producing plastic products. One has been to shape them by mold, and the other is to cast them and then fabricate. The process of fabrication can be done with tools in the workshop.

Plastics in Industrial Arts. Plastics might be known as "America's fast growing industry." We have evidence that this fascinating material has existed in one form or another for quite a number of years, but, find that its use in Industrial Arts is quite a recent development. A verification of this assertion may be found in a recent magazine article by Skomp, in which he said: (62, page 193)

> Until a short time ago, school shops, art classes and school laboratories could not make use of plastics for class projects because of their prohibitive price for the necessary equipment....Now that industrial art instructors see the possibilities for the use of plastics in the school shop, no doubt the industry will cooperate in every way to give the shop teacher cast blanks suitable for the student's requirement ....

In industrial arts there is still another value which should not be overlooked. It is not enough that material things shall function but there is also a demand for beauty. Pleasing form and color are found plentifully in plastic projects. Their use will aid in developing appreciation of the finer manufactured things for daily use.

Plastics contribute much to art and design. The student is given an opportunity to create and from reports many students are doing well in designing. The variety of the projects of plastics is as broad as the student's ability and creative imagination, as well as the tools he has available. In the past three years plastic projects have been fabricated by craftsmen, schools and institutions throughout the United States.

It would be futile to attempt to enumerate all of its uses in the shops. Dunham in writing on modern plastics says: (20, page 193)

> Already rumblings are heard of "The Plastic Age" and the alert industrial arts teacher will do well to keep his ear on the ground with industry....
> They present a challenge to one's imagination, and industrial arts teachers are fortunate indeed that they may introduce to their students this beautiful and striking modern material....here is a new material worthy of new and inspired design.

The use of plastics is giving the shop students a broad field in creative design. Many beautiful projects have been made in the past few years by the home craftsmen and shop pupils. Dorrance in an article on plastics in the Industrial Arts and Vocational Education Magazine states: (23, page 378)

> The use of plastics in the school shop has been steadily increasing, this is due to a number of reasons, the color range is very wide, the material works well with the ordinary tools, small space is required for storing the stock and the cost is reasonable.

The Contribution of Plastics to General Education. Plastics can contribute much to education through Industrial Arts. The industrial arts work is justified, not because the objectives of the industrial arts teacher are essentially different from the objectives of the general education teacher, but because the experiences provided in industrial arts offer a more effective and economical means of developing certain desirable objectives given as aims of general education than can be attained through so-called academic subjects. Practical experience in Industrial Arts is very effective in developing attitudes and habits which contribute to desirable goals of general education.

Summary. In this chapter the writer has attempted to show how plastics as a subject in the industrial arts field, would contribute to general education. This would give the students a knowledge of practically the most recent consumers product. In Chapter III the historical development of plastics will be given.

CHAPTER III

THE DEVELOPMENT AND USE OF PLASTICS IN AMERICAN INDUSTRY

In the nineteenth century a substitute for ivory seemed to be desirable. Through the research necessitated to make this discovery a new material called"Celluloid" was developed about 1870. This material was little changed for many decades. By 1907 a new synthetic resin known as "Bakelite" came into existance which because of its many properties was to have a great future and the last decade has witnessed a phenominal growth of the uses of this material in the United States. Today plastics occupies a permanent and important place in our national economy. There are many types of plastics now on the market under a variety of trade names. Many new types are being introduced and new methods of manufacturing have steadily increased until today plastics are molded, cast or fabricated into articles which can be used in the construction of the automobile, radio, airplane, lighting equipment, refrigerators, display signs in advertising, costume jewelry and many other items used for the individual.

THE EVOLUTION OF PLASTICS

The beginning of plastics had its first appearance in 1869 when Celluloid was discovered by Hyatt. In 1907 a new synthetic plastic material known as "Bakelite" was developed by Bakeland. Since that time many synthetic resins have been developed and in 1932 there were thirty companies manufacturing phenol-formaldehyde type of plastics. Today there are many chemical bases used such as urea, cellulose acetate, nitro-cellulose and methyl-methacrylate, and these are manufactured into cast, laminated and molded products for industrial uses. For further information on the evolution of plastics refer to appendix E.

The Discovery of Plastics. In 1869 the supply of elephant ivory had diminished sharply, which resulted in a stimulating effect on the price of billiard balls. A manufacturing company desiring to make cheaper billiard balls offered ten thousand dollars to anyone who could find a substitute. The challenge was accepted by a young printer, John Wesley Hyatt. By treating cotton cellulose with nitric acid, he achieved something he called celluloid, and today thousands of celluloid balls are sold annually.

Hyatt won the distinction of having created "something new under the sun," a material that could not be changed back into the substance from which it was made.

For the next twenty-two years, no new inventions appeared in this field. The celluloid corporation developed as a result of Hyatt's discovery, marketed its own plastic as a substitute for ivory, amber, mother-of-pearl, and tortoise shell, which were dear to the Victorian heart, and ended by making the celluloid collar an American symbol.

Second State of Development. In 1890 Dr. Adolph Spitteler of Hamburg, Germany, trying to make a white blackboard, whimsically mixed sour cow's milk with formaldehyde. The result was a shiny hornlike substance, the second plastic material, the base of which was casein. This is manufactured in the United States chiefly by the American Plastic Corporation and the Aladdinite Company, which has to do mostly with buttons and buckles.

Acrylic Resins. The industrial development and application of acrylic resins has been due mainly to the research of Dr. Otto Rohm of Darmstadt, Germany, who has worked continuously with these materials since his original collaborations with Von Pechmann in 1901. Recently many publications on these products have appeared in academic, industrial, and patent literature. Various methods of preparation of monomeric esters have been described; the essential starting materials for most of these syntheses are petroleum, air, coal, and water. Monomeric esters are manufactured from readily available organic chemicals by a series of reactions which involve several carefully controlled steps.

Not until 1909 did an important new substance emerge. When Dr. Leo Bakeland of Yonkers, New York (Belgium born), attempted to create a fusible and soluble material to compete with expensive natural resins, (damar, copal, shellac, etc.) got instead an insoluble, infusible, material now known as "Bakelite". This was man's first synthetic resin, created out of phenol (carbolic acid) and formaldehyde, two substances encountered most frequently in hospitals. It is a material that never existed before. This material was named "Bakelite" after its inventor. An article appeared in the Time Magazine, May 20, 1940, that read as follows: (66, page 50)

> Philadelphia's Franklin Institute presented one of its coveted gold medals to Leo Hendrick Bakeland inventor of Bakelite, "Father of Plastics."

Since that wonderful invention synthetic plastics have developed rapidly. So different are they from the things they are made to resemble or replace, that it would be difficult for any chemist to discover how they are made. In refining these materials, the chemist would find they are not characteristic of their chemical composition nor would they show the relative amounts of materials used in the plastic. The synthetic plastic is a glamorous substitute for many natural materials and is a tribute to the powers of man.

PLASTICS IN INDUSTRY

Since Bakeland's discovery synthetic plastics have developed rapidly. The great factor in the development of the new plastics in the post-war years was the advent of mass production methods and injection molding which is one of the major inventions of the age. This has played a large part in bringing plastics into the industry.

The author of the Fortune Magazine writes: (35, page 1)

> There is a wide spread impression that plastics have been making a phenomenal industrial progress; and they are about to supersede glass, wood, porcelain, rubber and even metal.

In almost every branch of industry plastics have brought about many changes. They combine light weight with remarkable strength and are able to resist the average of corrosion. Plastics thus find increasing use in the construction of chemical equipment and machine parts. As secondary materials of construction they have had a marked influence on the development of many industries, such as electrical engineering, radio, telephone, aircraft and the automobile. It is well to mention that in many instances the active collaboration of other industries with those engaged in the manufacturing of plastics has stimulated production.

Supplementary Building Material. The use of plastics in industry has been increasing rapidly in the past decade. Mass production started in 1935 and has advanced rapidly until it is predicted that 1940 will be the greatest year in its historical development. Leggett, in his article on plastics states: (42, page 655)

> ....the American of tomorrow will live in a plastic house, drive a plastic automobile and fly in a plastic airplane.

Plastics are being used in many of our industries today. Every day the plastic industry is taking a more important part in the economic structure of our nation. They are becoming more widely recognized as improved materials which have replaced age-old substances by making hundreds of products more useful, more beautiful and easier to obtain.

The leader in the use of plastics is the automobile industry although electricity has many uses for it as insulation. The past few years have seen the development of laminated plastics for interior decoration.

1935 Production. Taking a bird-eye view of the year 1929 makes it look like a continental divide separating the old from the new. Before 1929 the progress of plastics was very slow but following that period many new plastic products began to appear on the market. The progress from then on was very rapid until in 1935 production reached an all-time record. Nearly one hundred million pounds of synthetic resins were manufactured. The raw material was worth fifty million dollars and after being manufactured into finished articles, its value increased to about one hundred fifty million dollars.

1939 Production. The current plastic production has made a steady gain since the year of 1935. The total production of all synthetic resins was estimated by the government as being 231,027,548 pounds in 1939. This total production revealed a 38 per cent gain over 1938 and excelled any preceeding year. There are at least thirteen types of plastics now on the market with new types being introduced at the rate of one every twelve months, contrasted with the pre-1929 rate of about one every twenty years.

Types on the Market. The four general types of plastics in use today are cellulose, protein, natural and synthetic resins. These have several trade names although the chemical composition is about the same. The synthetic plastic is making the most rapid progress today and most of the new plastic developments have been of synthetic origin. These are the types that have made an increase in the field of production. The great difficulty was the lack of market facilities.

Buyers of Plastics. In the beginning it was difficult to sell this new material. It was completely unknown and manufacturers had no idea how to apply it to their advantages. They could see the beauty but could not visualize their fabricating processes, yet they realized a great need for this type of product existed. Jewelers, manufacturers of beautiful things for interior architecture and decoration foresaw a great future in plastics. Innumerable manufacturers of novelties had wished for a less expensive domestic material to replace the important precious and semiprecious stones, ivory, crystal and other materials which were so costly to make into consumer goods.

Therefore, manufacturers had only to be shown how to make use of this material and some of the possibilities it contained. Cast resins are admirably suited to novel and decorative uses and the need for this type of material has grown into a substantial demand.

Another field opened for further development is general hardware, such as handles for knives and forks, kettles, pots and pans, where a non-heat-conducting material can best be used for comfortable handling. Attention is being given by manufacturers to strengthening this material and standardizing colors to meet immediate decorative demands.

The field of decorative accessories, such as gifts, premiums and home accessories, has the greatest opportunity outside the building and button field for rapid growth.

Displays and exhibits are another great field served by cast resins in a limited way. It offers greater opportunities for volume in the cast resin industry than ever before. That means, in spite of tremendous coverage achieved by the material, the volume still has not been as it will be when fabricators realize its full scope.

With the growth of art in industry, cast resins have found a very practical use in modern packaging. The material is comparatively undeveloped in this field but cosmetic manufacturers are leading the way. This is evident that the use of plastics in every day life is becoming more in demand.

