A STUDY OF JUNIOR COLLEGE PLASTICS CURRICULUMS AND
THE REQUIREMENTS OF THE REINFORCED PLASTICS
INDUSTRY IN THE DALLAS-FORT WORTH AREA

APPROVED:

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The study is a comparison of junior college plastics curriculums in Dallas, Tarrant, and surrounding counties and the requirements of the reinforced plastics industry in the Dallas-Fort Worth area.

Two checklists are utilized in securing the data—one to the manufacturers of reinforced plastics in the Dallas-Fort Worth area and the other to junior colleges in Dallas, Tarrant, and surrounding counties which offer technical-vocational programs.

Chapter I includes the statement of the problem, purpose of the study, limitations of the study, sources of data, procedures for collecting the data, definition of terms, organization of the study, background and significance of the study and an examination of related studies. Chapter II covers the history and development of reinforced plastics starting in 1940, description of components, principles of reinforcement, and finishing operations. The information secured in the two checklists is described in Chapter III.
In Chapter IV is a comparison between the data secured from the two checklists and data compiled from a nation-wide survey conducted in 1967. The summary, findings, conclusions, and recommendations are presented in Chapter V.

The findings of this study are divided into two parts. The industry checklist findings are:

1. Sixty per cent of the companies indicated an individual would have an advantage in securing employment in the local industry with junior college plastics training.

2. Sixty per cent of the companies stated they would contribute to local program(s) if there were specific courses offered that would directly fulfill their needs.

The junior college checklist findings include

1. The one plastics technology program offered was a two-year (64 semester hour) program which lead to an associate degree in plastics technology.

2. No plastics training was offered in the form of crafts or leisure-time orientated courses by any of the responding junior colleges.

3. Local industry contributed to the one program through an advisory committee which was consulted in regard to course organization, content, and general curriculum materials. Also equipment, supplies for laboratory use,
When the needs of the local reinforced plastics industry in regard to technical trained personnel are compared with the output of the area junior college plastics technology program the following conclusions are drawn.

1. It is apparent that the existing program is adequately providing for the present needs of the local reinforced plastics industry, the one exception being actual experience in working with the materials of the field.

2. It is indicated by the data that any local plastics program would have to offer directly related training in reinforced plastics for any material contributions to be made available by local reinforced plastics manufacturers.

The following statements are recommendations for further study of the plastics field in the Dallas-Fort Worth area.

1. A follow-up study is highly recommended. The study should cover the complete plastics industry of the Dallas-Fort Worth industrial complex.

2. The proposed study is necessary for any inclusive recommendations in regard to any changes in the present plastics technology program being offered by the junior college contacted.
3. The same is true for the instigation of any additional programs to be offered by the junior colleges surveyed in this study.
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INDUSTRY IN THE DALLAS-FORT WORTH AREA

THESIS

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By

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CHAPTER I

INTRODUCTION

One of the objectives of industrial arts programs is to study industry. The field of industrial arts is organized by various industrial processes and procedures into basic areas and then grouped by related processes and procedures into an acceptable curriculum. Woods, metals, drafting, crafts, welding, printing, electricity and electronics, auto and power mechanics are usual categories of industrial arts. The industrial arts programs, through a relevant curriculum, must reflect the ever-expanding developments in present-day industry.

There is only one other area in industry which has paralleled the growth of plastics and that is electronics. Much work has been done in the field of electronics to keep it abreast of current industrial progress. It stands to reason that a need for similar growth exists for the field of plastics.

The use of plastics in the industrial arts laboratory is not new. It has been a material in crafts curriculums since the early 1940's. The introduction of plastics was
brought about by the shortage of wood during World War II and the early post-war years (10, p. 3). Because of this shortage plastics have generally been considered substitute materials. Other factors which have limited the progress of plastics in industrial arts have been the inadequate courses offered and insufficient facilities.

Statement of the Problem

The study was a comparison of junior college plastics curriculums in Dallas, Tarrant and surrounding counties and the requirements of the reinforced plastics industry in the Dallas-Fort Worth area.

