AN ANALYSIS OF A CURRICULUM GUIDE DEVELOPED FOR INDUSTRIAL PLASTICS AS LISTED IN BULLETIN 615 OF THE TEXAS EDUCATION AGENCY

THESIS

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By

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This study surveyed teachers of industrial plastics and personnel of the plastics industry to evaluate an industrial-plastics curriculum guide.

The respondents felt that there was no unnecessary material in the guide, that additional information should be added to several of the plastics processes in the curriculum guide, and that most of the subject areas in the guide should be studied for no less than an hour and no more than five hours.

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CHAPTER I

INTRODUCTION

For many years, plastics education, as related to industrial arts, has been a craft-oriented course, but the time has now arrived for plastics education to be recognized as a major field of industry to be studied as a separate area of industrial arts. In 1954 Fredrickson pointed out the need for making plastics education an approved subject within the field of industrial arts (2, p. 81), but as late as 1969, the American Council of Industrial Arts Supervisors and the American Industrial Arts Association listed a plastics education course in the area of crafts (1, p. 8).

Plastics education in Texas has started to move away from the concept of plastics education being a crafts-oriented course. In 1961, Bulletin 615 of the Texas Education Agency listed in the area of crafts a course entitled "Plastics." The course was to include a "study of plastics industries, their materials, processes, and products" (8, pp. 166-167). In April of 1971, the course was revised and renamed "Industrial Plastics." The course was described as follows: "Study of six or more plastic processing groupings: molding, reinforcing, thermoforming, casting, foaming, coatings, fabrication, and joining and fastening. . . . Particular attention is given to the study of materials of the Plastics Industry" (9, pp. 140-168).

In 1971, L. E. Sorrels, Assistant Professor of Industrial Arts at North Texas State University, developed a curriculum guide (Appendix A) for the Texas Education Agency. This curriculum guide was to be used as an aid to any school starting a course in industrial plastics. It was also to be used to help teachers of industrial plastics programs already in existance in the state of Texas to become unified in their presentation of industrial plastics.

Statement of the Problem

The problem was to analyze the curriculum guide developed for industrial plastics as listed in Bulletin 615 of the Texas Education Agency to determine if the curriculum guide contained any material that was unimportant, if any new or important phase of the plastics industry had been omitted or not completely covered, and also the amount of study time to be devoted to major subject areas listed in the curriculum guide [9].

Purpose of the Study

The purpose of the study was twofold. The first purpose was to determine whether or not the teachers of industrial plastics thought the curriculum guide contained all phases of the plastics industry that should be included and, if not, what phases should be added or deleted. A second purpose was to determine whether or not personnel employed in the plastics industry believed the curriculum guide contained all phases of the plastics industry that should be included and, if not, what phases should be added or deleted.

Sources of Data

Two sources of data were used in the study. One source of data was a jury of seven teachers who were teaching or had taught industrial plastics or a similar course. The other source of data was a representative sample of personnel employed in the plastics industry.

Limitations of the Study

The study was limited to the data obtained from a jury of seven teachers within the Dallas-Fort Worth metropolitan area who were teaching or had taught industrial plastics or a similar course. The study was limited to data obtained from twenty-nine personnel employed in plastics industries that operated within the Dallas-Fort Worth metropolitan area. The study was further limited to data obtained from personnel employed in plastics industries that were involved in at least one of the seven processes of study listed for industrial plastics in Bulletin 615 of the Texas Education Agency.

Procedure for Collecting the Data

Procedures for collecting the data for the study were as follows:

1. A questionnaire was developed to obtain the opinions of the jury of teachers and of the plastics personnel surveyed

concerning the content of the curriculum guide. The questions were formulated after examing the curriculum guide. L. E. Sorrels, Assistant Professor at North Texas State University and designer of the curriculum guide, was consulted for additional items that were used in the questionnaire.

2. Letters of invitation (Appendix B) were sent to fourteen teachers of industrial plastics in the Dallas-Fort Worth metropolitan area inviting them to participate in the study. A self-addressed post card allowing the teachers to accept or decline the invitation was enclosed. These teachers would then be used as a jury to evaluate the curriculum guide.

3. Four teachers returned replies stating that they were able to participate as members of the jury. Only one reply was received from a teacher stating that he was unable to participate as a member of the jury.

4. A follow-up letter (Appendix C) was then sent to the nine teachers from whom no reply was received. This letter resulted in five replies from teachers of which four stated that they would participate as jurors.

5. The questionnaire (Appendix D) and a copy of the curriculum guide (Appendix A) were then sent to the eight teachers who had consented to participate as jurors. Seven of the questionnaires were returned.

6. Letters of invitation (Appendix B) were sent to personnel in charge of customer relations in ninty plastics companies in the Dallas-Fort Worth metropolitan area. The

names of the companies were taken from the Greater Dallas Yellow Pages (4, pp. 865-871). Thirty replies agreeing to participate in the study were received. Twenty replies were received from personnel stating that they were unable to participate in the study.

7. A copy of the curriculum guide (Appendix A) and a copy of the questionnaire (Appendix E) were then sent to each of the thirty personnel. Fifteen of the questionnaires were completed and returned.

8. A follow-up letter (Appendix F) and another copy of the questionnaire were then sent to the fifteen plastics employees from whom no completed questionnaire was received. Fourteen completed questionnaires were then received making a total of twenty-nine completed questionnaires received from the thirty plastics personnel who agreed to participate in the study.

9. The data obtained from the questionnaires were then compiled and presented in the appropriate tables, summary, and conclusions.

Organization of the Study

Chapter I includes the introduction, statement of the problem, purpose of the study, source of data, limitations of the study, procedure for collecting the data, organization of the study, definition of terms, and related studies.

Chapter II presents the various aspects of the curriculum guide for industrial plastics. The presentation is broken down in regard to the materials of the plastics industry and the processes of the plastics industry.

Chapter III presents the data received from the jury of teachers, Chapter IV presents the data received from the personnel in the plastics industry.

Chapter V consists of a summary of the study, conclusions, and recommendations.

Definition of Terms

1. Alloy Plastics--are plastics which are a combination of two or more thermoplastic resins, thermosetting resins, or thermoplastic and thermosetting resins.

2. Available Forms--all plastics are available in many variations of liquids and solids commonly called resins; each of these variations is an available form in which plastics may be found. The basic available forms of plastics are molding compounds, liquid casting resins, solid structural shapes, coatings, adhesives, forms, laminates, and fibers and filaments.

3. Casting--described the process of pouring a liquid into a hollow mold and allowing it to harden without pressure.

4. Crafts--is the term used to describe an industrial arts course which studies areas such as leather work, enameling, lapidary, copper tooling, and ceramics.

5. Curriculum guide--as used in this study will refer to the curriculum guide for industrial plastics developed by L. E. Sorrels for the Texas Education Agency.

6. Fabrication--is the term used to describe the cutting, drilling, taping and threading, and the smoothing and polishing of plastics.

7. Foaming--is the term used to describe the process where a plastic resin is converted into a sponge-like material that is filled with either air or gas.

8. Industrial Plastics--is the title of an industrial arts course approved by the Texas Education Agency. It is the study of six or more plastic processing groupings: molding, reinforcing, thermoforming, casting, foaming, fabrication, and joining and fastening. It also includes a study of the materials of the plastics industry.

9. Joining and Fastening--is the process of joining plastics through the methods of cohesive bonding by solvents or heat sealing, adhesive bonding, or mechanical linkage.

10. Jury--as used in this study will refer to the teachers of industrial plastics that participated in the study.

11. Molding--is the term used to describe many different areas of the plastics industry. The processes within the molding process are press molding, injection molding, extrusion, lamination press molding, calendering, blow molding, and rotational casting.

12. Plastics--also known as resins, are synthetic, organic materials which at some stage in their production are capable

of being shaped or molded by the use of heat and/or pressure, but in their final state are in a more or less rigid condition.

13. Plastics Education--is the term used to define any type of study of plastics and/or the plastics industry.

14. Reinforcing--is the term used to describe a plastic resin combined with a reinforcing filler to strengthen the resin. This combination is them placed over or in a mold and allowed to harden.

15. Study Time--is the total amount of time to be devoted to the study of any subject. This includes class period time devoted to study of a subject as well as study outside of the class.

16. Thermoplastic Resins--are plastics that can be repeatedly softened by the addition of heat and hardened by cooling.

17. Thermosetting resins--are plastics that when heated become permanently hard.

18. Thermoforming--is the term used to describe the process of forming a thermoplastic sheet of plastics by heating it until soft and forcing it over a mold.

Related Studies

In 1951 James made a study of the development and use of plastics in industry. James treated the history of plastics in the United States and the origin and early development of plastics in Europe. James treated the use of plastics in electrical, chemical, and automotive industries, with an extensive treatment of the use of plastics in the architectural industry. James proposed the use of plastics in industrial arts and listed methods of using plastics in industrial arts courses (5, pp. 11-90).

Fredrickson made a study in 1954 of the different types of plastics to determine their suitability for use in construction of projects in industrial arts. Fredrickson reviewed early discoveries in plastics and also determined which types of plastics were best suited for use in industrial arts. Finally, Fredrickson provided information for the setting up of industrial arts laboratories for the teaching of plastics education courses in industrial arts classes (2, p. 77).

In 1967, the Dallas Independent School District developed a bulletin entitled the Plastics Curriculum Guide. The guide covered the expected outcomes of the course, the varuous phases of the plastics industry that a course in plastics should cover, and the various learning experiences that a student enrolled in such a course should experience. The guide also listed projects that could be built and a bibliography (7, pp. 7-12).

Geir, in 1972, made a study to compare the curriculums of junior college plastics programs in Dallas, Tarrant, and surrounding counties with the requirements of the reinforced plastics industry in the Dallas-Fort Worth area. The study determined that only one junior college offered a plastics technology program. Gier concluded that the needs of the reinforced plastics industry were being met by the one junior college program with the exception of work experiences with the materials of the field. The study also concluded that the junior college program should offer training directly related to the individual needs of the plastics industries (3, pp. 55-57).

Mack made a study in 1973 to identify the skills and knowledge required of employees in plastics industries in the Dallas metropolitan area. The study determined that the knowledge of specific subject matter areas as required by the plastics firms surveyed varied with the type of production of each firm. The study determined that persons having taken plastics courses in high school were prefered for employment. The study also determined that all of the firms utilized some type of in-service training program. Mack recommended periodical revision of industrial plastics curriculum to keep abreast of the changes of the plastics industry. He also recommended that students be encouraged to take industrial plastics courses. Finally, Mack recommended that some degree of emphasis be placed upon working from blueprints in plastics courses (6, pp. 38-42).

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CHAPTER II

A DELINEATION OF THE CURRICULUM GUIDE DEVELOPED FOR INDUSTRIAL PLASTICS

Industrial plastics is a course designed to provide the student with a general knowledge of the materials and processes of the plastics industry. Throughout the curriculum guide for industrial plastics, (Appendix A), a breakdown of these two areas of the plastics industry can be seen. This breakdown can be found in the course objectives, the instructional organization, and in the course content.

Course Objectives

The course objectives in the curriculum guide for industrial plastics are directed toward the students understanding of the materials and processes of the plastic industry. One objective directed toward the materials of the plastics industry is to acquaint the student with materials used in the plastics industry, and develop skill in recognizing and working with different types of plastic, (Appendix A). An objective pointed to the precesses of the plastics industry is to have the students acquire the knowledge of the different methods in producing plastic products. (Appendix A) Another course objective pertaining to the processes of the plastics industry is to acquaint the student with tools and machinery of the plastics industry. (Appendix A)

Instructional Organization

In the instructional organization section of the curriculum guide, the separation of materials and processes can be observed. This section suggest that the first eighteen weeks, or the first semester, should emphasize a study of the materials of the plastics industry. Also included in the study of materials in the first semester is an overview of six or more plastic processes. These processes are then to be studied in depth in the second 18 weeks as well as the design and construction of tools for plastic processing.

Course Content of Industrial Plastics Materials

The breakdown between materials and processes is emphasized most in the course content of the curriculum guide. The course content is divided into two sections, one section which outlines the materials of the plastics and how they will be studied, and the other which outlines the processes of the plastics industry and all their various aspects of each process.

Introduction to Plastics

The section on materials is begun with an introduction to plastics. The introduction points out uses of plastics in both the home and industry. The growth or history of plastics and the plastics industry are also included, as well as job opportunities in the plastics industry. Finally, the advantages and disadvantages of plastics are presented.