PLASTICS IN EVERY DAY LIFE

In less than seven years cast phenolic resins have come out of the laboratory into the hands of nearly every person in the United States. A certain manufacturer (15, page 1) estimated that seven out of every ten women wearing costume jewelry purchased this season will be jewelry of cast resins. About five out of every ten picnickers will have knives and forks with gaily colored handles. Three out of every ten automobiles on the highways will have from one to many pieces of plastics on them. People purchasing this material, however, do not know it by the name of cast resins.

Plastics and the Individual. Not long ago many people cherished collections of trinkets gathered through the years. In these collections are found rings, a gold bracelet, a locket and chain, a brooch set with tiny stones, pearls, and perhaps a few strings of beads, all memories of some special event. Then came costume jewelry, colorful, decorative, inexpensive, until today the same jewel box could not begin to accommodate the treasure. Since about six years ago seventy-five per cent of all costume jewelry is made from cast phenolic plastic material. Smartly shaped and designed with its jewel-like color and brilliant sparkle, it beams from the hair, neck, shoulders and wrist of well-dressed women everywhere.

A new plastic, cellulose acetate, has been especially suitable for jewelry production. Their modern settings were created by Ernest Stiner, a jewelry designer. Because of the full color of cellulose acetate plastic, this material was selected to execute into chinese designs. The original pieces on display at the Arden Gallery, were used as models by the die makers. There is almost no limit to the size, shape, and intricacy of motifs which can be produced. Good design is a noticeable feature in almost every display of this new version of plastic jewelry.

There were matching sets ingeniously fashioned from strips of laminated woven wood veneer. The exhibit also contained crystal-clear methyl methacrylate bracelets and pins decorated with artistically carved patterns. They come in jewelry colors as sapphire, ruby, pink, blue and many other shades. Now it appears that plastics are leading in the realm of costume jewelry, and progressive manufacturers should have little trouble if they follow the style trend with well designed pieces.

At this time the writer will attempt to enumerate many of the articles an individual might wear at a given time that are made from various plastic substances. Some of the most common are buttons and buckles of various designs. In the costume jewelry are found ear rings, bracelets, necklaces, hair ornaments, rings, breat pins and lockets. In the eyewear are optical frames of almost any design and travel goggles with colored lens of plastics which are very fashionable. The frame part of the ladies' purse in many cases is some type of plastic. In the purse is found a plastic rouge case, lipstick case, comb, vanity case, mirror back, pen and pencil set and key holder. As a part of the dress one may wear there may be belts, suspenders, garters, slide fasteners, wristwatch bands, trimmings on the hat, nylon hosiery and scuffless heels on ladies shoes.

At the Eleventh Annual Boston Conference on Distribution, Pitcher, the General Manager of the Du Pont Plastic Department, introduced a feminine model portraying "Princess Plastic" showing the development which the plastic industry has made in the last few years. The plastic articles that this model wore were as follows: (29, page 15)

> "Princess Plastics" wore a crushed crown hat of bright red velvet with an upturned visor type of jet black "plastacele" cellulose acetate plastic. This color was repeated in the slide fastener of her rayon velvet dress......and scuffless heels of her shoes covered with "Pyraheel" plastic heel covering material.
>
> Her jewelry ensemble consisted of a triple strand necklace of an entirely new pearl effect of "Lucite"........with a chain of "Plastacele" covered wire in a blended color. The black suede handbag she carried was built around a frame of attractively carved crystal "Lucite".
>
> Even the contents of her handbag displayed the versatile role "Lucite" is playing. A smart rouge container and lipstick case made of crystal clear plastic.........A ruby red carry all, light and dainty in appearance, had space for a comb, cosmetics and cigarettes. For a more determined sprucing up, she carried a collapsible "Pyralin" comb with short "Exton" bristles at the base.............................
>
> For style and utility in eyeware, she also turned to plastics, equipping herself with a pair of oxford eye glasses, with "Pyralin"

> rims of flesh tone to match her complexion and lorgnettes with brilliant red rims to match the shade of her velvet crown hat. Her stockings were of nylon, a product of chemistry. She carried a crystal clear walking stick of "Lucite" with a hand carved handle and tip. Some 16 articles of chemistry went to make up the plastic's attire truly fit for a princess.

From this quotation it is evident that plastic articles the individuals wear are becoming more fashionable every day. The designers are able to see the great future in the use of plastics for the individual.

Plastics in the Automobile. Chemically-made plastics predated the first motor car in this country by almost three decades, but only within recent years have the materials been used extensively by the automobile industry. Figuratively, they started very slowly, advanced somewhat in demand and then remained stationary for a long time. Now plastics are being more extensively used in the 1940 models.

Automotive consumption of plastic material increased in the manufacturing of 1939 models, and the new high may be achieved this year. The reasons for this increase in the use of plastics are many, but two or three deserve special mention. Within recent years the chemical industry has developed new molding compounds and automobile body engineers recognized the potentialities of these materials for interior and exterior decorative uses. Improvements have been made in molding equipment. On the purely utilitarian side, plastics have long been used for making gears, pump-rotors and distributor heads, and these applications are extending rapidly.

Kline tells us that: (41, page 50)

> A transparent celluloid storm front in a 1905 single.cylinder, 7 h.p. motor Oldsmobile runabout represents the first appearance of plastics in the automobile.

American motorists have been riding behind laminated safety glass for so long they have forgotten the years that predated the safety glass era. Since that time many states have required safety glass windshields and now most cars carry safety glass in the side windows. Laminated safety glass is a sandwich containing a plastic sheet pasted between two panes of plate glass. When the glass is broken the particles adhere to the plastic instead of flying.

Most of the new automobiles safety glass will carry a new type of plastic interlayer which gives greater safety and more satisfactory service. Here again the purchaser will not recognize this added improvement. Many years of research were made before the manufacturing process went into perfection. This product is "Butacite" polyvinyl acetate resin, the new safety glass interlayer. This material excells all previous materials in both appearance and protective characteristics. The outstanding improvement of the new interlayer is its ability to yield under impact without itself being broken and at the same time holding shattered pieces of glass together. Accepted tests show that laminated safety glass made with Butacite is superior to other types in both impact strength and behavior of the pane when broken.

Little does the average buyer of attractive new models realize the work entailed in making possible these glamourous colorful plastics which gives one the overwhelming desire to own a new car. Engineers are constantly busy testing materials for ability to stand up under the conditions it is likely to encounter.

These cars are not sold in the same community, therefore, they must test for varying temperatures. This plastic material must be able to withstand the wide extremes of temperature. Most of this material is put to a test of minus 55 degrees Fahrenheit and is then submitted to a temperature of 158 degrees for a period of twenty-four to seventy-two hours.

The 1940 models have reached a new level in the consumption of plastic materials. The General Motors Corporation is again in the lead for the utilization of plastic materials. "Lucite" methyl methacrylate and "Plastacele" cellulose acetate molding powders are used for eight parts of the Buick. These parts include the steering wheel, interior fittings, instrument dial parts, directional signal lenses, clock dial ring, radio push button and horn button cover. The Oldsmobile is also a big user of these materials with seven plastic applications.

The Chevrolet and Pontiac have radiator ornaments of "Lucite" and acetate plastic steering wheels and interior parts. In addition, the Pontiac is equipped with a "Lucite" horn button and speedometer background, molded of "Plastacele" powders.

Other manufacturers are using plastics liberally in the current models. The steering wheel and interior fittings of the Hudson are of acetate composition, other parts are made of "Lucite". In the Packard many parts are molded from the crystal-clear plastic, and both the Lincoln Zephyr and Lincoln cars use "Plastacele" beading inside for decoration. What the future has in store is still a prophecy. New compositions and new materials indicate applications that today seem remote.

Possibilities of the Use of Plastics in the Airplane. This material is strong, unbelievably smooth, resistant to time and weather, impervious to water, fireproof, corrosionproof, and easy to fabricate. These are the outstanding claims made for new plastic airplanes being built at Van Nuys, California, by the Timm Aircraft Corporation. Experts believe that the development may revolutionize the airplane industry and become one of the most potent factors in our national defense program.

The new airplane made of plywood impregnated and bonded with phenol resin plastic, can be molded to the proper shape in a press. The parts may be stamped out in only a fraction of time required to rivet or weld the metal. The rapid construction of military planes becomes a matter of vital significance. The construction of metal wings and fuselages is a slow process also, metal is expensive, heavy to transport and bulky to store.

Planes of plastics and plywood solve all these problems and furthermore they could be turned out in quantities that would stagger the imagination. The first such craft flew near Los Angeles, and may be the forerunner of a great swarm.

There are only two plants in the United States producing such planes on an experimental basis. No military aircraft has been completed from this plastic material but several experimental models are approaching the testing flight. No mass production has yet been attempted by the manufacturers. The first ship to be produced by this practical mass production method was the one used for the tryout near Los Angeles.

There is nothing in the method of production that cannot be applied to high-speed streamline production. Briefly there are only a half dozen steps in the method of construction. A half shell of each essential section is built up on a jig. Spruce strips, which are the full length of the section being formed and a few inches wide, and one twenty-fourth inch thick, are arranged to form three layers in the same order as three plywood.

The plies are sprayed with a phenol resin plastic compound which takes the place of glue used in plywood. Not only is this applied to the surface, but the plastic is forced into the wood. After the plastic binder sets, the section is placed in the mold which is the exact size and contour desired. Pressure is applied forming the precise shape and fusing the compound with the wood so as to form a completely new substance. The cold process used in forming seems to have a great advantage, thereby eliminating the problem of using heat.

When the plywood plastic shell comes from the press, it is smooth and almost metallic in appearance. Then it is placed in a huge jig which has the form of the fuselage and wings. The plywood plastic "skins" which are to cover each section of the plane are then arranged in place as diestamped sheets of metal, but instead of being riveted, the joints are simply sprayed with a plastic solution which when set makes the joint as strong as the material itself. The plane has been formed into several large sections, these include the entire fuselage, the wings, and the tail surface. These are given a final coating of plastic and placed in the baking ovens at temperature varying from one hundred eighty degrees to two hundred forty degrees. This heat sets the plywood plastic "skins" into a single mass without seams. To complete the plane, it is only necessary to attach the wings to the fuselage with a simple couplings. The tail surface and engine are assembled with swiftly completed attachments. The interior structure is completed while the other parts are being formed in the jig.

The plane which has been built with only a fraction of the labor necessary for metal construction, is ready to fly. The material is cheaper and more readily available. The plane is 20 per cent lighter than wood and is more resistant to fire.

Miller in his discussion on the plastic plane states: (50, page 69)

> Elimination of all external roughness, such as rivet heads and joints, gives increased speed potentialities of up to 25 per cent.

There is one defect of plywood plastic planes and that is they are difficult to repair. Engineers are now working on the problem. The objection is not so serious as far as military airplanes go, for war planes are usually either only slightly damaged or they are a total loss.