Purpose of the Study

The purpose of the study was to analyze and compare the field of reinforced plastics in the Dallas-Fort Worth area, its manpower needs and how the technical educational institutions of Dallas, Tarrant and surrounding counties were meeting these needs. Answers to certain specific questions were sought. They are as follows:

1. What is offered presently in junior college plastics curriculums?

2. Are the institutions located in the immediate area meeting the needs of industry in regard to trained manpower?
Limitations of the Study

The selection of reinforced plastics manufacturers was limited to those located in the immediate metropolitan area of Dallas-Fort Worth. Similar limitations were placed on the schools to be surveyed; only public junior colleges were contacted. The selection of junior colleges was further limited by the programs offered. Only those with technical vocational programs were contacted.

Sources of Data

The data were gathered through the use of two check lists; one was sent to selected manufacturers of reinforced plastics products in Dallas and Fort Worth, and the other was sent to the public junior colleges of Dallas, Tarrant and surrounding counties. Included was the utilization of material compiled through a previous study conducted under the direction of E. B. Blanton (4).

Procedures for Collecting the Data

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

1. Background and technical information were secured from current literature of the field. The majority of the information was gathered in a previous study.
2. A checklist (Appendix A) was sent to twenty-eight manufacturers of reinforced plastics products (Appendix C) in the Dallas-Fort Worth area to determine the educational requirements of employees.

3. The yellow pages of the Dallas and Fort Worth telephone directories were employed in selecting the manufacturers.

4. Another checklist (Appendix B) was sent to twelve public junior colleges located in Dallas, Tarrant and surrounding counties (Appendix D) to determine what was offered in the field of plastics.

5. The junior college catalogs located in the special materials section of the North Texas State University library were employed in selecting the junior colleges contacted in this survey.

6. Data generated from the checklists were tabulated and compared with a similar nation-wide survey conducted in 1967 by a joint task force of The Society of Plastics Engineers and The Society of Plastics Industry (10, p. 1).

Definition of Terms

For the purpose of this study, the following terms were defined.
1. Composite—a material resulting from the combination of a resin (matrix binder) with one and/or many different types of reinforcement.

2. Interface—a physically identifiable bond or glue line between the reinforcement and the resin.

3. Public junior college—any public post-secondary education of at least two years (four semester) which leads to the granting of associate degrees.

4. Plastics—a group of synthetic materials capable of being molded either at atmospheric or elevated pressures and solid in the finished state.

5. Plastic resin—a formulation of organic material which is soluble in organic solvents but not in water and is solid in the finished state.

6. Plastic system—a material whose components of resin, reinforcement (if present), catalyst, accelerator, and filler (if present), cure to form a homogeneous end-product.

Organization of the Study

Chapter I of the study includes the statement of the problem, purpose of the study, limitations of the study, sources of data, procedures for collecting the data, definition of terms, organization of the study, background
and significance of the study, and an examination of related studies.

Chapter II presents the history and development of reinforced plastics from the year 1940, description of components, principles of reinforcement, and finishing operations.

The information secured from the two checklists is presented in Chapter III.

In Chapter IV the data secured from the two checklists are compared and tabulated. The resulting information is then compared with the nation-wide survey (10) conducted by a joint committee from The Society of Plastics Engineers and The Society of Plastics Industry.

The summary, findings, conclusions, and recommendations are presented in Chapter V.

Background and Significance of the Study

The plastics industry is growing at a ratio (15 per cent annually) of four times that of the gross national product. This spectacular growth is due largely to the displacement of such established materials as glass, metals, paper, and wood. Also the development of new plastic systems has generated new markets and products not possible
until their development (10, p. 1). By 1983 it is forecast that plastics used for all purposes will exceed in volume the world consumption of iron and steel (10, p. 4).

The introduction of reinforcement in plastic resin systems has been a major contributing factor in the growth of plastics as structural materials. Reinforced plastics have reached a position of direct competition with materials such as aluminum, steel, and wood. A specific example would be polyester/fiberglass in the construction of boat hulls. Reinforced plastics have all but replaced wood as the standard building material. Such exotic materials as epoxy-boron and epoxy-graphite composites are shown to be competitive when compared to present aluminum and titanium structural systems. These materials in the last three years have moved from experimental to direct application. Much progress is foreseen in solving many of the major problems which have limited these high-strength composites to specific applications.

Since the 1940's, when engineered composites or reinforced plastics, had their most important start based on present-day knowledge, fiberglass has continued to be the most widely used ingredient. Even though the future for new type composites such as graphite, boron, and whiskers will provide more advances, the important era of fiberglass types with thermosets as well as thermoplastics will continue to
be vital and important to all industries on the basis of consumption and dollar profits (9, p. 1).