Basic Chemistry

After an introduction of plastics, the basic chemistry of plastics is investigated. A study is made of the various raw materials used in making plastics. The methods by which the many atoms and elements go together to form the various molecules and compounds of plastics are then explored. The study of the chemistry of plastics is finally carried into the study of polymerization of various compounds of plastics.

Ingredients

Following the study of the chemistry of plastics is a study of the ingredients and additives for plastics. The first item listed under ingredients is the resin which is in reality not an ingredient at all, but the base to which all the ingredients are added. All plastics start as a resin, and the various ingredients or additives are placed in the resin to enhance the different inherent properties of the resin. The next ingredient is a catalyst which is an additive that causes a reaction when added to a resin. That reaction is usually in the form of a hardening of the resin. The third additive is colorants which, as the name implies, are ingredients which are added to resins to color them. Another ingredient is a filler which is added to a resin to aid in resistance to harmful substances or to add to the apparence of the final product. A plasticizer is an ingredient that is added to resins to make the resin more flexible or resistant to impact when it is in its final state. A solvent is an ingredient that is added to a resin to thin it down. The final ingredient is a stabilizer which is added to a resin to provide protection against degradation by heat, light, and aging.

Major Resins

The next area to be studied is the individual resins. Each resin is studied for its strong and weak points. The processes for which each resin is best suited and the types of products that are made from each resin are to be discussed. The resins are divided into the three basic classifications of plastics which are thermoplastic resins, thermosetting resins, and alloy plastics.

The thermoplastic classification consists of the following individual plastics: acetal, acrylic, cellulosic, fluorocarbon, polyamide, polyolefin, styrene, and vinyl. The thermoset classification consists of the following individual plastics: amino, casein, epoxy, phenolic, polyester, sisicone, and urethane. Alloy plastics are combinations of thermoplastics and/or thermosets. The two alloy plastics listed for study are Acrylonitrile-butadiene-styrene (ABS) and Polyvinyl chloride (PVC).

Available Forms of Plastics

The various resins of the plastics industry may be found in many shapes, and those shapes are known as the "available forms." The available forms make up the next area for study. All resins start as a liquid or powder, which after processing, are made into the forms needed for the different processes of the plastics industry.

One of the most used forms of plastics is molding compounds. A molding compound may be a powder, pellet, preform, or a premix. Molding compounds are used in almost all molding processes.

Another much used form is liquid resins. Some plastics remain in the form of a "syrupy" liquid and may be caused to harden by the addition of a catalyst or external heat. Some liquid resins may be used for fiberglass work and others as coatings.

Still another common form in which plastics are found is structural shapes. The most common shapes are "sheets, rods, and tubes of many dimensions, cross-sectional shapes, and surface dimensions" (1, p. 20). These structural shapes are used for all types of fabrication.

Plastics used for coatings are another form of plastics to be studied. Coatings are, just as their name implies, plastics that have been developed to coat many types of surfaces such as wood, paper, and metal. Many different kinds of plastics are used as coatings.

The next form to be examined is adhesives. Plastic adhesives can be dry powders, liquids, or combinations of the two. They can be used on such items as wood, paper, metal, cloth, or other plastics.

Following adhesives, the next available form to be studied is plastics laminates. Laminates are several layers of cloth, paper, asbestos, or spun glass that have been saturated with a liquid resin and molded under heat and pressure to make a very strong sheet of plastic.

The next available form of plastic to be investigated is the very important area of plastics known as foams. The foams may be made of thermoplastics or thermosetting resins. Through various processes the plastics are made into beads that are filled with air or gas and expanded.

The last available form to be studied is fibers and filaments which are one of the most used forms of plastics. The most common use of fibers and filaments is in the ever present "permanent-press" clothing. Other uses of fibers and filaments are in bristles for brooms and monofilament line for fishing equipment.

As has been shown, there are many forms in which plastics are available, and there are many uses for each form. Most of the forms bear no relation to each other of the others, yet many of them may be made out of the same kinds of plastics.

Identification and Analysis of Plastic Materials

With a basic knowledge of the chemistry of plastics and a knowledge of the ingredients and addatives of plastics, the curriculum guide suggest a study into the identification and analysis of plastic materials. Several tests are recommended such as physical tests, burning tests, specific gravity tests, and solvent tests.

Although physical tests can be performed best with expensive testing equipment, they can also be accomplished with common industrial arts laboratory equipment. The types of physical tests suggested in the curriculum guide are cutting, shearing, bending, breaking, and stretching.

Another type of test that could be initiated in an industrial plastics laboratory is a burn test. A burn test involves igniting a sample of plastic and observing the ensuing reactions. One reaction that is observed is the type of flame produced. The flames are classified by their colors. Another reaction that is observed is the odor produced when the plastic burns. The color of the smoke produced, if any, is another reaction that is observed. How the material behaves while burning is another reaction that is observed. The ease of lighting is a final reaction observed when testing plastics by burning them.

Another test that may be performed on plastics is to determine the specific gravity of a plastic. This test is performed with a balance by weighing a sample of plastic in and out of water. Then by using a formula, the specific gravity is determined. Each plastic has a different specific gravity; therefore, a plastic may be identified if its specific gravity is known. The main problem involved in this test is that various ingredients added to plastics may change their specific gravity.

The last test listed in the curriculum guide is a solvent test. It involves applying a solvent to a plastic and observing the reactions. Each type of plastic reacts differently to each solvent. There are two handicaps to the solvent test. One handicap is that most thermosetting plastics are not affected by solvents. The other is that many solvents are too dangerous to be handled by high school students.

Storage and Handling of Materials

The last area of study of the plastics materials is the storage and handling of plastics and related materials. Each available form of plastic has a particular means by which it should be stored; for example, liquid resins should be stored in a cool, dry place to keep the resins from setting up into a hard plastic. Structural shapes need to be stored in such a manner as to keep them from warping. Related materials such as catalysts and solvents have certain storage characteristics; for example, catalyst and solvents are very combustionable and should be stored in a fire proof cabinet.

Certain precautions should be taken when handling plastics and related materials; for instance, some liquid resins and foams produce toxic fumes and should only be handled in a well ventilated area. Care must be taken when handling certain related materials as most catalyst and solvents are harmful to the skin and therefore should not come in contact with the skin. The storage and handling of plastics and related materials is probably one of the most important area of study of the plastic materials due to the safety factor.

Course Content of Industrial Plastics Processes

As was pointed out before, the section of the curriculum guide that contains the course content is broken down into the two areas of materials and processes of the plastics industry. The course content of the materials has already been presented. The course content of the processes will now be presented. The course content section on processes is broken down into units of molding, reinforcing, thermoforming, casting, foaming, coatings, fabrication, and joining and fastening.

Molding

The first process listed is molding. Due to the large number of unrelated molding processes, the unit on molding is broken down into smaller units covering press molding, injection molding, extrusion, laminating press molding, calendering, blow molding, and rotational casting.

The first molding process to be studied is press molding. There are three types of press molding to be studied; compression molding, transfer molding, and cold molding. There are several types of molds used in press molding that are to be studied. They are flash molds, semi-positive molds, fully positive molds, single cavity molds, and multiple cavity molds. The materials suitable for press molding such as powders, pellets, and preforms are also to be studied.

The next type of molding and one of the more important molding processes is injection molding. The methods of injection molding, plunger and screw ram, are to be studied. The materials used, powders and pellets, and the outstanding characteristics of injection molding are also to be studied.

Another important type of molding is extrusion. The types of extrusion such as sheet, film, wire coating, and profile shapes along with the materials such as powders and pellets will be studied. Also, the outstanding characteristics of extrusion will be brought out.

In the study of each of the last four molding processes, which are laminating press molding, calendering, blow molding, and rotational casting, each process will be studied in terms of two common items of information. One item to be studied will be the materials suitable for each of the four molding processes. The other item to be studied will be the outstanding characteristics of the four molding processes.

Reinforcing

The unit of the molding processes is followed by a unit on reinforcing. The methods of application of reinforced plastics, hand lay-up and spray lay-up, are to be studied. The methods of molding reinforced plastics, or means of forcing the reinforced plastic materials into the mold, are open or plug cavity molding, matched molding, vacuum bag molding, pressure bag molding, and premix molding. Finally, the materials used in reinforcing, such as resins and reinforcing materials, must be examined.

Thermoforming

The next unit of study covers the thermoforming process. It is divided into sections of freehand and jig molding, mechanical stretch forming, blow forming vacuum forming and material requirements for thermoforming.

The section on freehand and jig forming is further broken down into two smaller sub-divisions, one covering straight line forming which explores the use of strip heaters and simple fixtures. The other section on freehand and jig forming covers hand and drape forming which examines the use of heat guns, ovens, heat lamps, and other heat sources and the handling and forming of plastics by hand. Also, forming temperature requirements for various materials will be investigated.

The sections on mechanical stretch forming, blow forming, and vacuum forming emphasize two common areas of study. One area is the various forming techniques involved in each of the individual sections. The other area is the individual mold design characteristics of each of the sections.

The last section of study in the thermoforming process is the study of the materials needed for thermoforming. Of prime importance in this section is the forming temperatures of various plastics. Another important factor is the individual and specific requirements of materials used in the thermoforming process. Also of importance in the study of materials used in the thermoforming process is the tool and mold requirements of various thermoforming materials.

Casting

The next process listed in the curriculum guide to be covered is casting. In this process materials suitable for casting will be studied. The tools and applications of casting plastics will be examined, and the outstanding characteristics of the casting process will be pointed out.

Foaming

The process of foaming follows the casting process. The types of foaming processes which are mechanical foaming, physical foaming, and chemical foaming will be studied. The kinds of resins used in the foaming process will be investigated; and the methods of producing foam products, extrusion foaming, structural foaming, casting or expanded foaming, and expandable bead foaming, will be examined.

Coatings

The process of coating with plastics is the next unit to be examined. The type of coatings such as dip, slush, spray, extrusion, and flow coatings will be studied. The materials suitable for use as coatings will also be examined.

Fabrication

The next process to be studied is the fabrication process. It is divided into two sections, one of which concerns the cutting and machining of plastics. The cutting and machining of plastics with hand tools can be accomplished by examining the use of such tools as hand saws, scissors, snips, shears, files, and hand drills on plastics. The machines used for cutting and machining of plastics which should be examined are circular saws, band saws, jig saws, lathes, milling machines, routers, drill presses, and rule and blanking dies.

The second section of the fabrication process is the finishing of plastics. Hand finishing operations to be studied are scraping, sanding, and buffing. Machine finishing operations to be examined are sanding, ashing, and buffing. Other finishing operations to be investigated are flame polishing, solvent polishing, and decorating which involves painting, silk screening, hot stamping, carving and engraving, and vacuum metalizing.

Joining and Fastening

The last unit to be explored is the joining and fastening process of which there are three categories to be studied. One category is cohesion which includes solvent cementing, welding, of plastics, and sealing of plastics with heat. The next category is adhesion which involves the bonding of two pieces of plastic with a film of a disimilar material. The last category is mechanical linkage which involves either joining plastics by tapping and/or threading of the plastics or by joining plastics by the use of mechanical fasteners such as rivets, spring clips, and nuts and bolts.

After all of the processes, several suggested activities for a teacher of industrial plastics are listed. The suggested activities are:

> Have students design, make, and use molds using the previously described techniques.
>
> Demonstrate various methods of the previously described techniques.
>
> Make literature available containing projects that require the use of the previously described techniques.
>
> Collect samples of products made by each of the techniques described previously.
>
> Use visual aids to illustrate industrial applications of each of the techniques. (Appendix A)

It should be pointed out that a teacher of industrial plastics does not have to teach everything that is listed in the curriculum guide. A teacher may teach the students about the materials of the plastics industry by using the different types of tests listed in the curriculum guide or by teaching the chemical breakdown of the individual plastics. A teacher is required to teach at least six of the processes of the plastics industry; but he may choose which six he will teach, and he may teach more than six if he wishes to do so. The curriculum guide gives a teacher a good view of the materials and processes of the plastics industry; therefore, the teacher can choose the methods and areas that suit him or his facilities best in order to cover the materials and processes of the plastics industry.

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CHAPTER III

EVALUATION OF THE CURRICULUM GUIDE BY TEACHERS OF INDUSTRIAL PLASTICS

The data presented in this chapter were received from a jury of seven teachers of industrial plastics. The teachers were either teaching or had taught industrial plastics or a similar plastics course. The jurors had taught industrial plastics or a plastics course an average of 4.4 years with the number of years of teaching experience ranging from one to twelve years.