There is one more test the plywood plastic planes must pass, that is the actual experience, thousands of hours of flight, into storms and in calm, under every conceivable condition. When this test is complete and they have been successful, American may have airplane production potentialities which will make the future skies plane-filled.

Other uses of plastic materials in the airplane are given by Leggett as being: (42, page 128A)

> Acrylis resins, such as Acryloid, Crystalite and Plexaglass, are employed by the airplane industry in sheet form for landing-light covers, cockpit enclosures, windshields and windows and gun turrets, because of their light weight, weather resistance and clarity an important factor from the standpoint of visibility.

In the forward cockpit of the bombers plastics again play their important role, Conduit pipes, parts of seats, unstressed members of the internal arrangement are in many cases made of plastic material.

<u>The Use of Plastic Material in the Modern Residence</u>. For a number of years, interior designers have been favoring the use of plastics and

have been eager to use this material for decorative purposes. They could see so many opportunities in decoration where these new materials seem to fit, but the trouble was to bridge the gap between creation and materialization. No great amount of progress was made until 1936 when transparent acrylic resin appeared in the United States in sheets and also a molding compound in 1937. Things began to change in the interior design field.

Transparent plastics excited the imagination of the designers who visioned complete table settings of matching or contrasting colors, even tables and chairs of unprecedented delicacy and charm. Viewing the decorative they saw nothing but small and troublesome orders ahead. Those who have watched the advance of modern design and decoration, know that any good decorator is not easily discouraged and with hard work the designer will make great progress.

Manufacturers who cater to interior design and have sensed this market for some time now have been giving their best thoughts to the possibilities of introducing plastics into their products. More plastic materials are being made into furniture each year, the exhibit at the World Fair gives evidence of this.

Plastic furniture and decorative accessories are not cheap. The materials when properly handled have intrinsic value worthy of the price. Craft work is always more costly than mass production merchandise. On the other hand, plastic furniture is capable of production by modern manufacturing methods. So lamps and many other items which should bring them within reach of a normal budget are on the market today.

Perhaps the most recent example is the woven plastic furniture styled for use on porches and lawns by Ypsilanti Reed Furniture Company, another the Grosfield House, exhibiting the sixty-fifth Decorator's Interior, in which the furniture was made from crystal-clear Plexaglas.

The plastic used is cellulose acetate, a comparatively new molding compound which has low heat conductivity, absorbs little moisture and is resistant to weather. Custom furniture fixtures and accessories of clear transparent plastics are increasingly evident in smart shops, hotels and some of the wealthy homes.

While costly for the individual consumer, the charm of these pieces have gone beyond commercial application, and now the demand is so great the designers and decorators find it difficult to meet. Experience gained by craftsmen engaged in the work is rapidly translating itself into efficient technique.

A group movement of industrial design appears to be headed into the field of furniture and home furnishings where plastics may receive rather broad recognition as a fundamental material. They want to design furniture which can be brought into the American home styled to the living habits and needs of citizens of the United States. This statement is quoted from the Modern Plastic Magazine: (51, page 74)

> A group of designers, artists, craftsmen, manufacturers and retailers in the home furnishing industry have originated to do business under the name of "American Way" for the purpose of coordinating and accelerating the art-in-industry movement in this country.

They expect to have one retail store in each community who will offer products of these artists and craftsmen. Their purpose is to have this furniture reach every home in America.

Laminated plastics have become the number one choice for interior decorating. By rapid development this modern finishing material has grown familiar in the interior design sphere. New colors, materials and processes point a new way to increase applications for home and building construction. The decorative flexibility and versatility of these laminated plastics is represented from coast to coast.

The writer will attempt to list many of the furnishings in the modern home that are made of plastics. In the lady's bedroom there will probably be found a vanity set on the dressing table, lamp, picture with a plastic frame, a hat box, switch plates, plastic curtain tie-backs, flower vase, and the light shade may be made of plastics. If the furniture is relatively new there will be plastic drawer pulls.

In the living room will be found candle holders, curtain holders, ash trays, piano with plastic keys, picture frames, radio, flower vases, and lamps with shades. In the dining room will be a plastic fruit bowl, candle holders, trays, switch plates, light shades and there could also be glass sets, napkin rings, telephone set and desk set.

In the bath room are faucet handles, parts of a clothes hamper, bath salt containers, shelves, plastic wall panels, light shades, switch plastes and door push plate, etc. In the kitchen there might be plastic knobs or pulls on the built-in fixtures, plastic knobs and handles on cooking utensils, pulls on the stove and water faucet handles and possibly plastic measuring cups, knive and fork handles, and electric coffee pot handles, electric toaster handles, and electric mixer frame, some dishes, salt and pepper sets, bottle caps, clock frame, light sockets and the house number. If an electric refrigerator is in the kitchen, it will also have some parts made of plastics. Other articles of the home having some plastic parts are the typewriter, electric sweeper, and the electric washer.

At the rate plastics have advanced the past few years, there will be many more articles in the home that will be made of plastics. Some authors predict that many homes will have plastic furniture in the next few years. There is a possibility of plastics becoming one of our leading decorative materials.

Universal Decorative Uses of Plastics. There is not any doubt about the outstanding popularity of plastics as a decorative material. Leading organizations from coast to coast have experienced the use of plastics as an interior decorative material for such uses as soda fountain counters, etc. The designer can produce a wide range of effects since the strong selling force has been improved by having discovered a great number of popular colors. Spacious modern curved counters are one of the newest plastic developments.

An article in the House Beautiful relates how architects and decorators are adopting the use of plastics: (63, page 276)

> Architects and decorators have been quick to discover their unique effectiveness, as a wall covering....Architectural accents in interiors are often effectively made through the use of plastics.

For this reason architects and designers in both the United States and Great Britain have been using much of this material in recent years for public rooms of ships, hotels, restaurants and cafes, as well as for soda fountains in drug, variety, confectionery, and dairy stores. The latest innovation is the adding of this material in busses and streamlined trains.

In the Business Week this information concerning Britain's work in plastics was found: (11, page 50)

> In technical knowledge and ability in plastic industry of Britain is hardly inferior to the industry in America, but competent critics urge that it lags far behind in design.
>
> Plastic paneling has been used in some of the newer hotels in London and there is great interest among architects in plastic possibilities. Whispers from America of houses fabricated entirely from plastics intrigue people in Britain who anticipate no early fulfillment.

Much of this material is not brittle and will not chip or break. It is stain proof with any ordinary liquid and some will not tarnish from lighted cigarettes.

During the last few years many large cities have had glamorous Christmas displays which were made possible by the use of plastics. In 1938, Hollywood displayed a Chirstmas decoration showing the beauty of colorful stars made of "Cel-o-Glass" plastic coated wire mesh. Many of the large stores in New York and other cities are adopting plastic light reflectors which increase the volume of light in the room and decrease breakage losses.

Summary. The historical development of plastics shows that its greatest progressive uses have come about during the past few years. Greater trade applications have increased to the extent of the manufacturing of major pieces of furniture and magnificent decorative installations in ships, hotels and other large public places. In order to appreciate the historical background of plastics to the greatest possible degree one should know something of the scientific development of this material and in the following chapter, Chapter IV, a brief insight into such a development is presented.

CHAPTER IV

SCIENTIFIC BASIS FOR CHEMICAL DEVELOPMENT

Since plastics are being used so extensively by the individual and in industry, some information should be given about its chemical origin and composition. It is almost impossible to even imagine the material being of a chemical origin.

Types of Plastics. Plastics may be divided into two types, depending on their physical properties. They may also be classified according to their chemical source. The eighteen or so known basic types fall into four general fields: cellulose plastic, protein plastic, natural resin plastics and synthetic resin plastics. The physical properties, which include the thermo-setting and the thermo-plastic will be discussed first.

Thermo-plastic. Thermo-plastics soften when heat is applied and if heated above 200 degrees Fahrenheit will become a liquid state. This material possesses one advantage in that it may be reheated many times without changing its chemical composition. A typical example of this material was the first modern plastic, invented by John Wesley Hyatt in 1869. This material was known by the scientists as nitrocellulose plastic.

Thermo-setting. Thermo-setting plastics are compounds which definitely alter their chemical constitution in the course of molding under heat or pressure or by both. This plastic sets similar to cement, in like manner heat is applied to the unpolymerized plastic material and it sets by chemical action so that heat does not alter it later. This permits it to be used where considerable heat exists. A typical example is the phenol formaldehyde plastic developed by Dr. Leo Bakeland in 1907.

Cellulose. Cellulose the chief component of the solid part of plants, cotton linter and wood pulp, is combined with acids forming a resinoid suitable for plastic use. The nitrate plastic is inflammable therefore making considerable hazard in manufacturing and storing. The acetate plastics burn slowly like wood or similar materials, they are non-hazardous in production and use. Ethyl cellulose, a relatively new plastic material, is believed to have many possibilities.

Cellulose Nitrate. Cellulose nitrate is a thermo-plastic, "Pyroxylin" plastic being a current example. The cellulose being cotton linter is purified and treated with mixed nitric and sulfuric acid to produce plastic material. Camphor, alcohol and color, as desired, are added to this material making the mixture a dough-like substance which goes through a forming process and emerges in forms ready for the fabrication of articles by the manufacturers. They can be shaped into any form when heated; and these characteristics make them suitable for shop use. It is offered in practically any shade or hue one would desire.

Ethyl Cellulose. Like the older more extensively used cellulose plastics, the acetates and nitrates, ethyl cellulose relies on the same origins for its cellulose, cotton and wood pulp. Ethyl chloride the other component ordinarily used in making ethyl cellulose requires only such common chemicals as ethyl alcohol and hydrochloric acid for its products.

There are some suggestive uses for this product which may make it important.

Cellulose Acetate. Another versatile plastic, cellulose acetate, is a slow burning substance like wood or other similar material. To make it, chemists treat bleached and purified cotton linters with an acid mixture of glacial acetic and acetic anhydride acids to produce cellulose acetate flakes. Plasticizer and coloring ingredients are incorporated to form the dough-like mass to be rolled and baked into a block ready to finish or it may also be formed into a continuous sheet.

In addition to sheets, rods, and tubes, it is also available as molding powder. Current methods of molding are based upon first softening the powder by heat, then forming it in molds by pressure where it is left until cooled.

Protein Plastic. Protein plastic dates back to 1890 when Dr. Adolph Spitteler of Germany, mixed sour cow's milk with an acid to produce a hornlike substance known as casein plastics. The product of casein plastic constitutes a well established industry in Europe but has not progressed so well in the United States due to climatic conditions. More recent developments reveal that it is possible to use soy beans, coffee beans, lignin from wood, peanuts and other types of agricultural products in making protein-type plastics.

Casein Plastic. The product of the casein plastic constitutes a well established industry in Europe, where the product is sold under the name of "Golaith." The process is a potential consumer of large quantities of milk, which appeals to those who are concerned about utilizing agricultural surpluses.

The first successful casein plastic development in the United States was by the Aladdinite Company in 1919. By 1925 four other American firms were in the business. The applications were found to be impracticable in this country because of the marked variation in the climate. This plastic industry has declined, both in number of producing units and in volume of production.