The word composite evolved from industry's need for a more concise, all-inclusive term to describe the final material resulting from the combination of many different reinforcements and matrix binders (resins). The material is also known as reinforced plastics, fiberglass reinforced plastics, laminates, and filled molding compounds (9, p. 3).

Related Studies

It appeared from examination of available literature, that this study was the first conducted in Texas with these specific objectives and purposes; however, a number of studies have been conducted with plastics exclusively on national and local scales. Similar studies in other areas such as graphic arts, metallurgy, and automotive-type manufacturing industries have been made. The following is a brief summary of related studies.

A nation-wide survey (10, pp. 1-19) of plastics processing firms was made by the Society of Plastics Engineers and the Society of Plastics Industry joint Education committee in October, 1967. Approximately 25 per cent of the questionnaires were returned from a total of 4,000.
The survey indicated a serious shortage of all types of trained personnel in the processing of reinforced plastics. The shortage was forecasted to continue for the next five years (10, p. 15). This was based on the 1967 economic situation. The shortage was nation-wide and existed in direct proportion to the geographical location of present processing plants. The greatest need for qualified personnel was in New York and California, where 55 per cent of the plastics industry is located (10, p. 8).

Approximately 40 per cent of the companies stated that they currently supported some type of training program. Fifty-five per cent of those who did not support programs stated they would if any affiliated programs were available (10, p. 17).

Approximately 70 per cent of the replies indicated they were willing to make equipment and/or supplies available to educational institutions. Over 90 per cent of the larger companies (over 250 employees) indicated that supplies of all types could be placed at the disposal of these institutions.

The survey revealed that formal resources for the industries' manpower needs were practically non-existent. Over 60 per cent of the participants indicated the largest
shortage was in skilled employees. This particular dilemma varied in different locales and different sized companies.

Nearly every company responded that pre-employment training should be required at more than one school level. One of the most important aspects of the survey was the unquestionable willingness of the companies to support programs that would relieve this manpower shortage. These programs would have to be designed to train specific types of trained students to relieve this acute shortage.

Another study (1) conducted in 1970 at the University of Northern Colorado by Envick confirmed the results of the 1967 study. Several points should be highlighted which substantiate the earlier survey. Industry considers plastics education important for future employees but industry placed higher value on general education courses than on industrial education courses. The importance of a particular plastics process should be determined by analysis of the responses from processors who are directly concerned with the activity. All processes must be reviewed for curriculum content. The major conclusion of Envick's study was that communication channels between industry and education must be developed
Teamwork will provide the solution of chronic manpower shortages in the plastics industry.

Iowa State University of Science and Technology (7) in 1968 conducted a similar study to Envick's, except that it was concerned with the plastics industry in Iowa. It was designed to determine the personnel and training needs for skilled and technical workers in the plastics manufacturing and fabricating industries of the state.

Out of the 117 companies contacted in the study, 97 returned the questionnaires. In 75 per cent of the industries, skilled workers were taught by on-the-job and in-plant training programs. Training needs varied with size, process, and product manufactured. Molding was the principle process utilized, while thermoplastics were the principal production material, while again the need for new educational programs to meet the present requirements of industry was emphasized.

A more general study (11) was undertaken by Stron at the University of Northern Colorado in 1970. Industrial and technical education in Minnesota was compared with the requirements of industry in the state. Two items were of importance in respect to this study. First, aeronautics,
packaging design, and synthetics were new curriculums being planned for incorporation in the four-year industrial-technical schools in the state. Second, the development of a state committee to improve and coordinate the four-year non-teaching programs with industries' requirements was recommended. Stron recommended that formation of state committees for advisory and coordinating functions, utilization of industrial personnel in education programs, and clarification and standardization of technical terminology be the primary items for industrial education improvements in the state of Minnesota.

James (8, pp. 61-62) stated in his study in 1951 that the field of plastics could be used to show the students the materials and processes of industry. It could also be used to show the growth of industry in the United States. James' definition of plastics is hobby or leisure-time orientated, but he does not mention industrial processing and manufacturing techniques.

Frederickson (2, pp. 79-81) studied the suitability of plastics as a material for constructing industrial arts projects in 1954. Again, the introduction of plastics in an industrial arts curriculum was on the handicraft level. Much was said about the tremendous growth of the
industry, the increased use of plastics as a substitute, and replacement of established materials such as wood, metal, glass, and paper. Nothing was mentioned about mass production techniques, industrial use, and adaptation of these into an industrial arts curriculum. In 1954 plastics were still considered as hobby material.