Table I presents data pertaining to the importance of including certain basic materials about plastics as listed in the curriculum guide (Appendix A). The members of the jury were instructed to rate the questions as being of no importance, below average importance, average importance, or very important.

The teaching of the history and development of the plastics industry was rated as very important by one juror, being of average importance by three jurors, and of below average importance by three other jurors. Six jurors classified the teaching of the difference between thermoplastics and thermosets as very important. The teaching of the basic chemical structure of a thermoplastic was considered to be very important by three jurymen, but two jurymen rated the subject as being of below average importance. The teaching of the chemical structure of a thermoset was ranked as being very important by three jurymen, however, three other jurors ranked the topic as being of below average importance. Five jurymen rated the teaching of the chamical chain structure of each individual family of plastic

TABLE I

DATA CONCERNING THE IMPORTANCE OF THE INCLUSION OF BASIC MATERIALS IN THE CURRICULUM GUIDE

	Importance			
Information Areas	Very	Average	Below Average	None
The history and development of the plastic industry.	1	3	3	0
The difference between thermoplastics and thermosets.	6	1	0	0
The basic chemical structure of a thermoplastic.	3	1	2	1
The chemical chain structure of each individual family of plastic.	3	1	3	0
The processes by which plastics are made.	1	0	5	1
Is the ability of being able to identify various plastics important?	3	3	0	1
Is a knowledge of physical, chemical, electrical, and thermal properties important?	1	6	0	0
Is testing of plastic materials important?	1	4	2	0

as being of below average importance. The processes by which plastics are made were classified as being of below average importance by four of the jurors, while two jurors rated the topic as being of average importance. The ability of being able to identify various plastics was classified as being very important by three jurors and as being of average importance by three other jurors. The teaching of the physical, chemical, electrical, and thermal properties was rated as being of average importance by six jurymen. Four jurors ranked the testing of plastic materials as being of average importance, but two jurors rated the topic as being of below average importance.

Table II presents the data received from the jury concerning the amount of study time that should be devoted to each available form of plastics as listed in the curriculum guide. The available forms listed are molding compounds, liquid casting resins, solid structural shapes, coatings, adhesives, foams, laminates, and fibers and filaments. The jurors selected the amount of study time they thought should be devoted to each available form. The jurors had a choice of no time, 0-1 hour, 1-5 hours, 6-10 hours, and 11 or more hours.

Five of the jurors believed that 1-5 hours of study time should be devoted to molding compounds. Three members of the jury concluded that 1-5 hours of study time was appropriate for liquid casting resins, but two jurors adjudged the optimum amount of study time for liquid casting resins to be 11 or more hours. Three of the jurors recommended 11 or more hours of study time for solid structural shapes; however, two jurors suggested 6-10 hours, and two jurors advised 1-5 hours of study time for solid structural shapes. Coatings should be studied 1-5 hours in the opinion of five of the jurors. Three jurymen favored 1-5 hours of study time for adhesives, but two jurymen preferred 6-10 hours of study time for adhesives.

TABLE II

DATA CONCERNING THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF EACH AVAILABLE FORM IN WHICH PLASTICS MAY BE FOUND

	Time				
Available Forms	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Molding compounds	0	1	5	1	0
Liquid casting resins	0	1	3	1	2
Solid structural shapes	0	0	2	2	3
Coatings	0	2	5	0	0
Adhesives	0	1	3	2	1
Foams	0	0	7	0	0
Laminates	0	1	3	1	2
Fibers and filaments	0	3	3	0	1

All of the jurors, seven, recommended 1-5 hours of study time for foams. Three members of the jury believed that 1-5 hours of study time was suitable for laminates, yet two jurors concluded that 11 or more hours of study time was desirable for laminates. Three jurors suggested 0-1 hour of study time for fibers and filaments, while three other jurors recommended 1-5 hours of study time.

The jurors were given an opportunity to add any available form that had been omitted. One jurors added sheet thermoplastics as an available form that had been omitted; however, sheet thermoplastics are classified as solid structural shapes (1, p. 20). The juror advised a study time of sheet thermoplastics of 11 or more hours.

Data received from the jury concerning the amount of study time that should be devoted to the study of ingredients are presented in Table III. The ingredients included in the survey, as taken from the curriculum guide, are resins and retarders, catalysts, fillers, solvents, plasticizers, stabilizers, and colorants. The jurors were instructed to select the amount of study time they considered to be appropriate for the study of each ingredient. Once again the choices of the amounts of study time available to the jurors were no time, 0-1 hour, 1-5 hours, 6-10 hours, and 11 or more hours.

Four of the jurors concluded that resins and retarders should be studied 1-5 hours. Three jurors suggested that catalysts be studied 0-1 hour, but two jurors recommended

11 or more hours of study time for catalysts. Five jurors reasoned that fillers, solvents, plasticizers, and colorants should be studied 0-1 hour. The last ingredient surveyed, stabilizers, was judged to require 0-1 hour of study time by six of the jurors.

TABLE III

DATA CONCERNING THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF THE INGREDIENTS OF PLASTICS

	Time				
Ingredients	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Resins and retarders	0	1	4	1	1
Catalyst	0	3	1	1	2
Fillers	0	5	1	0	1
Solvents	0	5	1	1	0
Plasticizers	1	5	0	1	0
Stabilizers	1	6	0	0	0
Colorants	0	5	2	0	0

Tables IV, V, and VI present data concerning the amount of study time that should be devoted to the major resins of the plastics industry. The major resins are divided into three classifications which are thermoplastic resins, thermosetting resins, and alloy plastics. The jurors were instructed to select a suitable amount of study time for each major resin. The options available to the jurors were once again no time, 0-1 hour, 1-5 hours, 6-10 hours and 11 or more hours.

Table IV contains the data pertaining to the amount of study time that should be assigned to thermoplastic resins.

TABLE IV

DATA PERTAINING TO THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF THE MAJOR THERMOPLASTIC RESINS

	Time				
Thermoplastic Resins	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Acteal	0	3	4	0	0
Acrylic	0	1	2	0	4
Cellulosic	1	2	3	1	0
Fluorocarbon	0	3	3	1	0
Polyamide	1	2	3	1	0
Polyolefin	1	2	4	0	0
Styrene	0	1	2	0	4
Vinyl	0	1	3	2	1

The major thermoplastic resins, as listed in the curriculum guide, are acetal, acrylic, cellulosic, fluorocarbon, polyamide, polyolefin, styrene, and vinyl.

Four of the jurors recommended 1-5 hours of study time for acetal resins, but three jurors concluded that acetal resins should be studied 0-1 hour. Acrylic resins along with styrene resins received the highest ratings of any of the major resins; four jurors suggested 11 or more hours of study time for acrylic and styrene resins. However, acrylic and styrene resins were each judged to require 1-5 hours of study time by two jurors. One to five hours of study time was deemed to be the optimum amount of study time for both cellulosic and polyamide resins by three jurymen; two jurors concluded that cellulosics and polyamides each should be studied 0-1 hour. The 0-1 hour and 1-5 hours options were each selected by three jurors as the proper amount of study time for fluorocarbon resins. One to five hours of study time of polyolefin resins was recommended by four jurors; two jurors recommended 0-1 hour of study time of polyolefin resins. Three jurors concluded that vinyl resins should be studied 1-5 hours, and two jurors reasoned that 6-10 hours of study time should be devoted to vinyl resins.

The jurors were given an opportunity to add any thermoplastic resin that had been omitted. One juror recommended the addition of polysulfone resins with a study time of 1-5 hours.

Table V is comprised of the data received from the jurors concerning the amount of study time that should be devoted to the major thermosetting resins. The resins that make up the thermoset family, as listed in the curriculum guide, are amino, casein, epoxy, phenolic, silicone, and urethane.

TABLE V

DATA PERTAINING TO THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF THE MAJOR THERMOSETTING RESINS

	Time				
Thermosetting Resins	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Amino	2	2	3	0	0
Casein	2	2	3	0	0
Epoxy	1	0	2	1	3
Phenolic	1	1	2	2	1
Polyester	0	1	2	1	3
Silicone	1	2	3	1	0
Urethane	1	1	2	2	1

Amino and casein resins were each judged to require 1-5 hours of study time by three jurors; however, the "no time" and 0-1 hour options were each selected by two jurors as the optimum amount of study time for both amino and casein resins. Epoxy and polyester resins received the highest rating of any of the thermoset resins, each was deemed to required 11 or more hours of study time by three jurors and 1-5 hours of study time by two jurors. The 1-5 hours and 6-10 hours options were each selected by two jurors as appropriate amounts of study time for phenolic resins. Three jurors recommended 1-5 hours of study time for silicone resins, and two jurors suggested 0-1 hour of study time for silicone resins. Urethane resins should be studied 6-10 hours in the opinion of two members of the jury; however, two other jurymen concluded that 1-5 hours of study time was desirable for urethane resins.

Table VI presents the data received from the jurors pertaining to the amount of study time that should be devoted to the study of the alloy plastics. Only two alloy plastics, ABS and PVC were listed in the curriculum guide (Appendix A).

TABLE VI

DATA PERTAINING TO THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF ALLOY PLASTICS

	Time				
Alloy Plastics	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
ABS	1	1	2	1	2
PVC	1	2	3	1	0

The 1-5 hours and 11 or more hours options were each selected as the optimum amounts of study time for ABS plastics by two jurors. Three jurors recommended 1-5 hours of study time of PVC plastics; however, two jurors suggested only 0-1 hour of study time of PVC plastics.

The next section of the questionnaire pertained to the amount of study time to be devoted to identification and analysis, or testing of plastic materials. The data received from the jurors concerning this section of the questionnaire are presented in Table VII. Only those jurors that rated the last question of the first section of the questionnaire as being of average importance or very important were asked to complete this section of the questionnaire. Four jurors had rated the question as being of average importance, and one had rated it very important. The tests surveyed were physical tests, burn tests, specific gravity tests, and heat or melt tests. The jurors were once again allowed to recommend study times of no time, 0-1 hour, 1-5 hours, 6-10 hours, and 11 or more hours.

Three jurors recommended 1-5 hours of study time for physical tests; two jurors suggested a study time of 0-1 hour. Four jurymen concluded that 0-1 hour of study time should be devoted to burn tests. Three jurors recommended a study time of 0-1 hour for both specific gravity tests and solvent tests. Three jurors concluded that 1-5 hours of study time of heat or melt tests would be desirable; however, two jurors suggested 0-1 hour of study time for heat or melt tests.

TABLE VII

DATA CONCERNING THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF TESTING OF PLASTIC MATERIALS

	Time				
Tests of Plastic Materials	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Physical test	0	2	3	0	0
Burning test	0	4	1	0	0
Specific gravity test	1	3	1	0	0
Solvent test	0	3	1	1	0
Heat or melt test	0	2	3	0	0

Table VIII contains data concerning the amount of emphasis to be placed upon each process of the plastics industry as listed in the curriculum guide (Appendix A). The jurors were able to respond to each plastics process listed in the curriculum guide by noting that each process contained (1) too much information, (2) adequate information, or (3) inadequate information. The plastics processes surveyed were molding, reinforcing, thermoforming, casting, foaming, coatings, fabrication, and joining and fastening. The molding process was further broken down into press molding, injection molding, extrusion, laminating press molding, calendering, blow molding, and rotational casting.

TABLE VIII

EVALUATION OF EMPHASIS PLACED ON EACH PLASTICS PROCESS IN THE CURRICULUM GUIDE

Processes	Emphasis: Too Much	Emphasis: Adequate	Emphasis: Inadequate
Molding:			
Press molding	0	7	0
Injection molding	0	4	3
Extrusion	0	5	2
Laminating press molding	0	3	4
Calendering	0	3	4
Blow molding	0	3	4
Rotational casting	0	3	4
Reinforcing	0	6	1
Thermoforming	0	6	1
Casting	0	3	4
Foaming	0	6	1
Coatings	0	3	4
Fabrication	0	6	1
Joining and fastening	0	5	2

The emphasis devoted the molding processes of laminating press molding, calendering, blow molding, and rotational casting was judged to be inadequate by four jurors, but three jurors concluded that adequate emphasis had been devoted to the processes. The jurors were unanimous in their conclusion that adequate emphasis had been given to press molding. In the judgement of four jurors, adequate emphasis had been devoted to injection molding; however, the emphasis devoted to the injection molding process was adequate in the opinion of three of the jurors. Five jurors considered the emphasis addressed to extrusion to be adequate.