Coffee Plastic. In the use of plastics, one of the most recent developments is found in the coffee bean. Its use was described in an article in the Business Week, January 28, 1939: (12, page 33)

> Good Old Coffee, long the monarch of the American breakfast table, promises to enter a new sphere of influence. "Coffee Plastics" a fruit of a long-range program of the important South American interest. Most remarkable feature of the coffee plastic is the fact that it is wholly the product of unroasted coffee bean. Since the beans are not roasted in the production process, the plastic has no odor.

The process of making coffee plastics requires no additional material other than that found in the coffee bean. The natural characteristics of coffee are such that it produces its own chemicals, plasticizer, catalyst and filler material. This enables such an industry as that of coffee plastics to be self-contained. The plastic can be produced in a thermo-setting or a thermo-plastic form. It is supplied in green, red, mahogany, brown, yellow, and ebony black, by a chemical development of its own coloring material, in which the green coffee bean is wholly rich.

Another interesting article on coffee plastics was found in the Science American. This statement is quoted here: (60, page 224)

> Concerning the cost of manufacturing a bag of coffee weighing 132 pounds. This bag of coffee will produce 40 square feet of plastic 1/2" thick and about 1.25 gallons of coffee oil. The manufacturing process involves no unfamiliar machinery or special handling.

It seems that this new plastic will be ideal to aid the development of the plastic industry in South American countries.

Soya Bean. The principal use of the soybean in plastics is a filler material. The use of soybean meal in plastics is constantly increasing: (9, page 5)

> ....from 4000 pounds in 1934 to 311,750 pounds in 1937. This same company has also done some work on the development of textile fibre, similar to lanital, from soybean protein.

The Ford Motor Company uses most of this soybean plastic for electrical insulation and decorative purposes in the Ford and other cars manufactured by that company.

Natural Resins. Natural resins are those formed by nature such as rosin, copal, shellac, asphalt, rubber latex and tar. It is sometimes necessary for man to perform some operations when separating this material from other substances to make it usable. Shellac was used mainly for wood finishes prior to the advent of the phonograph industry. Copal, another important natural resin, is obtained from Africa where it is found as a fossil resin. An example of a natural resin is lac, secreted by a little bug that sucks the sap of certain trees and converts it into a covering for its own protection. The lac picked by hand from the bark of certain trees in India and South Asia is refined and dissolved into a suitable solvent, forming shellac.

Shellac Plastic. The first natural plastic to become important in this country was the shellac plastic. Shellac has been used for polishes and varnishes for several centuries. Some of the patents relating to its use as a molding composition were enumerated by Gorton M. Kline as follows: (41, page 51)

> One was to Merrick 1868 and another to Gardner in the same year. However the first application of any magnitude for shellac molding composition dates from its use by Emel Berliner in 1895 for phonograph records.

By 1888 he had worked out a detailed method so a sound groove could be cut in a flat disk. In 1895 he turned to plastic composition containing shellac as a binder and soon the technique of a molding shellac base for phonograph records was under full development. It remains today the largest single outlet for shellac plastic molding.

<u>Copal</u>. This is a hard lustrous resin varying in hue from an almost colorless transparent mass to a bright yellowish brown and when desolved in alcohol or spirits of turpentine it forms into a valuable varnish. Some copal is obtained in Brazil and other South American countries and other types are found in India and Africa. The most important resin gum, from a commercial point of view, is the Zanzibar or East African copal.

The resin is found in two distinct conditions: (1) raw or recent; and (2) ripe or true copal. The raw copal is obtained direct from the tree or found near their roots. The true or fossil copal is found embedded in the earth over the main coast line of Zanzabar. It is found at a depth greater than four feet, and occurs in pieces ranging from small pebbles to lumps weighing four or five pounds.

<u>Synthetic Resins</u>. The synthetic plastics are different from natural resins in that they are not found in the natural state but are made by man through chemistry. Synthetic resins are compounded to form a

chemical composition and are the results of chemical reaction. Synthetic resins are of three classes, namely, molded, cast and laminated. The molded plastics have made considerable progress and almost every type of synthetic plastics are found to be moldable. The cast resins are being used extensively as decorative, chemical resistant and photo-elastic materials. The use of the laminated plastics has been increasing in decorative construction, industrial services and electrical insulation.

Molded Phenolic. Phenolic molding materials are prepared from primary phenol resinoid and suitable fillers, such as wood-flour asbestos, fabric, and paper. The important ingredient is the resinoid, which is produced through the chemical union of phenol (carbolic acid) and formaldehyde. The fillers are used for the special properties which are needed in molding materials to produce better qualities, greater toughness and strength, and other important characteristics. Liggett in his article on phenolic plastics stated that: (42, page 130A)

> Phenolic resins which depend for their origin upon synthetic substances made from coal or other organic raw materials, may be cast or molded. The cast resins offer unusual ranges in translucency, transparency and opacity, and a wide variety of shades and hues, both in plain colors and in mottled effects, can be achieved through the addition of dyes and pigments.

Because of their dimensional stability, excellent electric insulating qualities, resistance to heat, water and chemicals, moldability and low cost, phenolic molding materials are leading among plastics. Their unique combination of properties is responsible for their wide spread adoption throughout all branches of industry and the reason why "Phenolics" have become the largest of all plastic groups in both volume and value.

Molded Urea. Through the chemical union of urea and formaldehyde, a light colored resin is obtained. This resin is the basis for a wide variety of urea molding materials. Like the phenolics, fillers, are added to gain certain desirable molding characteristics. Ureas have excellent resistance to color change. Their most delicate shades remain unaffected by exposure to light over long periods of time. The luster gives the material a distinctive rich appearance. Nelson (52, page 6) comments as follows in regard to Urea-formaldehyde:

> ....These, too, are thermosetting. While being molded under heat and pressure, a chemical condensation takes place which makes the finished pieces resistant to further application of heat.... Unlike ordinary wood-flour filled phenolic compounds, urea resins can be made with a considerable degree of translucency.

The urea resins introduced in this country in 1929, known as Beetle, Plaskon, and Bakelite Urea, are in moldable powder form and as a water soluble resin to treat paper, cloth and wood veneer for laminating. Not only are these materials valuable in product-styling, but they possess properties that contribute to product durability, such as unusual flexural and tensile strength, resistance to alcohol, and good dielectric qualities.

Molded Cellulose Acetate. Plasticizers, dyes and pigments of the best quality are blended to form cellulose acetate molding materials. These are supplied in powder form for injection and compression molding. These materials possess extreme toughness and resiliency offering very high resistance to impact. They are furnished in virtually any color desired, from opaque to crystal-clear forms. Products molded from cellulose acetate are noted for their exceptional luster. These characteristics, combined with relative lightness in weight, give these materials superiority over other types of plastics for many uses. Leggett (42, page 128A) states that cellulose acetates:

> Like the cellulose nitrates, are thermoplastic, softened by application of heat and hardened by cooling. Rugged, durable articles can be molded or formed with relatively thin sections and thus are almost ideal for use in the automobile in the form of steering wheels, control knobs, radio grills, horn buttons and compartment doors.

Among the unusual applications of these plastics, which are known as "Tenite," "Plastacele," "Lumarith," "Bakelite", "Cellulose Acetate" and "Monsanto Cellulose Acetate", are storm sash inclosures with acetate films in place of glass, lamp shades, watch crystals, toilet articles, costume jewelry and many other articles. Cellulose acetate butyrate, tenite II, is used in manufacturing sheeting and coated solutions, including airplane dopes. It can also be employed in the manufacture of automobile tail light lenses, emblems, thermometer castings and many other articles.

Cellulose acetates are custom made thermoplastics, as their molding properties and characteristics may be varied to suit a specific requirement.

<u>Molded Polystyrene</u>. Polystyrene resin plastics made from ethylene gas and benzene (basically from petroleum and coal) has been known to chemists for a long time. They are thermoplastic and may be tough or brittle, depending on the condition of their polymerization.

An unusual combination of properties is available in polystyrene plastics. As an electrical insulator, this material has extraordinary insulation value of high-frequency circuits. Leggett (42, page 130A) states that:

> When commercial Polystyrene was introduced in this country a short time ago, the plastic industry acquired a material with excellent electrical properties, crystal clarity, low specific gravity and other advantages....The mineral also has good resistance to alkalies and hydrofloric acid and therefore can be employed in the form of containers, substituting for glass which is attacked by both chemicals.

This material is light in weight, but strong, having a tensile strength of 5,000 to 5,500 pounds. Polystyrene is a crystal clear, water-white material which can be supplied in a wide range of translucent and transparent colors.

Cast Resinoids. Cast resinoids, of which "Catalin" and "Bakelite Cast Resinoids" are good examples, are thermosetting compounds. Several standard stock shapes are cast, which are used by manufacturers, craftsmen, and shop students in fabricating many common articles. The castings come from their form slightly tapered. This is necessary to make the casting less difficult to remove.

Cast resinoids are available in sheets, tubes, rods and many other shaped forms in transparent, translucent and opaque effects. They are strong, tough solids with a specific gravity one-half that of aluminum. They have excellent machining qualities and can be worked with hand tools or lathes, saws, drills and may be cemented to assemble large projects where size or shape is lacking.

Decorative Cast Resinoids. These materials are produced in a complete color range, in translucent and transparent forms, also in two-tone, mottle and marble effect. They are available in many stock forms of various sizes, thicknesses and shapes. They may be obtained in special rough blanks for final finishing and assembling.

Chemical Resistant Cast Resinoids. Special transparent cast resinoids possess a high degree of chemical resistance. They have proved the only satisfactory containers and laboratory utensils for hydrofluoric acid.

Photo-Elastic Cast Resinoids. For scientific studies of stresses and strains in structures and structural members, a special clear cast resinoid has been developed. When viewed in a beam of polarized light, scale models of bridges, I-beams etc., show visual patterns of the interior stresses under varying load conditions.

Transparent plastic materials are being used more extensively in building small scale models as a means of determining the most advantageous designs of structures of many descriptions. The ability to observe what conditions will be encountered in service is definitely helpful to designers and engineers. Some of the citations made by W. T. Collins are: (18, page 3)

> ....These were the scale models of the conduits of the Madden Dam, Panama Canal Zone; the conduits and deflectors of the proposed Redbank Creek flood-control dam....the outlet tunnel for the Tionesta Creek flood-control dam.

As time passes the number of problems to be solved will increase and their nature will become more complicated. Its value is not limited to cases of observation, but also where accuracy of dimension and trueness of shape are essential.

Laminated. The laminated plastic is made by impregnating sheets of paper or fabric with special thermosetting resin solution; then stacking these sheets to a required thickness; and under heat and pressure compressing them into a solid homogeneous mass. It can be furnished in sheets, rods, tubes and special shapes. The same method used in machining metal is adaptable to laminated plastics. It can be planed, milled, drilled, sawed, punched and threaded, and is supplied ready for use in selected sizes, shapes and thicknesses.