A more recent investigation (3, pp. 83-86) was undertaken by Geary in 1971 at North Texas State University. Geary was concerned with developing a metallurgy course at the university level with emphasis on destructive testing procedures for ferrous and non-ferrous metals.

Several of his concluding remarks seemed relevant to this study. The majority of the companies contacted believed there exists a gap between industry and education. Colleges were not placing enough importance on destructive testing and metallurgy in general. Curriculum content should be continuously up-dated to keep pace with industry. Investigations of available laboratory facilities should be conducted at the university level.

At the University of Northern Colorado in 1970, Glogorsky made a study in graphic arts. He made a comparison of graphic arts processes practiced by contemporary industry
with those taught in industrial arts and technical education (5).

Glogorsky concluded that objectives of giving insight into industry were only partially being met. Modern industrial graphic techniques were not being utilized in industrial technical education institutions. Predominance of lecture methods of instruction indicated lack of sufficient laboratory equipment. Finally, lack of uniformity in curriculum content indicated inadequate coordination and communication channels between educational institutions.

At Arizona State University in 1970, Hall's study (6) produced valuable data in regard to educational needs of industrial technologists in the automotive-type manufacturing industries. The companies contacted remarked that education and training in specific areas and practical experience should be included in employment requirements. Universities were not providing sufficient opportunities for practical application of learned material.

In summary, from examination of these related studies it was apparent that changes are imperative in the present industrial technical education field. Relevance and improved communications are the keys to betterment. The
development of new and improved plastics technology curriculums and programs lies in coordinated studies and joint projects of industry and education.
CHAPTER BIBLIOGRAPHY


CHAPTER II

REVIEW OF REINFORCED PLASTICS

History and Development

The basic components of reinforced plastics as composite materials were known before the year 1940, but it took the electronics of World War II to initiate the technological progress which developed the field as it exists today.

Radar developed the need for reinforced plastics as structural materials. Housings were required to shield delicate electronics gear from the elements. The physical requirements of the material were quite rigorous. It had to be strong enough to withstand aerodynamic loads, dimensionally stable, and corrosion-resistant. The most important requirement was to allow the passage of ultra-high frequency radar X-band pulses.

The years 1940 and 1941 saw active research and development with wood, hard rubber, acrylic (Plexiglas), and reinforced plastics. The result of two years of research and development was the first mass production of fiberglass/polyester resin systems which were known at that time as low-pressure and vacuum-pressure laminates.
Fiberglass-reinforced plastic randomes were first conceived, developed, and designed for secondary air-frame structures by the Air Force. The BT-15 airplane with a fiberglass-reinforced plastic randome was flown for the first time at Wright-Patterson Air Force Base on March 24, 1944 (5, pp. 6-7).

In 1946, fiberglass-reinforced plastics entered the commercial market as an important structural materials boats, automobiles, trucks, construction, appliances, containers, electrical materials, furniture, plumbing, pipes, and tanks. The early progress of fiberglass-reinforced plastic can be illustrated by the introduction of General Motor's Corvette in 1953, the first mass-produced fiberglass reinforced plastic car body in the United States.

Several factors have hindered the growth and progress of reinforced plastics; for example, relatively expensive raw materials, relatively slow and expensive processing methods, and the requirement of skilled labor. The molding field of plastics has been able to incorporate many of the latest high-speed automatic processes such as injection and blow-molding, which have benefited this portion of the industry.
Despite the dependence of reinforced plastics on skilled manpower, many semi- and fully-automatic processes have been developed to make reinforced plastics competitive with established materials such as wood, metals, glass, and paper.

The steady increase in consumption bears out the fact that reinforced plastics with their high strength and light-weight combination of resins and reinforcement are proving their value as competitive engineering materials. Also it shows that reinforced plastic products are successfully replacing more conventional materials with fewer corrosion problems, increased flexibility of design in mass production situations, and lower over-all costs (5, pp. 7-10).