The reinforcing, thermoforming, foaming, and fabrication processes were judged to have been given adequate emphasis by six of the jurors. Three jurors concluded that the casting and coatings processes had been given adequate emphasis, but four jurors concluded that the emphasis given to be inadequate. Adequate emphasis was devoted to the joining and fastening process in the opinion of five of the jurors.

After the emphasis placed on each process was evaluated, they were rated in regard to the amount of study time that should be devoted to each of them; and the data concerning the amounts of study time are presented in Table IX. In this section of the questionnaire, most processes were broken down into smaller subject areas of information as were the processes in the curriculum guide.

The molding process was again divided into the areas of press molding, injection molding, extrusion, laminating press molding, calendering, blow molding, and rotational casting. Three jurors recommended 0-1 hour of study time for press molding, but the 1-5 hours and 6-10 hours options were each suggested as desirable amounts of study time for press molding by two jurors. The 1-5 hours and 11 or more hours options were each selected by three jurors as the optimum amounts of study time for injection molding. The 0-1 hour, 1-5 hours, and 11 or more hours options were each recommended as appropriate amounts of study time for extrusion. Three jurors suggested that laminating press molding be studied 6-10 hours; however, 0-1 hour and 1-5 hours were each considered to be the desirable amounts of study time for laminating press molding by two jurymen. Zero to one hour and 1-5 hours were each considered to be the optimum amounts of study time for calendering. Four members of the jury recommended 1-5 hours of study time for the molding processes of blow molding and rotational casting.

The reinforcing process was divided into two subject areas which were hand lay-up and spray lay-up. Three jurors recommended 11 or more hours of study time for both hand lay-up and spray lay-up. Zero to one hour of study time should be devoted to hand lay-up in the opinion of two jurors and to spray lay-up in the judgement of three jurors.

The thermoforming process was broken down into the subject areas of freehand and jig forming, mechanical stretch forming, blow forming, and vacuum forming. Three jurors recommended

6-10 hours of study time of freehand and jig forming; however, the 1-5 hours and 11 or more hours options were each selected by two jurors as the desirable amounts of study time for freehand and jig forming. Three jurymen suggested that mechanical stretch forming be studied 11 or more hours, but two jurymen concluded that it should only be studied 0-1 hour. In the opinion of two jurors, blow forming should be studied 11 or more hours; three jurors concluded that 1-5 hours of study time would be sufficient. Four jurors recommended 11 or more hours of study time for vacuum forming.

The process of casting was divided into the subject areas of casting with thermoplastics and casting with thermosets. Two jurors concluded that casting with thermoplastics should be studied 11 or more hours; and, three jurors concluded that the same amount of study time, 11 or more hours, should be devoted to casting with thermosets. One to five hours was considered to be the optimum amount of study time for casting of thermoplastics by three jurors. Two jurors concluded that the same amount of study time, 1-5 hours, was the correct amount of study time for casting with thermosets.

The foaming process was separated into the three subject areas of mechanical foaming, physical foaming, and chemical foaming. Mechanical foaming and chemical foaming were judged to require 6-10 hours of study time by three jurors, and two jurors concluded that the same amount of study time should be devoted to physical foaming. Zero to one hour was considered

TABLE IX

DATA CONCERNING THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF THE PROCESSES OF THE PLASTICS INDUSTRY

Processes	Time				
	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Molding:					
Press molding	0	3	2	0	2
Injection molding	0	1	3	0	3
Extrusion	0	2	2	1	2
Laminating press molding	0	2	2	3	0
Calendering	1	3	3	0	0
Blow molding	0	2	4	1	0
Rotational casting	1	1	4	1	0
Reinforcing:					
Hand lay-up	0	2	1	1	3
Spray lay-up	0	3	1	0	3
Thermoforming:					
Freehand and jig forming	0	2	0	3	2
Mechanical forming	0	2	1	1	3
Blow forming	0	2	1	1	3
Vacuum forming	0	1	1	1	4

TABLE IX--Continued

Processes	Time				
	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Casting:					
With thermoplastics	0	2	3	0	2
With thermosets	0	1	2	1	3
Foaming:					
Mechanical foaming	0	2	2	3	0
Physical foaming	0	3	1	2	1
Chemical foaming	0	3	0	3	1
Coatings:					
Dip	0	3	3	0	1
Slush	1	4	2	0	0
Spray	0	3	2	1	1
Extrusion	1	3	2	1	0
Flow	1	4	1	0	1
Fabrication	0	2	0	4	1
Joining and fastening:					
Cohesion by solvent	0	2	1	2	2
Cohesion by welding and heat sealing	0	2	1	2	2
Adhesion	0	2	1	2	2
Mechanical linkage	0	3	1	2	1

to be the optimum amount of study time for physical and chemical foaming by three jurors; two jurors concluded that the same amount of study time, 0-1 hour, was desirable for mechanical foaming.

Dip, slush, spray, extrsuion, and flow were the subject areas into which the process of coatings was broken down. Three jurors concluded that dip, spray, and extrusion coatings should be studied 0-1 hour; four jurors recommended 0-1 hour of study time for slush and flow coatings. Three jurors suggested that 1-5 hours of study time be devoted to dip coatings, and two jurors suggested that slush, spray, and extrusion coatings be studied 1-5 hours.

The fabrication process was not broken down into subject areas. Four jurors considered 6-10 hours of study time for fabrication to be desirable. Two jurors judged the amount of study time required for fabrication to be 0-1 hour.

The process of joining and fastening was separated into the subject areas of cohesion by solvent process, cohesion by welding and heat sealing, adhesion, and mechanical linkage. The 0-1 hour, 6-10 hours, and 11 or more hours options were each selected by two jurors as the optimum amounts of study time for the joining and fastening processes of cohesion by solvent process, cohesion by welding and heat sealing, and adhesion. Three jurors suggested that mechanical linkage be studied 0-1 hour; two jurors recommended that 6-10 hours of study time be devoted to the joining and fastening process of mechanical linkage.

In the next section of the questionnaire, the jury members were informed that Bulletin 615 of the Texas Education Agency would allow a teacher of industrial plastics to teach six or more of the plastics processing groupings which are molding, reinforcing, thermoforming, casting, foaming, coastings, fabrication, and joining and fastening (2, pp. 140-168). The jurors were then asked the question, "If you were going to teach only six of the groupings, which six would you choose?" The jurors were then instructed to choose the six processes they would select if they were able to teach only six processes. The jurors were then instructed to rate the choices in order of their importance with a 6 being the most important, a 5 being the next important, and so on through 1. The data collected from this section of the questionnaire are presented in Table X.

By averaging the total responses for each process, the rank of each process in terms of importance was determined. The thermoforming process received the highest ranking from the jurors, a ranking of 5.57. The fabrication process received a 5.00 rating to be the second highest rated process. After fabrication, there was a drop in the ratings to a 3.33 for reinforcing closely followed by a 3.00 for foaming. The rating for the remaining processes ranged from 2.83 for the molding process to 0.00 for the coating process.

Another item of interest in Table X is the number of selections each process received. Thermoforming was chosen by all seven jurors. Processes being selected by six jurors were molding, reinforcing, casting, fabrication, and joining and fastening. Foaming was chosen by five jurors, and the coatings process was not chosen by a single juror.

TABLE X

THE IMPORTANCE OF THE PLASTIC PROCESSES

Processes	Rating							Average
	No. 6	No. 5	No. 4	No. 3	No. 2	No. 1	Total	
Molding	0	1	1	1	2	1	6	2.83
Reinforcing	0	1	3	1	3	0	6	3.33
Thermoforming	3	3	0	1	0	0	7	5.57
Casting	0	0	2	1	0	3	6	2.33
Foaming	0	1	1	1	1	1	5	3.00
Coating	0	0	0	0	0	0	0	0.00
Fabrication	3	1	1	1	0	0	6	5.00
Joining and fastening	1	0	0	1	2	2	6	2.50

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CHAPTER IV

EVALUATION OF THE CURRICULUM GUIDE BY PERSONNEL EMPLOYED IN THE PLASTICS INDUSTRY

The data presented in this chapter were received from personnel employed in plastics industries in the Dallas-Fort Worth metropolitan area. The personnel were employed in plastics companies that were concerned with either the materials or the processes of the plastics industry. Several of the employees were involved with the formulation and development of plastic resins; several more were concerned with the sales of plastics in their available forms. A majority of the plastics employees were employed by plastics firms that were involved in the plastics processes listed in the curriculum guide (Appendix A); this includes all of the major subject areas into which the molding process was divided. The only process that was not represented by an employee was the casting process. However, one of the plastics employees surveyed who had problem solving experience in all of the processes of the plastics industry including casting was employed as a plastics consultant, a person who aids plastics companies that are having manufacturing problems in any plastics process.

Table XI presents data pertaining to the importance of including certain basic information related to the materials of the plastic industry as listed in the curriculum guide.

Eight of the plastics employees said it was very important to teach the history and development of the plastics industry.

TABLE XI

DATA CONCERNING THE IMPORTANCE OF THE INCLUSION OF BASIC MATERIALS IN THE CURRICULUM GUIDE

Information Areas	Importance: Very	Average	Below Average	None
The history and development of the plastic industry.	8	15	5	1
The difference between thermoplastic and thermosetting resins.	20	8	1	0
The basic chemical structure of thermoplastic resins.	4	17	7	1
The basic chemical structure of thermosetting resins.	3	17	8	1
The chemical chain structure of each individual family of plastic.	2	9	17	1
The processes by which plastics are made.	9	15	5	0
Is the ability of being able to identify various plastics important?	17	9	3	0
Is a knowledge of physical, chemical, electrical, and thermal properties important?	17	11	1	0
Is testing of plastic materials important?	12	13	4	0

Thirteen said it was of average importance, and five said it was of below average importance. Twenty of the plastics employees said that it was very important to teach the difference between thermoplastics and thermosetting resins; eight said it was of average importance. The teaching of the basic chemical structure of thermoplastic resins was said to be of below average importance by seven of the employees surveyed, seventeen of the employees said it was very important. Eight of the plastics employees indicated that the teaching of the basic chemical structure of thermosetting resins was of below average importance, seventeen decided that it was of average importance, and three considered it very important. The importance of teaching the chemical chain structure of each individual family of plastic was judged to be of below average importance by seventeen of the employees of the plastics industry, and of average importance by nine. Nine of the employees said that it was very important to teach the processes by which plastics are made, fifteen said it was of average importance, and five said that it was of below average importance. The ability to be able to identify various plastics was said to be very important by seventeen of the plastics employees and of average importance by eight. Seventeen of the plastics employees surveyed concluded that a knowledge of the physical, chemical, electrical, and thermal properties of plastics was very important, and eleven decided that it was of average importance. Twelve of the plastics employees surveyed considered the testing of plastic materials to be very important, but thirteen believed it to be only of average importance.

The data presented in Table XII, as received from the employees in plastics industries, concerns the amount of study time that should be devoted to each of the available forms of plastic as listed in the curriculum guide. The available forms listed are molding compounds, liquid casting resins, solid structural shapes, coatings, adhesives, foams, laminates, and fibers and filaments. The employees were asked to select the amount of study time that should be devoted to each available form. The employees were given the selection of no time, 0-1 hour, 1-5 hours, 6-10 hours, and 11 or more hours.

The available form of molding compounds was judged to require 1-5 hours of study time by thirteen of the employees responding to the questionnaire; however, the 6-10 hours and the 11 or more hours choices were each selected by seven plastics employees as being the appropriate amount of study time for molding compounds. Sixteen of the employees thought 1-5 hours of study time was appropriate for liquid casting resins while ten of the employees surveyed believed 0-1 hour of study time would be sufficient. The 0-1 hour selection was chosen by thirteen of the employees as the proper amount of study time for solid structural shapes; ten preferred the 1-5 hours option. Thirteen of the employees surveyed concluded that 1-5 hours of study was the proper amount of time for coatings, and eleven judged the correct amount of time to be 0-1 hour. Ten employees decided that 1-5 hours of study time should be assigned to the study of adhesives, and twelve concluded that 0-1 hour of study time was ample.

TABLE XII

DATA CONCERNING THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF EACH AVAILABLE FORM IN WHICH PLASTICS MAY BE FOUND

	Time				
Available Forms	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Molding compounds	0	2	13	7	7
Liquid casting resins	1	10	16	1	1
Solid structural shapes	1	13	10	4	1
Coatings	0	11	13	4	1
Adhesives	0	12	10	5	2
Foams	0	9	13	6	1
Laminates	0	10	14	3	2
Fibers and filaments	0	14	11	2	2

One to five hours should be devoted to the study of foams in the opinion of thirteen of the plastics employees while nine believed that 0-1 hour would be adequate. Six of the employees thought foams should be studied 6-10 hours. Laminates were appraised as needing 1-5 hours of study time by fourteen of the plastics employees surveyed. Ten of the employees estimated that 0-1 hour was needed for the study of laminates. Fibers and filaments, in the opinion of fourteen of the plastics employees, require 0-1 hour of study; however, eleven plastics employees concluded that fibers and filaments should be studied 1-5 hours.