Decorative Construction. Laminated plastics are being used for such construction as table tops, wall paneling, signs and displays. These decorative laminated plastics possess a rich luster and are available in a wide range of colors that are integral with the material. It may be bonded to plywood or other materials for beautiful surface effects. It is non-flammable, resistant to water, alcohol, washing compounds, burning cigars and abrasion, and may be cleaned as easily as glass. It can be purchased in translucent types for modern lighting effects.

Industrial Service. It is available for silent gears, fire extinguisher nozzles, and a wide range of mechanical and electrical equipment parts. The rugged wear-resistant Bakelite Laminated is generally supplied in black or natural tan color.

Electrical Insulation. For electrical insulations in radios, power plant, domestic applicances and amny other electrical products, laminated plastics are used extensively. Much of this plastic material is a tough, shatter-proof insulation for high and low voltage.

Summary. Information of much value to this study is contained in this chapter. Descriptionsof the different types of plastics are given, pointing out their various uses and which of these are suitable for shop fabrication. A review of the products of selected firms will be presented in the next chapter.

CHAPTER V

COMPANIES SOLICITED AND MATERIALS RECEIVED

In writing this thesis there was need for much material of which only a small portion could be obtained in a library, due to the fact that there is very little literature in circulation. After investigating the few references available on this subject, it was decided to write direct to a number of manufacturing companies for any literature they might be able to supply for reference. A letter was prepared and approved by Dr. DeWitt Hunt, Head, Department of Industrial Arts Education and Engineering Shopwork, Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma, and sent to twenty-four companies manufacturing or distributing plastic materials. Returns were made by eleven of the companies which sent desirable help and information. These returns consisted of printed literature on their manufactured products, pictures pertaining to their plants and finished products, color charts, price lists and samples of their plastics. The following list shows the companies solicited, the companies responding and the material received.

Firms Solicited. The letter included in Appendix C was sent to the firms listed in this paragraph. Asterisks indicate the companies sending replies:

Aladdinite Corporation, 261 Wallace Street, Orange, New Jersey.

American Plastic Corporation, New York City.

Bakelite Corporation,* 30 East 42nd Street, New York City.

Beetle Products Division and American Cynamid Company,* New York City.

Brodhead-Garrett Company, 4560-4570 East 71st Street, Cleveland, Ohio.

Catalin Corporation,* One Park Avenue, New York City.

Carbide and Carbon Chemicals Corporation, New York City.

Celluloid Corporation, 10 East 40th Street, New York City

Durez Plastics and Chemicals Incorporated,* North Tonawanda, New York City.

Durite Plastics, 5010 Summerdale Avenue, Philadelphia, Pa.

E. I. Du Pont De Nemours and Company, Incorporated,* Arlington New Jersey.

Ford Motor Company, Plastic Division, Detroit, Michigan.

Formica Insulating Company,* Cincinnati, Ohio.

General Electric Company, Plastic Department, Pittsfield, Massachusetts.

Mansanto Chemical Company, St. Louis, Missouri.

National Vulcanized Fibre Company, Wilmington, Delaware.

Nixon Nitration Works,* Nixon, New Jersey.

Plaskon Company, Incorporated,* 2112-24 Sylvan Avenue, Toledo, Ohio

Rohm and Haas Company,* 222 West Washington Square, Philadelphia, Pa.

Tennessee Eastman Corporation,* Kingsport, Tennessee.

Trafford Modern Materials and Design,* 360 Washington Street, Springfield, Massachusetts.

Universal Plastic Company, New Brunswick, New Jersey.

Waterbury Button Company, Waterbury, Connecticut.

Westinghouse Electric and Manufacturing Company, Trafford, Pennsylvania.

Companies Responding and Material Contributed. In response to the letters sent out a variation of material was received consisting of literature in the forms of bulletins, pamphlets and leaflets, and cast, laminated and molded samples. The names of the companies and the materials each contributed will be listed here.

Bakelite Corporation.

New Paths to Profits.
Plastics in the Hobby Workshop.
Bakelite Cast Resinoids--Machining and Finishing.

Beetle Products Division and American Cynamid Company.

Plastic Lighting Comes of Age.
Beetle Color Parade.
Beetle It's all Color and in all Colors.
The Aim of the Molder is the Success of Your Job.

Catalin Corporation.

The Fabrication of Catalin the Gem of Plastics.
Catalin the Gem of Modern Industry.
Catalin the Gem of Plastics.
Catalin and Prystal Exquisite Jewelry.
Catalin the Gem of Modern Plastics.
A Nice Collection of Samples.

Durez Plastics and Chemicals, Incorporated.

Durez Molding Materials and other Products.

E. I. Du Pont De Nemours, Incorporated.

Plastics for the Products of Today and Tomorrow.
Du Pont Plastic Bulletin 1,2,3,4, Volume I, 1939
Bulletin 5, Volume II, 1940
A Story of Lucite.
Ten Times Acclaimed.
Design for Modern Plastics.
Plastics go Into High Gear.
A New Du Pont Plastic Material for Industrial Use.
A large collection of samples.

Formica Insulating Company.

What Formica is.
Formica a Modern Plastic.
Formica colors--Patterns and Realwood Grains.
Translucent Formica for Signs, Lighting Fixtures and Counter Paneling.
Formica Soda Fountains and Bars.
New "Realwood" Formica.

Nixon Nitration Works.

Steps in the Manufacturing of Nitrate and Acetate Plastic Articles.
Sample color sheets and hollow tubing.

Plaskon Company.

Molded Color.
Plaskon Hand Book.
Samples.

Rohm and Haas Company.

Traditional Transition.
Plexaglas and Crystalite Direction Sheets.
Acrylic Resins.
Crystalite Acrylic Resin Molding Powder.
Samples of plexaglas.

Tennessee Eastman Corporation.

Tenite
Tenite Specifications.
Tenite Molding.
Samples.

Trafford Modern Materials and Design.

Trafford Handbook.
Trafford Portfolio.
Thirteen sheets including projects with drawings.
Samples of sheets, rods and buttons.

Value and Uses of Material Received. The literature received from these companies gave a varied description of the materials, processes and uses of plastics. Their products are manufactured to fit the many fields of industry. The literature gave an introduction of the historical development of the various kinds of plastics and dealt extensively on the scientific structure of cast, laminated and molded processes. From the bulletins and the pamphlets received, the writer used portions in assembling this thesis. Furthermore, it was of value to the writer in building statistical records of the kinds, description and manufacturers of plastics, also the projects and drawings suitable for the field of the industrial arts and home workshop. (See Appendix D)

Besides being of use as direct information to the writer in building this thesis, this literature as received forms a group of somewhat limited library references to be on file in the industrial arts library at Weatherford High School.

The samples received from this solicitation constitute a display composed of sheets in varied composition, thickness and kinds, rods in round, square and fluted forms, hollow tubes, different colors of molding powders, discs and laminated safety glass.

Without this information, it would have been impossible for the writer to have assembled the valuable information contained in this thesis.

Summary. In this chapter the companies solicited are listed, showing those responding and the materials received. In Chapter VI of this study will be found a proposed Course of Study for Plastics to be included in the industrial arts field. This course should make the youth more cognizant of the new developments in industry and how they are used by the individual.

CHAPTER VI

A PROPOSED COURSE OF STUDY FOR PLASTICS

The writer, having experimented with the use of plastics in the shop, feels that there is sufficient manipulative activity and informational material in working with plastics to make this an appropriate industrial arts course. The past ten years have seen another of those romances of modern industry that are so common in America--the birth of new material with beauty which stands out like our most beautiful gems.

Until recently, cast phenolic resins were only available to the manufacturer but in the past few years it has been offered to the school and the homecraft trade. No material has ever presented similar beauty and artistic possibilities, united with the ease of workability with common equipment. This course could be conducted as a general shop unit in connection with woodworking or metalworking.

Specific Objectives. Earlier discussions have suggested the general objectives of industrial arts as a school subject. A statement of specific objectives for plastics as an industrial arts course is presented here.

1. To make youth cognizant of new developments in industry.
2. To develop in the pupil skill and clear thinking in the use of plastics in the workshop.
3. To develop initiative and give the pupil confidence in his ability to do things and plan definite procedures for practical manipulative activities.
4. To discover interests and aptitudes that have significance in life work. The artistic side of the pupil's nature is especially developed by this course.

5. To develop manipulative ability and intelligence with the common tools and materials useful in home life and leisure time activities.

6. To develop industrial intelligence and appreciation of plastics in industry and its place in society.

Grade Placement. Due to the wide range of projects no student should be handicapped by the cost and selecting a design that will fit any age student. With this in mind the course could be offered in any junior or senior high school grade in connection with woodworking or metalworking classes.

Teaching Methods. The course in plastics should be taught by a combination of methods consisting of lecture, demonstration, and class discussion periods utilizing from fifteen to twenty per cent of the total time. These teaching aids correlated with shop practice on project selected by the student form a desirable industrial arts program. Whenever possible, visual educational pamphlets, charts and samples would be of great aid. Tests should be given sufficiently often to check on manipulative and informational phases, and a final examination should be given at the close of the course.

Textbooks are to be used by the teacher and students. Pupils should be referred to the textbook for answers to questions fully covered in the text. Tests should cover specific chapters or topics. Assignments for outside work should be given and an oral report to the class should be required of each pupil as often as is expedient.

Not less than five reference books should be used each semester, and be available in the school library, with permission to transfer to the shop library.

A personnel organization should be set up with a general superintendent, clerk, librarian, safety director, purchasing agent, tool checker, etc. Democratic cooperation will be developed through student organizations of this type.

A Summary of Units of Instruction in Plastics

This summary sheet may be used as a course outline, a grade sheet for each individual pupil, a record sheet for dates of lectures, demonstration or student report, or as an assignment sheet for student participation in the course.

Manipulative Units	Topics of Information
1. Make Plan of Procedure.	1. Story of Plastics______
2. Saw stock to dimension.	2. Kinds of machine screws and self-tapping screws______
3. Squaring stock to size.	3. Surface decoration of plastics______
4. Rough finishing by hand or power______	4. How to make a jig and other holding devices______
5. Boring holes______	5. The moving picture "The Fourth Kingdom"______
6. Using self-tapping screws.	6. "Study Chart" and vials of the raw and finished material______
7. Drive screw with screwdriver.	
8. Join pieces with rivets.	7. How sandpaper is made______
9. Drill and tap______	8. Synthetic resins for surface coating______
10. Shape by file.	9. Traditional Transition. (Plastic Furniture)
11. High-luster finishing.	10. Kinds of saws.
12. Inlaying surfaces.	11. Size and shape of plastic stock.
13. Overlaying surfaces.	12. Making a bill of material.
14. Turning designs on the lathe.	13. Job planning.
15. Carving surfaces.	14. Kinds of buffing compounds.
16. Veining and shaping with machines.	15. The cutting wheel and how it is used.
17. Form pieces by bending with heat.	
18. Cement and clamp materials.	
19. Buffing and polishing.	