Principles of Reinforcement

The most important factor which determines the strength of a reinforced plastic part is the reinforcement content, which is expressed by per cent of weight. Strength is directly proportional to a point where the resin can no longer completely wet-out (saturate) the fibers. This maximum point depends on reinforcement and the particular process being utilized (6, pp. 24-26).
It may be informative to compare the strengths of several metals with a number of different types of glass-fiber-reinforced plastics to show their advantages (see Table I). The values used to compare the materials are

**TABLE I**

COMPARISON OF STRENGTH OF METALS TO REINFORCED PLASTICS*

<table>
<thead>
<tr>
<th>Material</th>
<th>Condition</th>
<th>Equal Stiffness</th>
<th>Equal Strength</th>
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<tr>
<td></td>
<td></td>
<td>Relative Thickness</td>
<td>Relative Weight</td>
</tr>
<tr>
<td>4140 Steel</td>
<td>Quenched and Tempered</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>75ST6 Al.</td>
<td>Heat Treated</td>
<td>144</td>
<td>51</td>
</tr>
<tr>
<td>75A Ti.</td>
<td>Annealed</td>
<td>123</td>
<td>72</td>
</tr>
<tr>
<td>181 Fabric-polyester**</td>
<td>62% glass</td>
<td>239</td>
<td>54</td>
</tr>
<tr>
<td>Boat cloth-polyester**</td>
<td>50% glass</td>
<td>272</td>
<td>59</td>
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</table>

*Source: (6, p. 66).

**Terminology to be explained in detail later in the chapter.

derived from the ratios of the tensile strength, thickness, and specific gravity of each material. For example, for a
part manufactured from 181 fabric-polyester to have the same strength as a steel part it would have approximately 2 1/2 times the thickness, but approximately 1/2 the weight.

**Fibrous-glass Reinforcement**

Glass fibers are extremely fine—1.0 \times 10^{-4} to 7.0 \times 10^{-4} inches in diameter. Unlike the final products such as strands, rovings, and mats, individual fibers are very flexible. Glass fibers are elastic, and elongations of 3 1/2 per cent can be obtained before failure.

What makes glass fibers so attractive as reinforcement is the uniformity of the fibers and the high tensile strengths. It has proven difficult to measure the exact tensile strength of individual fibers because of the small size, but the most common tests show a strength of 5.0 \times 10^5 psi for "E" type glass and 6.665 \times 10^5 psi for "S" type glass (6, p. 6).

Continuous-winding is the normal process used in the production of glass fibers. An electric furnace is used to melt glass marbles. As glass melts it flows through orifices in a bushing mounted on the base of the furnace. As the glass cools it is pulled, or "attenuated", into
continuous fibers or filaments. The major control is the speed at which the fibers are drawn (between 5,000 and 10,000 fpm). A surface-treating material (size) is applied at the gathering device. Usually 204 fibers (204 end) are drawn to form a bundle (strand) from one furnace (6, pp. 6-7).

Glass fiber reinforcement is divided into nine categories: three types of mats, chopped strands, milled fibers, yarns, woven fabric, and two types or roving. Mats are made by binding or mechanically needling chopped or swirled strands to form a non-woven matting. Binders are normally used in the United States while needling is common in Europe. Non-woven mats are available in a variety of thicknesses and are classified in terms of weight/ft². Weights range from 3/4 oz. to 4 oz.

All forms of non-woven mat, except surfacing mat, give essentially the same degree of reinforcement. Handling characteristics are the major difference of the non-woven mats. They range from soft, bulky, and drapeable to stiff and dense material. The swirled continuous-strand mats are used for molding complex shapes because of the greater drawability.

Woven fabrics were the first reinforcement to be used. Their relative expense when compared with the various mats
is balanced by the higher strength produced by the increased density and subsequent higher glass content in the composite structure.

Five types of woven fabrics (styles 112, 128, 143, 181, and boat fabric) account for practically all usage of the woven fabrics. These styles designate the specific weave of the fabric. In a fabric the warp and filling are interwoven or interlaced, to produce a cloth. The warp runs parallel to the length while the filling runs perpendicular to the length and ties the strings together. Generally, cloth has greater strength in the warp direction because of the heavier strands used. As with yarns, cloth must be heat-cleaned and surface-treated to be compatible with the resins.

Woven-rovings are similar to woven fabrics except that they are coarse and heavy but still drapeable. In contact molding woven-rovings have all but replaced the more expensive heat-cleaned and surface-treated heavy fabrics in thick molded parts.