Table XIII presents data pertaining to the amount of study time that should be devoted to the ingredients that are added to plastics. The ingredients were resins and retarders, catalyst, fillers, solvents, plasticizers, stabilizers, and colorants. The selection for the amounts of study time were the same as for the questions on the available forms of plastics which was: no time, 0-1 hour, 1-5 hours, 6-10 hours, and 11 or more hours.

Six of the plastics employees surveyed selected the 6-10 hours choice as the proper amount of study time for resins and retarders, thirteen of the employees chose the 1-5 hours option, and seven picked the 0-1 hour response. Fifteen of the plastics employees estimated the amount of study time needed for catalyst to be 0-1 hour; eleven of the employees surveyed favor 1-5 hours of study time for catalyst. Fourteen plastics employees selected the 0-1 hour choice and twelve picked the 1-5 hours option as the correct amount of study time for solvents. Sixteen of the plastics employees concluded that plasticizers should be studied 1-5 hours; but in the opinion of eleven of the plastics employees, plasticizers should be studied 0-1 hour. Sixteen of the employees decided that stabilizers should be studied 0-1 hour, and eleven of the employees concluded that 1-5 hours of study time for stabilizers was sufficient. The 0-1 hour and 1-5 hours options were each selected by eleven employees as being the correct amount of time to be devoted to the study of colorants.

TABLE XIII

DATA CONCERNING THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF INGREDIENTS OF PLASTICS

	Time				
	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Resins and retarders	0	7	13	6	3
Catalyst	1	15	11	2	0
Fillers	1	14	12	2	0
Solvents	1	12	15	1	0
Plasticizers	0	11	16	1	1
Stabilizers	0	16	11	1	1
Colorants	0	11	11	5	2

The employees of the plastics industry surveyed were given an opportunity to add any ingredient that had been omitted and to recommend the amount of study time for the added ingredients. One of the employees recommended the addition of thixotropic agents, systems, and additives with a study time of 11 or more hours.

The next three tables, Table XIV, Table XV, and Table XVI, contain information pertaining to the amount of study time that should be devoted to the study of the major resins of the plastics industry. The major resins are divided into their categories: thermoplastic resins, thermosetting resins, and alloy plastics. Table XIV presents the data received from the plastics employees concerning the amount of study time that should be devoted to the study of the major thermoplastic resins. The major resins of the thermoplastic classification, as listed in the curriculum guide, are acetal, acrylic, cellulosic, fluorocarbon, polyamide, polyolefin, stryene, and vinyl.

Acetal plastics received the greatest number of responses in one single selection of any of the major resins; nineteen of the employees surveyed chose the 0-1 hour selection as the proper amount of study time for acetal resins. Eight of the plastics employees judged the amount of study time for acetal resins to 1-5 hours. Fifteen of the employees questioned concluded that acrylic plastics should be studied 1-5 hours, but the 0-1 hour and 6-10 hours choices were each selected by seven plastics employees as being the optimum amount of time for the study of acrylic resins. Seventeen of the employees of the plastics industry questioned appraised the study time needed for cellulosic resins to be 0-1 hour while ten employees decided that 1-5 hours was more appropriate.

TABLE XIV

DATA PERTAINING TO THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF THE MAJOR THERMOPLASTIC RESINS

	Time				
Thermoplastic Resins	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Acetal	0	19	8	2	0
Acrylic	0	7	15	7	0
Cellulosic	0	17	10	2	0
Fluorocarbon	0	13	12	4	0
Polyamide	0	16	7	6	0
Polyolefin	0	8	11	8	2
Styrene	0	8	11	8	2
Vinyl	0	6	16	7	0

Fluorocarbon resins should be studied 0-1 hour in the judgement of thirteen of the plastics employees whereas twelve of the plastics employees concluded that the amount of study time needed for fluorocarbons to be 1-5 hours. Polyamide resins should be studied 0-1 hour in the opinion of sixteen of the employees of the plastics industry while seven employees picked the 1-5 hours response, and six chose the 6-10 hours option. Polyolefin resins and styrene resins received a like proportion of responses with eleven plastics employees concluded that they should be studied 1-5 hours. The 0-1 hour and 6-10 hours selections were each chosen by eight employees as the optimum amount of study time to be given to the study of polyolefin and styrene resins. Six of the employees selected the 0-1 hour option as the correct amount of time to be devoted to the study of vinyl resins, sixteen chose the 1-5 hours response, and seven preferred the 6-10 hours selection.

The employees answering the questionnaire were allowed to add any important thermoplastic resin that had been omitted. Two of the employees added polyethylene resins recommending 1-5 hours of study time. Another plastics employee suggested the addition of polypropylene resins with 1-5 hours of study time. However, polyethylene and polypropylene resins are types of polyolefin resins (2, p. 37) and should be studied when polyolefin resins are studied. Another employee recommended that polycarbonate resins should be added and suggested that it be studied 0-1 hour. Another employee suggested that polysulfone resins be added with a study time of 0-1 hour.

The information contained in Table XV was received from the plastics employees concerning the amount of study time that should be devoted to the study of thermosetting resins. The members of the thermosetting classification of resins, as taken from the curriculum guide, are amino, casein, epoxy, phenolic, polyester, silicone, and urethane.

TABLE XV

DATA PERTAINING TO THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF THE MAJOR THERMOSETTING RESINS

	Time				
Thermosetting Resins	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Amino	4	17	7	1	0
Casein	6	16	7	0	0
Epoxy	1	7	16	6	0
Phenolic	1	8	15	5	0
Polyester	0	6	13	9	1
Silicone	0	13	15	1	0
Urethane	0	6	13	9	1

In the opinion of four of the plastics employees, amino resins should not be studied; however, seventeen concluded that amino resins should be studied 0-1 hour, and seven chose the 1-5 hours response. Six of the employees of the plastics industry decided that casein resins need not be studied. Sixteen plastics employees considered 0-1 hour of study time of casein resins to be adequate, and seven estimated 1-5 hours of study time to be ample. Seven of the plastics employees decided that epoxy resins should be studied 0-1 hour; sixteen chose the 1-5 hours selection, and six picked the 6-10 hours option. Phenolic resins were judged to require 0-1 hour of study time by eight of the employees. Fifteen employees of the plastics industry concluded that phenolic resins should be studied 1-5 hours; five estimated that 6-10 hours of study time would be sufficient. Polyester resin and urethane resins received the same proportion of responses. Nine of the plastics employees surveyed concluded that 6-10 hours of study time should be devoted to the study of both polyester and urethane resins, and thirteen of the plastics employees decided that both polyester and urethane resins should be studied 1-5 hours. Six of the employees thought polyester and urethane resins should be studied 0-1 hour. Silicone resins were judged to require 1-5 hours of study time by fifteen of the employees questions; however, thirteen decided that silicone plastics should only be studied 0-1 hour.

The information presented in Table XVI pertains to the amount of study time that should be devoted to the study of alloy plastics. The two alloy plastics that the plastics employees were questioned about, as taken from the curriculum guide, were ABS and PVC plastics. Nine of the plastics employees concluded that ABS plastics should be studied 6-10 hours, but seventeen decided that only 1-5 hours of study time should be devoted to ABS plastics. PVC plastics require 6-10 hours of study time in the opinion of twelve of the plastics employees; however, fourteen of the employees believed that PVC plastics should be studied 1-5 hours.

TABLE XVI

DATA PERTAINING TO THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF ALLOY PLASTICS

	Time				
Alloy Plastics	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
ABS	0	3	17	9	0
PVC	0	3	14	12	0

Data obtained from the next section of the questionnaire directed toward the amount of time that should be devoted to the study of identification and analysis, or testing of plastic materials are presented in Table XVII. Only those plastics employees that rated the testing of plastic materials as being very important or of average importance were asked to complete this section. Twelve of the employees rated the testing of plastic materials as being very important, and thirteen rated it as being of average importance. The four remaining employees had rated the question as being of below average importance; therefore, they were not required to answer the question pertaining to testing of plastic materials. However, one of the four did complete the section of the questionnaire pertaining to testing of plastic materials, and his responses are included with the other responses in Table XVII. The tests of plstic materials surveyed, as taken from

TABLE XVII

DATA CONCERNING THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF TESTING OF PLASTIC MATERIALS

	Time				
Tests of Plastic Materials	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Physical	1	8	11	4	2
Burning	1	9	15	1	0
Specific gravity	1	14	11	0	0
Solvent	2	11	12	1	0
Heat or melt	2	10	10	4	0

the curriculum guide, were physical tests, burning tests, specific gravity tests, and heat or melt tests.

Physical tests should be studied 1-5 hours in the opinion of eleven of the plastics employees; eight of the employees judged that 0-1 hour of study time was required for physical tests. Fifteen of the plastics employees surveyed decided that 1-5 hours of study time should be allocated to burning tests, but nine of the employees concluded that burning tests should be studied 0-1 hour. One to five hours was judged to be a suitable amount of time for the study of specific gravity tests by eleven of the plastics employees; however, fourteen of the employees considered 0-1 hour to be the appropriate amount of time for the study of specific gravity tests. Eleven of the plastics employees decided solvent tests should be studied 0-1 hour while 1-5 hours was the proper amount of time for the study of solvent tests in the opinion of twelve of the employees questioned. The 0-1 hour and 1-5 hours selections were each chosen by ten employees as the optimum amounts of study of heat or melt tests.

The employees surveyed were asked to add and rate any tests of plastic materials that were omitted. Three of the employees suggested the addition of tensile, enlongation, and contraction tests. One of the three recommended 0-1 hour of study time, another 1-5 hours, and a third 6-10 hours; however, both Baird (1, p. 73) and Swanson (2, p. 23) list tensile tests as types of physical tests. Another employee recommended the addition of rheology tests with a study time of 11 or more hours. However, Baird defines rheology as the study of the flow properties of plastics; therefore, rehology tests would be included as part of the heat or melt tests (1, p. 309). Two of the plastics employees surveyed recommended 1-5 hours of study of weathering exposure tests. Finally, one employee advised the addition of a study of wear tests for 1-5 hours.

The information presented in Table XVIII pertains to the amount of emphasis placed upon each process of the plastics industry as listed in the curriculum guide. The employees surveyed were able to respond to each process by noting that each included (1) too much emphasis, (2) adequate emphasis, or (3) inadequate emphasis. The plastic processes examined were molding, reinforcing, thermoforming, casting, foaming, coatings, fabrication, and joining and fastening. The molding process was divided into press molding, injection molding, extrusion, laminating press molding, calendering, blow molding, and rotational casting.

The various molding processes received the following responses. The curriculum guide was thought to contain adequate emphasis pertaining to press molding by twenty-five of the employees surveyed. Twenty-three of the plastics employees concluded that adequate emphasis was provided in the curriculum guide for injection molding; however, six of the employees believed that more emphasis was needed. The emphasis included in the curriculum guide for extrusion was ample in the opinion of twenty-three of the employees, but five thought more emphasis was needed. In the judgement of twenty-six of the employees of the plastics industry, adequate emphasis was provided for laminating press molding.

TABLE XVIII

EVALUATION OF THE EMPHASIS PLACED ON EACH PLASTICS PROCESS IN THE CURRICULUM GUIDE

Process	Emphasis		
	Too Much	Adequate	Inadequate
Molding:			
Press molding	3	25	1
Injection molding	0	23	6
Extrusion	1	23	5
Laminating press molding	1	26	2
Calendering	4	22	3
Blow molding	0	24	5
Rotational casting	0	26	3
Reinforcing	3	22	4
Thermoforming	4	23	2
Casting	2	25	2
Foaming	1	27	1
Coatings	1	24	4
Fabrication	2	24	3
Joining and finishing	1	26	2

The molding process to receive the greatest number of responses, four, for too much emphasis was calendering; however, twenty-two of the employees surveyed concluded that calendering was provided adequate emphasis, and three believed the emphasis provided calendering to be inadequate. Twenty-four of the plastics employees thought blow molding was provided with enough emphasis, but five employees decided more emphasis was needed. The last molding process, rotational casting, was judged to have ample emphasis by twenty-six of the plastics employees.