Summary Sheet. The summary sheet should be a guide for the teacher and student to follow in order to cover all the manipulative and informational units. The minimum number of units of instruction which should be included in a course in plastics are included in the summary sheet.

This sheet is designed to show in condensed form the extent of the course. It includes the teaching aids covering both the manipulative and informational units. It is recommended that the sheet be duplicated and distributed to all students to use as a guide.

Recommended Texts. Several texts should be listed suitable for a text in this course. Sufficient number should be ordered to provide each member of the class ready access to a book. The following text books are recommended as satisfactory for the course in plastics listed in order of their importance.

A. Mansperger, Dale E., and Pepper, Carson, W., Plastics Problems and Processes, International Textbook Company, 1938, 178 pages, cost $2.50.

B. Lockrey, A. J., Plastics in the School and Home Workshop, Governor Publishing Company, 1937, 228 pages, cost $2.50.

Required Reference Texts. These are the books recommended for use as reference. One copy of each book should be available.

1. Griffith, Ira Samuel, and Cox, George B., Woodwork for Secondary Schools, Manual Arts Press, 1937, 319 pages.

2. Hjorth, Herman, Principles of Woodworking, The Bruce Publishing Company, 1930, 307 pages, cost $1.76

3. Hunt, DeWitt, Hand Woodworking, Harlow Publishing Company, 1937, 253 pages, cost $1.25.

4. Lockery, A. J., Plastics in the School and Home Workshop, Governor Publishing Corporation, 1937, 228 pages, cost $2.50

5. Mansperger, Dale E., and Pepper, Carson W., Plastics Problems and Processes, International Textbook Company, 1938, 178 pages, cost $2.50

Magazines. These magazines have been found useful in shops where plastics are taught.

1. Home Craftsman, bi-monthly, Home Craftsman Publishing Corporation, New York City, cost $1.50 per year.

2. Industrial Arts and Vocational Education, monthly, Bruce Publishing Company, Milwaukee, Wisconsin, cost $2.50 per year.

3. Modern Plastics, monthly, Breskin Publishing Corporation, New York City, Cost $5.00 per year.

4. Popular Homecraft, bi-monthly, General Publishing Company, Chicago, Illinois, cost $2.00 per year.

5. The Deltagram, bi-monthly, Delta Manufacturing Company, Milwaukee, Wisconsin, cost $ .50 per year.

6. The Du Pont Magazine, monthly, E. I. Du Pont De Nemours and Company, Inc., Wilmington, Delaware, cost $1.00 per year (Probably free on the request of the teacher of plastics.)

Visual Aids. Only one motion picture on the subject of plastics has been found. Its title and contents are described here.

1. The Fourth Kingdom, The Motion Picture Bureau of the Y.M.C.A. 19 S. LaSalle Street, Chicago, Illinois.

The plastics study chart contains a graphic picture of the manufacture of plastics, small vials of the actual raw and finished materials.

2. Plastic Study Chart, Durez Plastics and Chemicals Inc., N. Tonawanda, Development Division, cost $3.50.

A Course of Study Involving the Use of Plastics. In the following outline, "A" indicates manipulative work included in each unit of instruction, "B" indicates the informational material to be covered, and "C" indicates suggestive projects or exercises. Columns "1" and "2" have been provided for page references to the two textbooks previously recommended and named. For convenience they are named again at this point:

1. Mansperger, D. E. and Pepper, C. W., Plastics Problems and Processes.

2. Lockery, A. J., Plastics in the School and Home Workshop.

Units of Instruction. The work in this course of study is divided into units of instruction. Each unit represents the complete lesson or lecture-demonstration. The numbers in the outline refer to reference text and page. The first number refers to the author as listed on page 67 of this thesis and the second number refers to the page in that book. For example, 1-64 in "B" in Unit I refers to Griffith, Woodwork for Secondary Schools, page 64.

THE COURSE OUTLINE FOR PLASTICS

Outline of Instructional Units	1 M & P	2 Lockery	3
Unit 1. Getting out Stock			
A. Cutting to size by hand or machine tools			
B. How to sharpen a saw for plastic use Kinds of saws and their uses, 1-64; 2-9; 3-5	26	35	
C. Shade pulls, switchplate, paper knives, rings, letter holders			
Unit II. Squaring to a Given Dimension.			
A. Squaring stock			
B. Surfacing stock............................ Kinds of planes and their uses, 2-11; 3-13 Kinds of files and their uses; 3-97; 2-22; 1-42; 55. Surfacing plastics	43		
C. Switch plates, door push plate, shade pulls bill file			

THE COURSE OUTLINE FOR PLASTICS

Outline of Instructional Units	1 M & P	2 Lockery	3
Unit III. Rough Finish.			
A. Sanding or polishing by hand or machine.....			
B. Kinds and grades of abrasives		40 88	
Kinds of abrasive machines; 1-108; 2-49; 50, 156; 3-46.			
Kinds of abrasives recommended for plastics	45		
C. Shade pulls, switch plates, paper knives, rings, bracelets			
Unit IV. High-luster Finishing.			
A. Finishing by hand or buffing wheel			
B. Making of pumice and rotten stone...........	45	88	
Commercial compounds used for finishing	47		
C. Final finish on all projects			
Unit V. Assembly preparation.			
A. Drilling a hole and tapping it			
B. Kinds and sizes of drill bits	174		
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Kinds and sizes of rivets			
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THE COURSE OUTLINE FOR PLASTICS

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C. Bracelets, desk blotters, drawer pulls......			
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B. Inlaying and overlaying .... Inlaying and wood carving, 1-215	34		
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A. Turning simple designs			
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Unit XI. Carving			
A. Carving simple designs			
B. Carving plastics .... Wood carving, 1-223	35		
C. Bracelets, rings, table center pieces			

THE COURSE OUTLINE FOR PLASTICS

Outline of Instructional Units	1 M & P	2 Lockery	3
Unit XII. <u>Veining and Shaping</u>.			
A. Cut vein or design edges with shaper			
B. How veining is done	35	29	
Using handee tool to design	35		
C. Refer to "C" in the other units			

<u>Fabricating Processes</u>. When plastics are being cut with woodworking tools such as band saws and circular saws, regular woodworking blades may be used, but it is advisable to refile the teeth.

Circular saw blades, either rip, crosscut, or combination can be used if the teeth are small. The smaller the teeth the less chance there is of chipping the face of the plastic as the saw cuts. The teeth of the rip saw will have to be re-shaped. Hollow ground saws may also be used for cutting plastics, these saws should be given a little set to prevent binding.

The operating speed of a circle saw for plastics may range from 1800 to 2500 R.P.M. The higher cutting speed produces a smoother cut, but too high a speed will produce heat of sufficient intensity to take the temper out of the saw blade. It is important to adjust the saw in relation to the table so that the points of the teeth will project slightly above the material that is being cut.

Band saw and jig saw blades having fine teeth will be found satisfactory if the shape of the teeth is changed in the same manner as the circular saw teeth. Hand saws, such as the back saw or coping saw will do good work cutting this material.

Turning. Either metal working or wood working lathes can be used for turning. In turning rod, jaw chucks in the head stock of the lathe may be used and if possible, a hardened steel metal working center can be used for the tail stock. Speeds from 1500 to 3500 R.P.M. can be used for machining the material. Shaped files may be used for forming tools, or preferably high-speed tool steel bits mounted in handles. Since cast plastics are poor conductors of heat, it is evident that the tools or tool bits have to take the entire burden. It is, therefore, good practice to use Stellite or tungsten carbide tools since they stand up better, if a great deal of turning is done.

Turning bracelets or tubes is probably the most common operation on the lathe. Bracelets are made from tubes of the proper inside and outside diameter; these are easily turned on an expanding arbor or mandrel. The tubes are slipped over the arbor and the arbor is then mounted between the head stock and tail stock of the lathe. As the tail stock is brought into position, the arbor expands and grips the tube more tightly and keeps it from slipping around the arbor.

Clearance is so important to the turning operation in turning plastics, that it should be mentioned here again. A tool properly shaped keeps cooler; thus, it stands up better and does not shatter the material being cut off or shaped. High-speed tool steel should be used wherever possible, if Stellite or tungsten carbide tools are not available, particularly for long turning jobs. Tools made of brass and bronze have been used for short turning jobs, but are not recommended for permanent work. Be certain to sharpen tools frequently in order to have smooth turnings which consequently require less effort in the final finishing operation.

Bending and Expanding. If cast resins are immersed in water at about 200 degrees F., they soften and can be bent into shape while still soft. Sharp bends cannot be made, but long easy curves can be bent. In bending pieces they should be bent a little further than the final shape which is expected, since the material tends to return to its former shape when the pressure is relieved. Great care should be exercised not to bend the material before it has become pliable enough to shape.

Cast plastics are very often used for the handles of knives, letter openers and other metal utility implements. Holes, which are drilled for insertion of the blade ends, should be made a few thousandths of an inch smaller than the part that is to be forced into the handle. The handle should be immersed in hot water, where the hole will expand so that the metal blade can be forced into the hole. Upon cooling, the hote in the plastic handle contracts and the blade is held firmly in place.

Sometimes findings, such as clips and hooks, are forced into the softened material. This method is used instead of fastening the hardware or findings to the cast resin with wood screws or drive screws.

Carving. Carving is the hobbyist's medium of artistic expression. No other operation in working cast resinoids affords one greater satisfaction, reward or appreciation. Many very interesting effects can be created by carving on the surface of the material or by carving the back of transparent crystal. In this operation the craftsman can create to his heart's content. Hand carving may be done by using the edge of a file or by using an engraver's tool. The small, high-speed electric hand grinders are excellent tools for carving and for general turning and drilling.

Some of these small portable electric grinders can be converted into lathes, drills, routers, milling machines and polishing heads. For small, light work the hand grinder is a tool that every craftsman should own, for it can be used with steel cutters or abrasive wheels, burrs or points. There are also portable flexible shaft drills much the same as dentists' drills which can be used for carving, drilling and many other operations.

If the hobbyist likes to do a great deal of carving, or specializes in this type of work, a carving spindle will work out to advantage, for it is possible to work very rapidly on it. Carving of this type is done by holding the work in the hand and bringing it to the steel cutter in the spindle chuck.

Finishing Operations. Generally, the last operation in finishing a cast resin piece consists in bringing the beauty which rests beneath the skin of this material to the surface. Since the color and mottles run through the entire mass of material, an ashing or sanding operation and the final buffing, suffice to bring the material to a very high lustrous polish or finish.

Tool marks or high spots, and rough edges, should be removed from the piece before polishing. This can be done by either sandpapering, filing or ashing.

Sandpapering and filing are done the same as they should be on wood or metal, after all the rough or tool marks are removed.

Ashing. The ashing operation consists of grinding the surface or edges of a piece of material or completed assembly to remove all the rough spots or marks. It is in reality a fine sandpapering operation, done wet to keep the dust down and to guard against too much heat from friction which might scorch the cast resin piece.