Many types of reinforcement are utilized besides the many forms of glass fabric. Asbestos and synthetic fibers (of which nylon [polyamides], acrylice and polyesters are examples) are a few of the many different types of reinforcement which are utilized in reinforced plastics.
Asbestos is available in short fiber forms, yarn, cloth, tape, felt, and paper. In many applications it is used in conjunction with glass fibers in reinforced plastic mixes. Finely divided fibers (milled strands) tend to improve the bond between resin and surface-treatment, reduce shrinkage, crazing of resin, make resins tackier, reduce the thermal coefficient of expansion, and augment the glass in increasing mechanical properties of the composite structure. Cost reduction from decreased glass content and greater flexural modulus are cited as other advantages of asbestos additives (5, pp. 182-184).

Synthetic fibers are produced by extrusion, and various methods are employed. Either the fibers may be extruded from a molten polymer such as nylon and then cooled to harden; or, they may be extruded as a solution of a polymer in a volatile solvent such as cellulose acetate in acetone and the solvent evaporated to produce a solid strand. Normally, the filaments are stretched after cooling to physically align the molecules which increases the tensile strength (1, pp. 159-160).

Normally pigments can be mixed into the resin to produce any color required. Most organic dyes have poor
resistance to heat and sunlight, so inorganic pigments are more commonly used. Carbon and black iron oxide are examples of black pigments (6, p. 18).

Resin Systems

Polyester resins used as reinforced plastics are generally prepared by reacting unsaturated dibasic acids with dihydric alcohols and dissolving this mixture in a reactive monomer such as styrene. The entire amount of reactive monomer used becomes part of the cured resin structure during polymerization (5, p. 23). Styrene is also employed to assist in the escape of trapped air, permit greater use of fillers, increase the heat distortion point, improve wetting of the reinforcement fibers, increase resistance to attack by water in the finished product, and reduce costs (5, p. 32). Thirty-five per cent styrene content by volume is required for hand lay-up resins. A higher styrene content will necessitate excess catalyst and will weaken the cured plastic. This weak, thin resin will not bond to the reinforcement and leads to poor quality end products (4, p. 7).

When a plastic hardens, molecules form tight chains which transform the mass from a liquid to a solid. This
formation of long cross-linked chains is called polymerization. The agent which causes these chains to form is heat. With the addition of catalyst methylethyl-keton peroxide in dimethyl phthalate and cobalt naphthenate accelerator, exothermic heat is generated. This catalyst is referred to as MEKP.

Because plastics are basically non-conductors of heat, this energy is trapped in the cast part. This heat may cause the part to cure too quickly, causing fractures and cracking. If the same resin mix is applied as a coating there is an increase in exposed surface area for the heat to be dissipated. The thicker and larger the casting, the smaller proportion of catalyst and accelerator employed (4, pp. 10-11).

According to Lannon there are four general types of polyester resins, which he denotes by types 1, 2, 3, and 4. Type 1 is a coating resin which contains wax. The wax rises to the surface and forms an air-tight seal. With this type of resin a fast surface cure with a comparatively long pot life is available. Type 2 is a resin which does not contain wax. Bonding resins will remain tacky for long lengths of time allowing the formation of several piles of reinforcement to be laid-up at one time. For the
composite to cure, a coating resin is used to saturate the last ply of the reinforcement. This will cure the entire mass if the proper amount of catalyst is added. Type 3 is a clear casting resin which is used in combination with catalyst methylethyl-ketone peroxide and cobalt accelerator. This resin is the most highly refined of the four general types. Opaque pigments, transparent dyes, phosphorescent powder, and fillers of many different combinations can be added. Type 4 is a clear resin with a slight amber tint. It can be used with benzoin (sunlight catalyst) or with the methylethyl-ketone peroxide and cobalt accelerator systems. Benzoin catalyst cures by ultra-violet light; therefore, the resin must remain clear. This resin will give a fast thorough surface cure.

The curing of polyesters can be divided into four time periods.

1. Gel-time is the length of time required for the coating to start to thicken.

2. Pot life is the length of time the resin will flow. It will be less than the gel-time.

3. Ready-to-sand is when the surface has cured hard enough but not cured completely. Normally (at 72°F) sanding can be done after four hours.
4. The complete cure of the resin system can be tested by a drop of water. If the water does not blush the surface, complete cure has been obtained.

All of these time periods will vary with the temperature, the humidity, proportion of catalyst, and thickness of coating. For a complete cure at least twenty-four hours are required at 72° F. (2, pp. 7-8).