The remaining processes received the following responses. The curriculum guide was judged to contain adequage subject matter pertaining to the reinforcing process by twenty-two of the employees. However, three employees concluded that too much emphasis was decoted to reinforcing, yet four decided that more emphasis was needed. The thermoforming process was cited as having ample emphasis by twenty-three of the employees of the plastics industry, but four of the employees believed too much emphasis was provided for thermoforming. The casting process was judged to contain adequate emphasis by twenty-five of the plastics industry employees. The foaming process received the greatest number of responses for adequate emphasis of any of the processes surveyed; twenty-seven of the employees decided adequate emphasis was included in the curriculum guide for the foaming process. The coating process was provided ample emphasis in the curriculum guide in the judgement of twenty-four of the plastics employees, but four of the employees thought more emphasis should be provided the coating process. Twenty-four of the employees of the plastics industry concluded that adequate emphasis was provided the fabrication process in the curriculum guide. The joining and fastening process was said to have adequate emphasis in the opinion of twenty-six of the plastics employees questioned.

The plastics employees were asked to list any process that had been omitted. One of the employees believed that the process of co-extursion should be added; however, Van Ness lists co-extrusion as one of the variations of the molding process of extrusion (4, p. 350, pp. 373-374); therefore, co-extrusion would be studied in the extrusion process.

In the next section of the questionnaire, the plastics employees were asked to rate the amount of time that should be devoted to the study of the plastics processes as listed in the curriculum guide. The data received from this section are presented in Table XIX. In the curriculum guide, most of the processes are divided into the individual subject areas of each process, and this section of the questionnaire was divided accordingly.

In the process of molding, press molding should be studied 0-1 hour in the opinion of eleven of the plastics employees. Injection molding received the highest rating of any of the molding processes surveyed; fourteen of the plastics employees concluded that 11 or more hours should be decoted to the study of injection molding. Nine of the employees considered 6-10 hours to be an appropriate amount of study time for extrusion while thirteen of the employees decided that 1-5 hours should be devoted to the study of extrusion. Fourteen of the plastics employees judged the proper amount of study time for laminating press molding to be 1-5 hours, but 0-1 hour was considered to be the appropriate amount of study time for laminating press molding by ten of the employees. The calendering molding process should be studied 0-1 hour in the judgement of eleven of the plastics employees surveyed, but thirteen of the employees decided 1-5 hours of study time was needed. Thirteen of the employees reasoned that blow molding should be studied 6-10 hours; however, nine of the employees favored the 1-5 hours choice. The last molding process, rotational casting, should be studied 1-5 hours in the opinion of sixteen of the employees surveyed.

The reinforcing process was divided into two subject areas; hand lay-up, and spray lay-up. The hand lay-up area was judged to require 1-5 hours of study time by fifteen of the employees surveyed. Thirteen of the employees concluded that spray lay-up should be studied 1-5 hours.

The next process surveyed was thermoforming which was divided into the subject areas of freehand and jig forming, mechanical forming, blow forming, and vacuum forming. In the subject area of freehand and jig forming, thirteen of the

TABLE XIX

DATA CONCERNING THE AMOUNT OF STUDY TIME THAT SHOULD BE DEVOTED TO THE STUDY OF THE PLASTICS INDUSTRY

Processes	Time				
	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Molding:					
Press molding	0	11	8	7	3
Injection molding	0	1	8	6	14
Extrusion	0	0	13	9	7
Laminating press molding	1	10	14	3	1
Calendering	0	11	13	2	3
Blow molding	0	3	9	13	4
Rotational casting	0	8	16	5	0
Reinforcing:					
Hand lay-up	1	4	15	4	5
Spray lay-up	1	6	13	4	5
Thermoforming:					
Freehand and jib forming	2	11	13	3	0
Mechanical forming	1	10	11	6	1
Blow forming	1	5	17	4	2
Vacuum forming	0	3	11	8	7

TABLE XIX--Continued

Processes	Time				
	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Casting:					
With thermoplastics	2	9	15	3	0
With thermosets	1	9	15	4	0
Foaming:					
Mechanical foaming	1	14	11	3	0
Physical foaming	1	12	10	6	0
Chemical foaming	1	8	14	5	1
Coatings:					
Dip	0	20	8	1	0
Slush	0	20	8	1	0
Spray	0	16	11	1	1
Extrusion	0	18	8	3	0
Flow	0	19	7	3	0
Fabrication with structural materials	0	10	15	4	0
Joining and fastening:					
Cohesion by solvent process	0	15	13	2	0
Cohesion by welding and heat sealing	0	10	15	4	0
Adhesion	0	11	16	2	0
Mechanical linkage	0	10	14	5	0

plastics employees decided 1-5 hours of study time were required; however, eleven concluded that 0-1 hour was a suitable amount of study time. The 1-5 hours response was chosen by eleven of the plastics employees and the 0-1 hour response was chosen by ten employees as the proper amount of study time for mechanical forming. Seventeen of the employees considered the optimum amount of study time for blow forming to be 1-5 hours. Eleven of the employees judged the amount of study time needed for vacuum forming to be 1-5 hours. Eleven of the employees judged the amount of study time needed for vacuum forming to be 1-5 hours; however, eight employees decided vacuum forming should be studied 6-10 hours, and seven recommended 11 or more hours.

The casting process was separated into the subject areas of casting with thermoplastics and casting with thermosets. Fifteen of the plastics employees concluded that casting with thermoplastics should be studied 1-5 hours, and a like number reasoned that casting with thermosets should also be studied 1-5 hours. Casting with thermoplastics and casting with thermosets were each judged by nine employees to need only 0-1 hour of study time.

Mechanical foaming, physical foaming, and chemical foaming were the subject areas into which the foaming process was divided. Fourteen of the employees questioned concluded that 0-1 hour of study time should be devoted to the study of mechanical foaming, but eleven of the employees decided that mechanical foaming should be studied 1-5 hours. Twelve of the employees of the plastics industry considered 0-1 hour to be an appropriate amount of study time for physical foaming while ten of the employees favored 1-5 hours of study time for physical foaming. One to five hours was judged to be the optimum amount of time for the study of chemical foaming by fourteen of the employees.

In the curriculum guide, the coatings process was divided into several different types of coatings which were dip, slush, spray, extrusion, and flow coatings. Both dip and slush coatings were deemed to require 1-5 hours of study in the opinion of twenty of the employees. Spray coating should be studied 0-1 hour in the judgement of sixteen of the plastics employees surveyed, but eleven of the employees favored the 1-5 hours response. Extrusion coating was judged to require 0-1 hour of study time by eighteen of the plastics employees. Flow coating, the last type of coatings surveyed, was deemed to need 0-1 hour of study time by nineteen of the employees of the plastics industry that were questioned.

The fabrication with structural materials process was not subdivided as the other processes were. Ten of the plastics employees decided 0-1 hour was an ample amount of study time to be devoted to the study of fabrication with structural materials while fifteen employees decided that fabrication with structural materials should be studied 1-5 hours.

The last plastic process to be surveyed was the joining and fastening of plastics. Joining and fastening was divided into the areas of cohesion by the solvent process, cohesion by welding and heat sealing, adhesion, and mechanical linkage. Fifteen of the plastics employees reasoned that cohesion by the solvent process should be studied 0-1 hour; however, thirteen of the employees chose the 1-5 hours response as the proper amount of time for the study of cohesion by the solvent process. Ten of the plastics employees concluded that cohesion by welding and heat sealing should be studied 0-1 hour, but fifteen of the employees preferred 1-5 hours of study time. The joining and fastening process of adhesion should be studied 0-1 hour in the opinion of eleven of the employees; however, sixteen of the employees preferred the 1-5 hours option. Ten of the plastics employees concluded that mechanical linkage required 0-1 hour of study while fourteen of the employees concluded that 1-5 hours should be devoted to the study of mechanical linkage.

The plastics employees were allowed to add any plastics process that had been omitted, and they were asked to rate the amount of study time they believed should be devoted to the study of each added process. One of the plastics employees suggested the addition of ultrasonic bonding and suggested a study time of 0-1 hour. However, Swanson points out that high-frequency bonding or ultrasonic bonding is a cohesive type of thermal welding (2, p. 118); therefore, ultrasonic bonding should be studied with the cohesion by welding and heat sealing section of the joining and fastening process.

In the last section of the questionnaire, the plastics employees surveyed were informed that teachers of industrial plastics were allowed by Bulletin 615 of the Texas Education Agency to teach six or more of the plastics processing groupings which are molding, reinforcing, thermoforming, casting, foaming, coatings, fabrication, and joining and fastening (3, pp. 140-168). The plastics employees were then asked the question, "If you were going to teach only six of the groupings, which six would you choose?" (Appendix E). The employees were then instructed to rate their six choices in order of their importance with a 6 being the most important, a 5 being of next importance, and so on through 1. The data received from the section of the questionnaire are presented in Table XX. Though twenty-nine plastics employees completed and returned the questionnaire, only twenty-eight responses are presented in Table XX because one of the plastics employees checked six of the processes; but he did not number them in order of their importance. The employee checked the processes of reinforcing, thermoforming, casting, coatings, fabrication, and joining and fastening.

The importance of each process in the opinion of the employees may be obtained by averaging the ratings given each process by the employees. The most important process in the judgement of the employees was molding with a rating of 5.50.

The thermoforming process received a rating of 4.60. The reinforcing process was given a 3.40 rating and fabricating a 3.19. The remaining ratings ranged from a 2.47 for coatings down to a 2.29 for casting.

TABLE XX

THE IMPORTANCE OF THE PLASTICS PROCESSES

Process	Rating						Total	Average
	No. 6	No. 5	No. 4	No. 3	No. 2	No. 1		
Molding	20	5	0	3	0	0	28	5.46
Reinforcing	1	5	4	4	3	3	20	3.40
Thermoforming	4	13	3	4	1	0	25	4.60
Casting	0	1	5	1	1	9	17	2.29
Foaming	0	1	3	5	6	6	21	2.38
Coatings	1	0	2	2	7	3	15	2.47
Fabrication	2	3	8	4	5	2	24	3.19
Joining and fastening	0	0	3	5	5	5	18	2.33

A final item of interest in Table XX is the number of responses each process received. All of the twenty-eight plastics employees selected the molding process as one of the six processing groupings they would teach. The thermoforming process was selected by twenty-five employees and fabrication by twenty-four. The remaining processes ranged from twenty-one for foaming to a low of fiteeen for coating.

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CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This study was made to determine (1) whether or not the teachers of industrial plastics thought the curriculum guide developed for industrial plastics contained all phases of the plastics industry that should be included, and, if not, what phases should be added or deleted; (2) to determine if personnel employed in the plastics industry believed the curriculum guide included all phases of the plastics industry that should be included and, if not, what phases should be added or deleted.

The data and information used in the study were obtained (1) from a jury of seven teachers who were teaching or had taught industrial plastics or a similar course and (2) from twenty-nine personnel employees in plastics industries operating within the Dallas-Fort Worth metropolitan area. The plastics employees were all employed in firms that were involved in at least one of the eight processes of the plastics industry as listed in Bulletin 615 of the Texas Education Agency.

Letters explaining the purpose of the study and an invitation to participate in the study were sent to fourteen teachers that were teaching or had taught industrial plastics in the Dallas-Fort Worth metropolitan area. The teachers were able to accept or decline the invitation by returning a self-addressed post card with a notation that they were able or unable to participate in the study. Four teachers returned replies stating that they were able to participate in the study, and one stating that he was unable to participate. A follow-up request was sent to the nine teachers from whom no reply was received. This letter brought five responses from teachers of which four were able to participate in the study making a total of eight of the teachers able to participate in the study.

Letters explaining the purpose of the study and an invitation to participate in the study were sent to personnel in charge of customer relations employed in ninty industrial plastics companies in the Dallas-Fort Worth metropolitan area. Thirty replies were received from plastics employees agreeing to participate in the study.

A copy of the curriculum guide and copy of the questionnaire were then sent to the eight teachers and thirty plastics employees. Seven, or 87.5 percent, of the teachers and fifteen of the employees returned the questionnaire. A follow-up letter was sent to the fifteen employees from whom no completed questionnaire was received. An additional fourteen completed questionnaires were then received from plastics employees making a total of twenty-nine, or 96.6 percent, completed questionnaires received from plastics employees. The data obtained were then studied, tabulated, and put in tabular form.