A soft muslin buff about 6" in diameter and about 1" wide is employed. The buff rotates at about 2500 R.P.M. A hood over the buff and pan is used to keep the particles of (00) pumice stone from flying around into space and onto the operator. The (00) pumice stone and water mud are applied to the wheel from time to time either with the hand or a trowel. The piece to be ashed may be held in the hand or on a board. The ashing operation can be used for grinding edges from sharp cut pieces. After applying the piece to be ashed to the buff a number of times the abrasive action of the buff will remove all the rough spots and leave the piece perfectly smooth.

Buffing or polishing is done on the same type of buff as is used in the ashing operation, except that a hood or pan is not required. To one-half of the width of the muslin buff is applied bar polishing wax. The rest of the wheel is kept clean. The polishing operation consists of applying the article to be polished to the buff containing the polishing wax and then cleaning it off on the clean, bare part of the buff. This operation is continued until the desired luster is obtained. If the article has been ashed before polishing, the piece should be washed with a fiber brush and water to get rid of all the abrasive pumice stone. Speed and size of buff are the same as is used for ashing.

Inlaying and Overlaying. Inlaying opens a new field for the industrial arts student who is interested in working with plastics. Undoubtedly he will have a creative desire to make new designs. There will be a desire to try out some of the new combination colors. A few of the materials which may be used are plastics, metal, shellac, resin and wood. Wood or metal may be used for inlay or overlay with plastics. Wood and plastics look well together, as is evidenced by their use in furniture manufacturing. Also, different colored pieces of plastics make a splendid design. Some of the beautiful foreign woods look well in overlayed patterns. Some use liquid to do inlay work, this liquid becomes solid when cooled. After the grooves have been filled be sure to break all bubbles, in order to have a smooth surface. Another form of inlaying is scribing of lines or patterns with a sharp-pointed instrument.

Routing and Shaping. Routing may be done on a high speed router or on a drill press. The speed of the router should be from 3500 to 4000 R.P.M. Router bits or carving burs may be used for this purpose. Plastics may be given varied designs, by the use of a shaper. This machine must have a high speed of about 8000 to 10,000 R.P.M. to produce smooth work. Very attractive designs may be cut on edges of flat stock.

The cutters for this purpose must be small, because the designing is usually done on small pieces which are about 1/2 inch in thickness.

Joining. Many large problems may be made from plastics by joining several pieces together to make a complete project. There are many of these methods such as cement, screws, rivets and if done properly the joint will be as strong as the material. In almost every case the manufacturer furnishes a special cement for their own product. Some of the glue used for wood or glass may be used for temporary purposes. Cement for plastic material consists of the raw resinoid itself, only it has not been permitted to polymerize. In order to bring about this polymerization, hydrochloric acid is used. When the uncured resinoid and the acid are mixed, heat is generated and polymerization takes place. This material should be mixed on a glass plate and stirred with a glass rod. A 75 per cent solution of acid is always mixed with the cement. The time of drying depends upon the amount of acid that is being used. If too little is used polymerization does not take place and if too much acid is used the substance will harden before the clamps can be set. Always cement joints on sanded surfaces before buffing is done. The excess cement may be removed with a linoleum block knife, or sanded off before buffing.

Machine Screws. These can be used wherever the thickness of the stock will permit. Care should be taken to see that the tap is started in line with the pilot hole. The tap should be removed several times when cutting threads the full length. Screw threads, 8/32 machine screw should be used.

Drive Screws. Another holding device serves about the same purpose as a rivet. Drill the hole and drive the screw until the parts are held firmly together. The size drill recommended for the screw should be used.

Rivets of soft metal may be used, escutcheon pins are quite common and appropriate. Countersink the hole on the back to provide for the swelling metal. Be sure soft metal rivets are used to avoid breaking the material when riveted. Self-tapping screws may be applied with less expense than machine screws, because no taps are necessary. Drill a hole of the proper size and drive the screw to place with a screwdriver. Due to the nature of the thread this type of assembly possesses greater strength than a machine screw assembly.

<u>Hand Tools and Machine Tools.</u> Hand tools and machine tools are both used in working plastics. Practically all the hand and machine tools in a woodworking or metalworking shop are usable in the work of plastics, however, a few additional tools may be needed. A suggestive group of extra tools is listed:

Set of needle files 4", 1 dozen	$2.65
1 10" single cut flat file	.26
1 10" double cut, second cut file	.38
1 6" single cut, smooth flat file	.21
1 6" single cut, smooth half round file	.33
1 6" smooth round file	.21
Jeweler's saw frame (5" adj.)	1.10
Swivel bench vise	2.65
Hand vise	1.08
Tap and die set (26 pieces) U. S. Standard 1/4-20, 5/16-18, 3/8-16, 7/16-14, 1/2-13, and SAE 1/4-28, 5/16-24, 3/8-24, 7/16-20, 1/2-20, 1/8" pipe; set includes 11 dies, 11 taps, 9" die stock, bits stock die holder, tap wrench and screwdriver Total	6.75
High speed flexible shaft and attachment including a sheepskin polishing head, 6" cloth buffer, sanding disk wheel, 1/4" 3 jaw chuck, 4"x1/2" grinding wheel, and a ball bearing coupling for 1/2" motor shaft	6.95
Total	$22.07

<u>Equipment Directory</u>

Brodhead-Garrett Company, 4560 East 71st Street, Cleveland, Ohio

Walker-Turner, Inc., Plainfield, New Jersey

William Dixon, Inc., 32-36 East Kinney Street, Newark, New Jersey

Delta Manufacturing Company, Milwaukee, Wisconsin

Much of this material can be supplied by a local hardware dealer or various other agencies within a community such as the Kress Store, Woolworth Store or any other similar type.

Supplies Directory for Synthetic Resins.

Amberol, Fellowcrafters, Incorporated, 64 Stanhope Street, Boston, Massachusetts.

Catalin, Fanwood Specialties Company, Box C-56, Scotch Plains, New Jersey.

"Garalin", (Catalin), Brodhead-Garrett Company, 4560-4570 East 71st Street, Cleveland, Ohio.

Marblette, The Marblette Corporation, 37-21 Thirtieth Street, Long Island City, New York. (Sold in lots of not less than fifty pounds.)

Trafford, Roger Wolcott, 360 Worthington Street, Department 43, Springfield, Massachusetts.

A List of Project Descriptions. A list of project sheets giving a few articles that can be made of plastics is found in appendix D. These projects include several designs for bill files, drawer pulls, salt and pepper sets and a wall lamp. The next few pages of this chapter will contain the name and source of various projects found in magazines of a workshop type.

Sources of Plastics Projects

1. "Blue Moon Cigarette Box", Practical Delta Projects, Book 5, page 2.
2. Burton, L. A., "Novelties Made of Plastics", The Home Craftsman, 4:231, July and August 1935.
3. Bruehl and Bonney, "Plastic Tie Rack", Popular Homecraft, 10:452, April and May, 1940
4. "Candlelight in Plastics", The Delta Gram, page 3, November, 1939.
5. "Cigarette Box", Practical Delta Projects, Book 4, page 8.
6. "Door Knobs in Color", The Home Craftsman, 8:34, November and December, 1939.
7. "Half Moon Salt and Pepper Set", Practical Delta Projects, 9:3 October, 1939.

8. "Jewel Case in Plastics", The Home Craftsman, 8:39, November and December, 1938.

9. Livingston, J. B., "Introducing a Switch Plate Made of Plastic Material", Industrial Arts and Vocational Education, 27:256-7, June, 1938.

10. Livingston, J. B., "Making Penholders of Plastics", Industrial Arts and Vocational Education, 27:75-76, February, 1938.

11. "Make a Modern Lamp", The Home Craftsman, 8:19, July and August, 1939.

12. "Modern Book Ends", The Home Craftsman, 8:24, November and December, 1938.

13. "Modern Lamp", Practical Delta Projects, Book 5, page 7.

14. "Modern Plastics Candlesticks", The Home Craftsman, 8:19, January and February, 1939.

15. "Modern Plastics Clock", The Home Craftsman, 8:18, March and April, 1939.

16. "Modern Tempo in Jewelry", Popular Home Craft, 7:30, May and June, 1936.

17. "Musical Powder Box", Practical Delta Projects, Book 5, page 27.

18. "Novelties of Colored Plastics", The Home Craftsman, 5:166, March and April 1936.

19. "Peggy Ann-A Timely Clock", Popular Homecraft, 7:540, January, 1937.

20. "Plastic Candlesticks", Popular Mechanics, 72:265, August, 1939.

21. "Plastic Cigarette Box," Practical Delta Projects, Book 6, page 5.

22. "Plastic Cribbage Board", The Home Craftsman, 9:24, May and June, 1940.

23. "Plastic Lamp," Practical Delta Projects, Book 4, page 21.

24. "Salt and Pepper Set", Practical Delta Projects, Book 6, page 5.

25. "Salt and Pepper Set", The Home Craftsman, 8:32, September and October, 1938.

26. "Service Tray", The Home Craftsman, 6:23, March and April, 1937.

27. "The Modern Tempo in Jewelry", Popular Homecraft, 7:204, September, 1936.

28. "Turned Serving Tray", Practical Delta Projects, Book 5, page 12.

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31. Wilcott, Roger, "Modern Clock and Lamp in Plastics", Popular Home-Craft, 8:438, December, 1937.

Conclusions. Not until the past decade has any work with plastics ever been offered in the industrial arts field. This was due to the fact that too little was known about it as a working medium. It has become apparent in the last two or three years that plastics can be fabricated by woodworking or metalworking tools. During this period a considerable number of industrial arts teachers have endeavored to introduce plastics as a new phase of industrial arts.

In Chapter II the writer has attempted to show how plastics contribute to general education through the field of industrial arts. The objectives of general education and industrial arts coincide to the extent that the general aims can be accomplished through this phase of work. Based upon the findings as related in Chapter III and Chapter IV, which refer to the historical and scientific development of plastics in the manufacture of consumer goods, this course should be included in the industrial arts field to further the development of the youth in consumers education.

Chapter V has a list of the companies solicited and an asterisk indicates the firms sending replies. The literature received indicated that plastics are manufactured to fit the many fields of industry. The last chapter, Chapter VI, consists of a proposed course of study, a group of fabrication processes, a source of plastic projects and blue prints having suitable projects for the beginner. These are to be used as a tentative guide by teachers introducing this new material into their workshops.

Recommendations. To the writer's knowledge only one thesis has been written on this subject and it deals altogether with soft moldable materials such as clay. A few topics suitable for further study in plastics are here recommended: (1) A Book of Plastic Projects; this book should contain material suitable for junior and senior high school levels; (2) The Use of Plastics in Foreign Countries; (3) The Use of Plastics in Industries of the United States; (4) The Scientific Development of Plastics; (5) The Historical Development of Plastics.

Due to the rapid development in the use of plastics in the industrial arts, it is recommended that this subject be rated as a basic course in the field of industrial arts. The writer contends that such a course has many possibilities some of which are as follows: (1) the same tools can be used for the process of fabrication as are used for wood or metal; (2) plastics have working possibilities beyond those of wood or metal but work well with wood or metal; (3) plastics have a wider range of use due to its beauty when finished, ease of workability and the durability of the finished product.