Findings

The study of the curriculum guide developed for industrial plastics revealed the following results:

1. In the questionnaires (Appendix D)(Appendix E), the jurors and the plastics employees were asked to determine the importance of including basic materials in the curriculum guide; the jurors and the employees were able to denote that it was very important, of average importance, of below average importance, or of no importance to include the materials in the curriculum guide. The jurors and the plastics employees decided that it was of average importance to include most of the basic materials in the curriculum guide. Both the jurors and the employees concluded that it was very important to include basic material about the difference between thermoplastics and thermosets. The jurors and the employees judged that it was of below average importance to include basic material in the curriculum guide in the area of chemical chain structure of each individual family of plastic.

2. The most popular choice of the jurors and the employees for the amount of study time to be devoted to the available forms of plastics was 1-5 hours. However, thirteen of the employees concluded that solid structural shapes, adhesives, and fibers and filaments should be studied 0-1 hour. Three

of the teachers also believed that fibers and filaments should be studied 0-1 hour. Seven of the employees each decided that molding compounds should be studied 6-10 hours or 11 or more hours. Three jurors concluded that solid structural shapes should be studied 11 or more hours while two were of the opinion that 6-10 hours was sufficient.

3. The employees decided that the ingredients of plastics should be studied either 0-1 hour or 1-5 hours. However, the jurors concluded that all the ingredients of plastics with the exception of resins and retarders should be studied 0-1 hour. Four jurors thought resins and retarders should be studied 1-5 hours.

4. The most popular choices of the employees for the amount of study time that the thermoplastic resins listed in the curriculum guide should be studied were 0-1 hour or 1-5 hours. The most popular choice of the jurors for the amount of study time that the thermoplastic resins should be studied, with the exception of acrylic and styrene resins, was either 0-1 hour or 1-5 hours. Four jurors concluded that acrylic and styrene resins should be studied 11 or more hours.

5. The popular choice of the employees for the amount of study time that the thermosetting resins should be studied was 1-5 hours with the exception of the amino and casein resins which was 0-1 hour. The jurors decisions for the study time for each thermosetting resin were greatly varied. Epoxy and ployester resins were juedged to require the largest amounts

of study time, 11 or more hours, by three jurors each with the remaining resins being judged as requiring decreasingly lower amounts of study time. The thermosetting resins that were deemed to require the least amount of study time, no time, by two jurors each were amino and casein resins.

6. The popular choice of study time by jurors and the plastics employees for alloy plastics was 1-5 hours.

7. The popular choice for the amount of study time that should be devoted to the testing of plastic materials by the employees was either 0-1 hour or 1-5 hours. Three jurors decided physical tests and heat or melt tests should be studied 1-5 hours while four decided burning tests, three decided solvent tests and specific gravity tests should be studied 0-1 hour.

8. The employees concluded that the amount of emphasis placed on each plastic process in the curriculum guide was adequate. However, the jurors decided that only the molding processes of press molding, injection molding, and extrusion and the reinforcing, thermoforming, foaming, fabrication, and joining and fastening process contained adequate information. The molding processes of laminating press molding, calendering, blow molding, and rotational casting and the casting and coatings processes were deemed to need more information by the jurors.

9. The popular choice by the jurors and the employees for the amount of study time that should be devoted to each

phase of each process was generally 1-5 hours; however, there was one major exception. The popular choice for both the jurors and the employees for all phases of coatings was 0-1 hour.

10. The jurors decided that if they were going to teach six if the plastics processes, the six they would teach in order of their importance are: thermoforming, fabrication, reinforcing, foaming, molding, and casting. The plastics employees concluded that, if they were going to teach six of the plastics processes, the six they would teach in the order of their importance are: molding, thermoforming, reinforcing, fabrication, coatings, and foaming.

Conclusions

The following conclusions are based upon the findings:

1. The curriculum guide, as viewed by the jurors and the plastics employees, si adequate for a course of industrial plastics.

2. Most of the subject areas in the curriculum guide should be studied no more than five hours or less than one hour.

3. More emphasis should be placed on the molding processes of laminating press molding, calendering, blow molding, and rotational casting as well as the casting and coating processes.

4. The order of importance of the plastics processes is: (1) thermoforming, (2) molding, (3) fabrication, (4) reinforcing, (5) foaming, (6) joining and fastening, (7) casting, and (8) coatings.

Recommendations

In view of the data presented in this study, it appears that the following recommendations are justified:

1. The subject areas listed in the curriculum guide should be studied approximately the same amount of time as recommended by the jurors and the plastics employees.

2. Teachers of industrial plastics should greatly emphasize the difference between thermoplastic and thermosetting resins when teaching certain basic information about plastic materials. However, teachers need not emphasize the chemical chain structure of each individual family of plastic. Other basic information should receive only average emphasis.

3. More emphasis should be provided in the molding processes of laminating press molding, calendering, blow molding, and rotational casting and in the casting and coatings processes.

4. If a teacher of industrial plastics is going to teach only six plastics processes, he should teach thermoforming, modling, fabrication, reinforcing, foaming, and joining and fastening. If the teacher chooses to teach a seventh process, it should be casting, and an eighth would be coatings.

5. The results of this study be made known to teachers of industrial plastics.

6. A follow-up study be made after the curriculum guide has been in use for a period of time.

APPENDIX A

CURRICULUM GUIDE

INDUSTRIAL PLASTICS

Grade Placement: 10-12
Prerequisite: none

Time: 18 or 36 weeks
Credit: 1/2 - 1 unit

Introduction

Industrial plastics is designed to give the student a general knowledge of the materials, tools, and processes used in the plastics industry. Particular attention is given to the study of materials of the plastic industry as to classification, structure, ingredients, testing, and identification.

Industrial processing is explored by a study of six or more plastic process groupsing: fabrication, casting, coating, foaming reinforcing, molding, thermoforming, and joining and fastening. Specific skills are developed by testing materials, by machine operation, by product construction, and by development of tools for plastic work.

Safety instruction includes general laboratory safety, the proper handling of chemicals, and the correct operation of machines.

Efficient practices in storing, handling, and using plastics material is stressed so that students will develop an understanding and an appreciation of the many plastics available from suppliers for his use as a consumer.

Course Objectives

To acquaint the student with materials used in the plastics industry, to develop skill in recognizing and working with different types of plastics.

To acquaint the student with prevocational information in the field of industrial plastics.

To acquaint the student with tools and machinery of the plastics industry.

Knowledge of the different methods in producing plastics products.

Skill in designing and developing useful products.

Development of safe work habits.

Instructional Organization

The first 18 weeks of the course emphasize a study of the materials of the plastic industry to the extent that plastics may be recognized and used effectively in processing applications. An overview of the plastic processes (six or more) is introduced following the study of materials. The second 18 weeks involve the design and construction of tools for plastic processing with more in-depth study of the six or more processes covered in the first 18 weeks.

Laboratory (maximum of 25 students)

- Work station for each student
- Storage facilities for each student
- Student personnel organization

- Instructional techniques
  - Lecture
  - Illustrated lecture
  - Experimentation and testing
  - Class or group discussion
- Evaluation
  - Written tests
  - Performance tests
  - Experiment tests
- Instructional aids
  - Textbook
  - Films, slides, and transparencies with facilities for effective use
  - Magazines, bulletins, etc.
  - Field trips to regional plastic processors
  - Chalkboard and bulletin board
  - Models and mock-ups
  - Charts and posters
  - Products from consumer market

Course Terminology

Due to the extensive terminology used in industrial plastics, please consult an appropriate text for any needed terms.

Content of Industrial Plastics-Materials (First 18 weeks

- Introduction to plastics
  - Uses of plastics in our homes and industry
  - Growth of plastics industry
  - Occupational needs of plastics industry
  - Advantages and disadvantages of plastics
- Basic chemistry of plastics
  - Raw materials
  - Atoms and elements
  - Molcules and compounds
  - Polymers
- Basic ingredients and addatives for plastics
  - Resins and retarders
  - Catalyst
  - Colorants
  - Fillers
  - Plasticizers
  - Solvents
  - Stabilizers
- Major resins of the plastics industry
  - Thermoplastics
    - Acetal
    - Acrylic
    - Cellulosic
    - Fluorocarbon
    - Polyamide

        - Polyolefin
        - Styrene
        - Vinyl
    - Thermosets
        - Amino
        - Casein
        - Epoxy
        - Phenolic
        - Polyester
        - Silicone
        - Urethane
    - Alloy plastics
        - ABS
        - PVC
- Available forms of plastics
    - Molding compounds
    - Liquid resins
    - Structural shapes
    - Coatings
    - Adhesives
    - Laminates
    - Expanded and expandable
    - Fibers and filaments
- Identification and analysis of plastics materials
    - Physical tests
        - Cutting
        - Shearing

Bending

Breaking

Stretching

Burning tests

Types of flame

Odors

Material behavior

Specific gravity

Solvent tests

Storage and handling of plastics and related materials

Catalyst

Addatives

Shelf life

Safety

Content of Industrial Plastics-Processes (Second 18 weeks)

Molding

I. Press molding

A. Types of press molding

1. Compression

2. Transfer

3. Cold

B. Materials suitable for press molding such as powder, pellet, and preform.

C. Molds for press molding

1. Flash mold

2. Semi-positive mold

3. Fully positive mold
4. Single cavity mold
5. Multiple cavity

D. Outstanding characteristics of press molding

II. Injection molding

A. Materials suitable for injection molding such as powder or pellet

B. Methods of injection molding

1. Plunger
2. Screw-ram

C. Outstanding characteristics of injection molding

III. Extrusion

A. Materials suitable for extrusion such as powder or pellets

B. Types of extrusion

1. Sheet
2. Film
3. Wire coating
4. Profile shapes

C. Outstanding characteristics of extrusion

IV. Laminating press molding

A. Materials suitable for laminating

B. Characteristics of laminating

V. Calendering

A. Materials suitable for calendering

B. Outstanding characteristics of calendering

VI. Blow molding

A. Materials suitable for blow molding such as powder or pellets

B. Outstanding characteristics of blow molding

VII. Rotational casting

A. Materials suitable for rotational casting such as powder or liquid plastisols

B. Outstanding characteristics of rotational casting

Reinforcing

I. Methods of application

A. Hand lay-up

B. Spray lay-up

II. Types of molding

A. Open or plug cavity molding

B. Matched molding

C. Vacuum bag molding

D. Pressure bag molding

E. Premix molding

III. Types of materials used

A. Resin

B. Reinforcing materials

Thermoforming

I. Freehand and jig forming

A. Straight line forming

1. Techniques in the use of the strip heater

2. Simple fixtures

B. Hand and drape forming

1. Temperature requirements for various materials

2. Use of the heat gun, oven, heat lamp, etc.

3. Techniques in handling and forming material by hand

II. Mechanical stretch forming

A. Techniques of mechanical forming

B. Design of mechanical forming molds

III. Blow forming

A. Techniques of blow forming

B. Design of blow forming molds

IV. Vacuum forming

A. Techniques of vacuum forming

B. Design of vacuum forming molds

V. Material requirements of thermoforming

A. Material requirement for thermoforming

B. Forming temperatures for various materials

C. Tool and mold requirements for various materials

Casting

I. Materials for casting

II. Tools and applications for casting

III. Outstanding characteristics of casting

Foaming

I. Types of foaming processes

A. Mechanical foaming

B. Physical foaming

C. Chemical foaming

II. Types of resins used for foaming

III. Methods of foaming

A. Extrusion foaming

B. Structural foaming

C. Casting or expanded foaming

D. Expandable bead foaming

Coatings

I. Types of coatings

A. Dip

B. Slush

C. Spray

D. Extrusion

E. Flow coating

II. Materials suitable for coatings

Fabrication

I. Cutting and machining of plastics

A. Hand tools

1. Hand saws

2. Scissors

3. Snips

4. Shears

5. Files

6. Hand drills

B. Machines

1. Circular saws
2. Band saws
3. Jig saws
4. Lathes
5. Milling machines
6. Routers
7. Drill presses
8. Rule and blanking dies

II. Finishing

A. Hand finishing

1. Scraping
2. Sanding
3. Buffing

B. Machine finishing

1. Sanding
2. Ashing
3. Buffing

C. Flame polishing

D. Solvent polishing

E. Decorating

1. Painting
2. Silk screening
3. Hot stamping
4. Carving and engraving
5. Vacuum metalizing

Joining and fastening

I. Types of joining

A. Cohesion

1. Solvent

2. Welding

3. Heat sealing

B. Adhesion

C. Mechanical linkage

1. Tapping and threading

2. Mechanical fasteners

a. Rivets

b. Spring clips

c. Nuts and bolts

Suggested activities

Have students design, make, and use molds using the previously described techniques.

Demonstrate various methods of the previously described techniques.

Make literature available containing projects that require use of the previously described techniques.

Collect samples of products made by each of the techniques described previously.

Use visual aids to illustrate industrial applications of each of the techniques.

APPENDIX B

1001 Cascade Apt. U
Mesquite, Texas 75149

Dear Sir:

I am a graduate student at North Texas State University. I am conducting a study of a curriculum guide that was recently developed for industrial plastics.

Industrial plastics is a high school industrial arts course that teaches students about the materials and processes of the plastics industry. Although the purpose of the course is not to provide the students with training through which they would be able to obtain employment in the plastics industry, some students of industrial plastics find employment within the plastics industry upon completion of the course.

With your help this study will attempt to determine what the plastics industry thinks of the new curriculum guide. The information needed will be acquired through the use of a questionnaire which has been developed to require a minimum amount of your time. If you are able or unable to participate in the study, please check the appropriate blank of the enclosed postcard and return it before_______________. The information you supply will be treated in a very confidential manner.

Sincerely yours,

William E. Smith

APPENDIX C

1001 Cascade Apt. U
Mesquite, Texas 75149

Dear Sir:

I am in the process of collecting data for my thesis and would appreciate it if you would be willing to devote a few minutes of your time to assist me. I realize that you are now on vacation, but it is necessary that I obtain these data as soon as possible.

My study involves an analysis of the recently developed curriculum guide for teaching industrial plastics in the Texas public schools. The primary purpose of the study is to obtain the opinion of the teachers who are presently teaching or have taught industrial plastics to see if they think the curriculum guide is adequate, and, if not, what should be added to or deleted from the guide. This data will be obtained by the use of a check list type questionnaire which has been developed to be completed in the minimum amount of time.

Since there is such a small number of teachers of industrial plastics in the state, it is hoped that all teachers will participate. This would increase the validity of the study.

Will you please indicate on the enclosed postal card if you will or will not be able to participate, and return it at your earliest convenience as time is an important factor?

Thank you for your assistance.

Sincerely yours,

W. E. Smith

APPENDIX D

1001 Cascade Apt. U
Mesquite, Texas 75149

Dear Sir:

Thank you for your postcard of ____________________ volunteering to help me with my study of the new curriculum guide for industrial plastics. Enclosed in this letter you will find a copy of the curriculum guide and a copy of the questionnaire that I am using to determine what the plastics teachers think of the curriculum guide. Please complete the questionnaire and return it in the stamped self-addressed envelope before ____________________ if possible. If you have any question, do not hesitate to contact me. Thank you for your cooperation and assistance.

Sincerely yours,

William E. Smith

QUESTIONNAIRE

A STUDY OF A CURRICULUM GUIDE DEVELOPED FOR INDUSTRIAL PLASTICS AS LISTED IN BULLETIN 615 OF THE TEXAS EDUCATION AGENCY

Directions: Please supply the information requested by checking the appropriate response or by writing in the blanks and spaces provided. Please refer closely to the enclosed curriculum guide when answering each section of the questionnaire.

Please indicate the importance you place upon each of the following.

	Very Important	Average Importance	Below Average Importance	No Importance
The history and development of the plastic industry.				
The difference between thermoplastics and thermosets.				
The basic chemical structure of a thermoplastic.				
The basic chemical structure of a thermoset.				
The chemical chain structure of each individual family of plastic.				
The processes by which plastics are made.				
Is the ability of being able to identify various plastics important?				
Is a knowledge of physical, chemical, electrical, and thermal properties important?				
Is testing of plastic materials important?				

Rate each of the following ingredients of plastics in regard to the amount of study time that should be devoted to each of them.

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Resins and retarders					
Catalyst					
Fillers					
Solvents					
Plastizers					
Stabilizers					
Colorants					
If any ingredient has been omitted, please list it and rate it.					

Rate each of the following major resins of the plastics industry in regard to the amount of study time that should be devoted to each of them.

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Thermoplastics:					
Acetal					
Acrylic					
Cellulosic					
Fluorocarbon					
Polyamide					
Polyolefin					
Styrene					
Vinyl					

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Thermosets:					
Amino					
Casein					
Epoxy					
Phenolic					
Polyester					
Silicone					
Urethane					
Alloy plastics:					
ABS					
PVC					
If any resin of outstanding importance has been omitted, please list it and rate it.					

If you answered the last question in the first section of this questionnaire concerning testing of materials as being of average importance or very important, which of the following test do you think should be used and how much study time should be devoted to each of them?

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Physical test such as cutting shearing, bending, and breaking.					
Burning test					
Specific gravity test					
Solvent test					
Heat or melt test					
If any test has been omitted, please list it and rate it.					

Rate each of the following plastic processes in regard to the amount of information that was included in each process in the curriculum guide. Please refer closely to the enclosed curriculum guide when answering this portion of the questionnaire.

	Too Much Information	Adequate Information	Inadequate Information
Molding:			
Press molding			
Injection molding			
Extrusion			
Laminating press molding			
Calendering			
Blow molding			
Rotational casting			
Reinforcing			
Thermoforming			
Casting			
Foaming			
Coatings			
Fabrication			
Joining and fastening			

If any process has been overlooked, please list it.

____

____

____

Rate the following plastic processes in regard to the amount of study time that should be devoted to each of them.

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Molding:					
Press molding					
Injection molding					
Extrusion					
Laminating press molding					
Calendering					
Blow molding					
Rotational casting					
Reinforcing:					
Hand lay-up					
Spray lay-up					
Thermoforming:					
Freehand and jig forming					
Mechanical forming					
Blow forming					
Vacuum forming					
Casting:					
With thermoplastics					
With thermosets					

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Foaming:					
Mechanical foaming					
Physical foaming					
Chemical foaming					
Coatings:					
Dip					
Slush					
Spray					
Extrusion					
Flow					
Fabrication with structural materials					
Joining and fastening					
Cohesion by solvent process					
Cohesion by welding and heat sealing					
Adhesion					
Mechanical linkage					
If any process has been omitted, please list it and rate it.					

Bulletin 615 of the Texas Education Agency will allow a teacher of industrial plastics to teach six or more of the following plastic processing groupings. If you were going to teach only six of the groupings, which six would you choose? Pick six of the process groupings in the order of their importance. Place a 6 by the one you think is most important, a 5 by the one you think is of next importance, and so one through 1.

Molding . . . . ( )

Reinforcing . . . . ( )

Thermoforming . . . . ( )

Casting . . . . ( )

Foaming . . . . ( )

Coatings . . . . ( )

Fabrication . . . . ( )

Joining and fastening . . . . . . ( )

Please supply the following information.

Name______________________________

School____________________________

Number of years you have taught industrial plastics.________

If you would like a copy of the results of this study, check this blank. ( )

Thank you for your help in completing this questionnaire. I appreciate all of your help. If I can be of any assistance, please contact me.

William E. Smith
1001 Cascade Apt. U
Mesquite, Texas 75149
Ph. 288-6791

APPENDIX E

1001 Cascade Apt. U.
Mesquite, Texas 75149

Dear Sir:

Thank you for your postcard of ______________________ volunteering to help me with my study of the new curriculum guide for industrial plastics. Enclosed in this letter you will find a copy of the curriculum guide and a copy of the questionnaire that I am using to determine what the plastics industry thinks of the curriculum guide. Please complete the questionnaire and return it in the stamped self-addressed envelope before _____________ if possible. If you have any question, do not hesitate to contact me. Thank you for your cooperation and assistance.

Sincerely yours,

William E. Smith

QUESTIONNAIRE

A STUDY OF A CURRICULUM GUIDE DEVELOPED FOR INDUSTRIAL PLASTICS AS LISTED IN BULLETIN 615 OF THE TEXAS EDUCATION AGENCY

Directions: Please supply the information requested by checking the appropriate response or by writing in the blanks and spaces provided. Please refer closely to the enclosed curriculum guide when answering each section of the questionnaire.

Please indicate the importance you place upon each of the following.

	Very Important	Average Importance	Below Average Importance	No Importance
The history and development of the plastic industry.				
The difference between thermoplastics and thermosets.				
The basic chemical structure of a thermoplastic.				
The basic chemical structure of a thermoset.				
The chemical chain structure of each individual family of plastic.				
The processes by which plastics are made.				
Is the ability of being able to identify various plastics important?				
Is a knowledge of physical, chemical, electrical, and thermal properties important?				
Is testing of plastic materials important?				

Rate each of the following ingredients of plastics in regard to the amount of study time that should be devoted to each of them.

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Resins and retarders					
Catalyst					
Fillers					
Solvents					
Plasticizers					
Stabilizers					
Colorants					
If any ingredient has been omitted please list it and rate it.					

Rate each of the following major resins of the plastics industry in regard to the amount of study time that should be devoted to each of them.

	No Time	0-1 Hour	1-5 Hour	6-10 Hours	11 or More Hours
Thermoplastics:					
Acetal					
Acrylic					
Cellulosic					
Fluorocarbon					
Polyamide					
Polyolefin					
Styrene					
Vinyl					

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Thermosets:					
Amino					
Casein					
Epoxy					
Phenolic					
Polyester					
Silicone					
Urethane					
Alloy plastics:					
ABS					
PVC					
If any resin of outstanding importance has been omitted, please list it and rate it.					

If you answered the last question in the first section of this questionnaire concerning testing of materials as being of average importance or very important, which of the following test do you think should be used and how much study time should be devoted to each of them?

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Physical test such as cutting shearing, bending, and breaking.					
Burning test					
Specific gravity test					
Solvent test					
Heat or melt test					
If any test has been omitted, please list it and rate it.					

Rate each of the following plastic processes in regard to the amount of information that was included in each process in the curriculum guide. Please refer closely to the enclosed curriculum guide when answering this portion of the questionnaire.

	Too Much Information	Adequate Information	Inadequate Information
Molding:			
Press molding			
Injection molding			
Extrusion			
Laminating press molding			
Calendering			
Blow molding			
Rotational Casting			
Reinforcing			
Thermoforming			
Casting			
Foaming			
Coatings			
Fabrication			
Joining and fastening			

If any process has been overlooked, please list it.

____

____

Rate the following plastic processes in regard to the amount of study time that should be devoted to each of them.

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Molding:					
Press molding					
Injection molding					
Extrusion					
Laminating press molding					
Calendering					
Blow molding					
Rotational casting					
Reinforcing:					
Hand lay-up					
Spray lay-up					
Thermoforming:					
Freehand and jig forming					
Mechanical forming					
Blow forming					
Vacuum forming					
Casting:					
With thermoplastics					
With thermosets					

	No Time	0-1 Hour	1-5 Hours	6-10 Hours	11 or More Hours
Foaming:					
Mechanical foaming					
Physical foaming					
Chemical foaming					
Coatings:					
Dip					
Slush					
Spray					
Extrusion					
Flow					
Fabrication with structural materials					
Joining and fastening					
Cohesion by solvent process					
Cohesion by welding and heat sealing					
Adhesion					
Mechanical linkage					
If any process has been omitted, please list it and rate it.					

Bulletin 615 of the Texas Education Agency will allow a teacher of industrial plastics to teach six or more of the following plastic processing groupings. If you were going to teach only six of the groupings, which six would you choose? Pick six of the process groupings in the order of their importance. Place a 6 by the one you think is most important, a 5 by the one you think is of next importance, and so on through 1.

Molding . . . . ( )

Reinforcing . . . . ( )

Thermoforming . . . . ( )

Casting . . . . ( )

Foaming . . . . ( )

Coatings . . . . ( )

Fabrication . . . . ( )

Joining and fastening . . . . ( )

Please supply the following information.

Name______________________________

Title______________________________

Firm______________________________

Process or processes your firm is involved in such as injection molding, thermoforming, etc. ______________________________

____

If you would like a copy of the results of this study, check this blank. ( )

Please place the questionnaire in the stamped self-addressed envelope and return it before ______________ if possible.

Thank you for your help in completing this questionnaire. I appreciate all of your help. If I can be of any assistance please contact me.

William E. Smith
1001 Cascade Apt. U
Mesquite, Texas 75149
Ph. 288-6791

APPENDIX F

1001 Cascade Apt. U
Mesquite, Texas 75149

Dear Sir:

I am writing in regard to the questionnaire I sent you concerning the newly developed curriculum guide for industrial plastics. It is important to the validity of the study that all people that agreed to participate in the study complete and return the questionnaire.

As I have not received the questionnaire I sent you, I am enclosing another. I hope you have time to check and return it as soon as possible. If you have sent the first one, please ignore this letter.

Thank you for your time and assistance.

Sincerely yours,

William E. Smith

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