A P P E N D I C E S

A. A selected bibliography

B. Kinds of synthetic plastic solids

C. Letter

D. Drawings

E. A chart giving the important developments of plastics from 1770 to 1940.

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Kinds of Synthetic Plastic Solids

The chart below indicates as follows:
(1) Cast resinoid plastic
(2) Laminated plastic
(3) Molded plastic

Trade Name	Description	1	2	3	Manufacturer
Alladinite	Casein	1			Alladinite Corp., 261 Wallace St., Orange, N.J.
Ameroid	Casein	1			American Plastic Corp., New York City
Bakelite	Phenol-formaldehyde	1		3	Bakelite Corp., 247 Park Ave., New York City
Aqualite	Phenol-formaldehyde		2		National Vulcanized Fibre Co., Wilmington Delaware
Beetle	Urea-Formaldehyde		2	3	Beetle Product Division American Cynamid Co., New York City
Catalin	Phenol-formaldehyde		1	3	Catalin Corp., 1 Park Avenue, New York City
Celluloid	Nitrocellulose			3	Celluloid Corp., 10 E. 40th St., New York City
Crystalite	Acrylate			3	Rohm and Haas Co., Inc. Philadelphia.
Dilecto	Phenol-formaldehyde		2		Continental Diamond Fibre Co., Newark, Del.
Dilophane	Urea-formaldehyde		2		ditto
Duraloy	Phenol-formaldehyde		2		Detroit Paper Product Corp., Detroit, Mich.
Durez	Phenol-formaldehyde			3	General Plastic, Inc. N. Tonawanda, N.Y.
Durite	Phenol-formaldehyde and Phenol-fufural			3	Durite Plastics, 5010 Summerdale Ave., Philadelphia
Fiberloid	Nitrocellulose			3	Monsanto Chemical Co. St. Louis, Missouri

Trade Name	Description	1 2 3	Manufacturer
Fiberlon	Phenol-formaldehyde	1	Mansanto Chemical Co., St. Louis, Missouri
Fibroc	Phenol-formaldehyde	2	Fibroc Insulation Co. Valparaiso, Indiana
Formica	Urea-formaldehyde and Phenol-formaldehyde	2	Formica Insulation Co. Cincinnati, Ohio
Harvite	Urea-formaldehyde	3	Siemon Company, Bridgeport, Connecticut
Indur	Phenol-formaldehyde	3	Reilly Tar and Chemical Corporation, New York
Insurok	Phenol-formaldehyde	2 3	Richardson Co., 2707 Lake St. Melrose Park Chicago, Illinois.
Kaynite	Phenol-formaldehyde	3	Waterbury Button Co. Waterbury, Connecticut
Lamicoid	Phenol-formaldehyde	2	Mica Insulating Co. 200 Varick St., New York City.
Lucite	Methyl-methacrylate	3	E. I. Du Pont De Nemours and Company, Inc., Arlington, New Jersey.
Lumarith	Cellulose Acetate	3	Celluloid Corporation, 10 East 40th St. New York City
Makalot	Phenol-formaldehyde	3	Bakalot Corporation, 262 Washington St., Boston Massachusetts
Marblette	Phenol-formaldehyde	1	Marblette Corporation, 37-21 30th St., Long Island City, New York.
Masuron	Cellulose Acetate	1 3	John W. Masury and Son 50th Jay St., Brooklyn New York.
Micarta	Urea-formaldehyde & Phenol-formaldehyde	2	Westinghouse Electric and Mfg. Co. Trafford, Pennsylvania

Trade Name	Description	1	2	3	Manufacturer
Moldite	Phenol-formaldehyde			3	Moldite Corporation 345 W. 35th St. New York City
Nixonite	Cellulose Acetate			3	Nixon Nitration Works, East Nixon, New Jersey
Nixonoid	Nitrocellulose			3	Nixon Nitration Works, East Nixon, New Jersey
Ohmoid	Phenol-formaldehyde		2		Wilmington Fibre Specialty Co., Wilmington, Delaware
Panelyte	Phenol-formaldehyde		2		Panelyte Corporation, 230 Park Avenue, New York City
Phenalin	Phenol-formaldehyde	1			E. I. Du Pont De Nemours & Co., Inc., Arlington, New Jersey.
Phenolite	Phenol-formaldehyde		2		National Vulcanized Fibre Co., Wilmington, Delaware.
Plaskon	Urea-formaldehyde			3	Plaskon Co., Inc. 2212 Sylvan Ave., Toledo, Ohio
Plastacele	Cellulose Acetate			3	E. I. Du Pont De Nemours & Co., Inc., Arlington New Jersey
Plexiglas	Phenol-formaldehyde	1			Rohm and Haas Co., Inc., Philadelphia, Pa.
Pyralin	Nitrocellulose			3	E. I. Du Pont De Nemours & Co., Inc., Arlington New Jersey.
Resinox	Phenol-formaldehyde			3	Resinox Corporation, 230 Park Ave., New York City
Spauldite	Phenol-formaldehyde		2		Spaulding Fibre Company, Tonawanda, New York.
Synthane	Phenol-formaldehyde		2		Synthane Corporation, Oaks, Pennsylvania
Taylor	Phenol-formaldehyde		2		Taylor Fibre Company, Inc., Norristown, Pennsylvania.
Tenite	Cellulose Acetate		2		Tennessee Eastman Corporation, Kingsport, Tennessee.

Trade Name	Description	1 2 3	Manufacturer
Texolite	Phenol-formaldehyde	2 3	General Electric Co., Plastics Dept. Pittsfield, Mass.
Vinylite	Vinyl	1	Carbide and Carbon Chemical Corporation, New York City.
Uniplast	Phenol-formaldehyde	3	Universal Plastic Co. New Brunswick, New Jersey
Unyte	Urea-formaldehyde	3	Plaskon Company, Inc. 2112 Sylvan Avenue, Toledo, Ohio
"P V A"	Polyvinyl	1 3	E. I. Du Pont De Nemours & Co., Inc., Arlington, New Jersey.
Butacite	Polyvinyl		E. I. Du Pont De Nemours and Co., Inc., Arlington New Jersey
Bakelite	Cellulose Acetate	3	Bakelite Corporation, 247 Park Avenue, New York City
Bakelite	Urea-formaldehyde	3	Bakelite Corporation, 247 Park Avenue, New York City
Aqualite	Phenol-formaldehyde	2	National Vulcanized Fibre Company, Wilmington, Delaware.

Oklahoma
Agricultural and Mechanical College
Division of Engineering
Stillwater

Department of
Industrial Arts Education
And Engineering Shopwork

June 27, 1940

Sirs:

This letter is addressed to you to enlist your support in studying a problem of deep interest and importance. This problem is on the development and uses of plastics in industry and its possibilities in the school workshop.

In making this study it seems desirable to secure specific information from the manufacturer of this product. Since the plastics industry is changing so fast that literature on this subject soon becomes out-of-date, I am attempting to secure assistance from the leading manufacturers of this new industrial product.

It is my purpose, as a part of my graduate program, to produce a workbook on the use of plastics which will be suitable for junior and senior high school students. The completed copy will be published as a master's thesis and certain chapters will be used in the new state course of study now in process of completion.

Will you cooperate with me by sending to me two copies of each of such publications on the general subject of plastics as you may have available. The material I hope to receive from you might be classified under the six headings listed below. Catalogs are included in this list because they frequently contain valuable informational material.

1. Catalog of supplies.
2. Information booklets, pamphlets, periodical publications, etc.
3. Pictures of machines and various production rooms.
4. Samples of products.
5. Drawings and pictures of projects that can be used in the industrial arts shop.
6. List of films available as teaching aids.

All materials will be indexed under the name of the manufacturer issuing it. May I urge you to send this material immediately, as it is my purpose to complete this study in the next two months.

Please send this material to me at 100 North Third Street, Tonkawa, Oklahoma.

Thanking you in advance for your cooperation, I am

Yours very truly,

C. T. Collins
Teacher Training and Shopwork
Southwestern State College
Weatherford, Oklahoma

APPROVED: /s/ DeWitt Hunt
DeWitt Hunt
Head, Department of
Industrial Arts Education
And Engineering Shopwork

This chart was prepared by Morris Sanders and published in the Architectural Record, July, 1940.

Decades	Year	New Developments
1770-1780		
	1773	Compound called urea is discovered in the urine of mammals.
1780-1790		
1790-1800		
1800-1810		
1810-1820		
1820-1830		
	1828	Urea produced synthetically by Wohler.
1830-1840		
	1838	Regnault discovers white powder form in sealed tubes of vinyl chloride exposed to sunlight.
1840-1850		
	1843	Redtenbacher reports preparation of acrylic acids.
	1846	Dr. Schonbein of Switzerland discovers Cellulose-nitrate plastics.
1850-1860		
	1856	Sir William Perkins introduced first practical synthetic dye, "Aniline."
1860-1870		
	1869	John Wesley Hyatt, in searching for ivory substitute discovers process for solidifying cellulose-nitrate resinoids.
1870-1880		
	1872	Bayer records that a resin-like substance could be made from phenol and formaldehyde.
		E. Bauman succeeds in polymerizing vinyl halides, "unaffected by solvents or acids."
1880-1890		
	1875	Production of celluloid sheets, rods and tubes.

1890-1900

1900-1910

1901 Dr. Otto Rohm publishes results of researches with acrylic resinoids.

1904 Production of casein thick sheets and rods.

1909 Phenol-formaldehyde castings.

1910-1920

1908-1912 Dr. L. H. Bakeland secures patents on phenol-formaldehyde resinoid processes. Two Americans, Redman and Aylsworth, are active along similar lines.

1911 Cellulose-acetate sheets, rods and tubes.

1919 Vinyl-acetate-polymers adhesives.

1920-1930

1922 Phenol-formaldehyde laminated sheets.

1924 Phenol-formaldehyde molding powders.

Urea-formaldehyde cast forms.

1929 "Beetle" molding compounds introduced. It is claimed to be the pioneer in this form of plastic.

Modified vinyl-acetate powders, films and sheets

1930-1940

1931 Acrylic-esters castings and moldings.

Phenol-formaldehyde modified cast resins.

Urea-formaldehyde laminated sheets.

1932 Methacrylic-esters castings and moldings.

1933 Vinyl-benzene molding powders.

Cellulose-acetate injection molding powders.

Benzyl-cellulose sheets, rods and tubes.

1934 Celluloid and cellulose-acetate continuous extruded sheets.

1935 Vinyl-chloride-polymers sheets, rods, powders and films.

1936 Phenol-formaldehyde extruded tubes.

Ethyl-cellulose sheets and powder.

1937 Urea-formaldehyde transparent molding powders.

1938 Casein injection molding powders.

Polystyrene transparent molding powders.

1939 Cellulose-butyrate molding powders.

TYPIST: Winnifred Vogler
Stillwater, Oklahoma