When practical, an external source of heat can be utilized in the form of heated molds, ovens, or heat lamps. With an increase in temperature, a faster cure will result. When molding temperatures are between 200° and 300° F., benzoyl peroxide is the most commonly used catalyst. When operating between 150° and 200° F., lauryl peroxide is normally used as a catalyst. With these systems, a thin part will cure in two minutes with 1/2 to 2 per cent peroxide content by volume. Several hours extended pot life is one advantage of these catalyst systems (6, pp. 17-18).

In summary, polyester resins can be obtained tailormade in forms for specific processes and end results. Several catalyst systems can be used, depending on working conditions and specific processes. They should always be stored in a cool place, preferably in cold storage. The shelf life of
polyester resins is directly related to temperature; one month at 90° F. or above, four months at 72° F., and a year or more at 0° to 40° F. Particular care must be taken not to contaminate any resins with catalyst. Even with 500-pound drums, a few drops will cure a mass of resin in a short time (2, p. 11).

The commercial epoxy resins (the diglycidyl ethers of bisphenol A) were first introduced into this country in 1948. They are the most versatile resins commercially available. Other resins exhibit single outstanding characteristics but the epoxies have a number of characteristics which may be employed at the same time. The following are a few of these outstanding properties.

1. Epoxies can be formulated for almost any application, ranging from extremely low viscosities to high-melting-point solids.

2. Resin systems can cure slowly or quickly at almost any temperature, ranging from 40° to 356° F. Although variations are possible with specific hardeners used, the resin systems are rather insensitive to time, temperature, and precise hardener ratios. Because of the insensitive nature of the resin systems, the conditions during curing are usually unnecessary.
3. Outstanding adhesive qualities are due to the low shrinkage (less than 2 per cent), which assists in the formation of strong, relatively unstrained bonds.

4. These strong, relatively unstrained, bonds account for the high mechanical properties of tensile strength and modulus of elasticity.

5. Chemical resistance of epoxy resins is extremely good. They have high resistance to alkali (which will attack polyesters), acids and solvents.

Like the polyesters, epoxies show marked decreases in strength after prolonged exposure (up to ten years) to the elements. The life of both polyesters and epoxies can be somewhat controlled and extended by surface finish and colorant. Oxidation is the main problem with both resin systems. Paint helps seal the material and colorant reduces the absorption of ultra-violet light which oxidizes the material. High cost in comparison to polyester, limitations in service life, possible health hazards in handling, due to the toxic effect of certain resins, and hardness are cited as disadvantages of epoxy resins (4, pp. 46-48, 57, 67).

Depending on the resin system, hardeners promote curing by catalytic action or chemical reaction with the resin
chains. All reactants combine and no by-products are given off in the cure of either the catalytic or chemical combining resin forms. Resin systems can be tailor-made from combinations of the general groups of resins and the many hardener chemicals available. Because of the chemical reaction with the resins, large proportions of curing agents are required, usually from 10 to 25 per cent. Amines are most commonly used as hardeners but anhydride compounds are also enlisted.

Since the hardeners chemically combine with the resins in curing, gel-times and pot life are relatively short (less than one hour at 72° F.). Even with these rapid gel-times, curing times are rather long at ambient temperatures. Several days may be required for complete cure. With elevated temperatures, curing times can be reduced to three hours (5, pp. 19-20).

The storage of liquid resins poses no problems provided moisture is excluded. Storage is similar to polyester resins. Cool places and cold storage are recommended for maximum shelf life (5, pp. 79-80).

In summary, the epoxy resins have the widest range of application of any of the available resin systems. Because of their superior mechanical properties these resins have
had the greatest use as high strength composites. Processing controls are not as critical as with the polyesters. Therefore, highly skilled and experienced labor is not essential. High cost of the resins and the health problems due to toxic components have limited the manipulation of the epoxies as commercial reinforced plastics.

The phenolic resin systems are the oldest and cheapest thermosetting polymer systems. The resin is the end-product of the condensation of phenols (carbolic acid) and aldehydes such as formaldehyde. Many combinations of the resins are available and the variations are controlled by the chemical nature of the phenol and aldehydes used, the type and quantity of catalyst, and time and temperature of the reaction (5, pp. 85-86, 88).

Phenolic resins cure in two steps. (1) They pass from a water-soluble liquid (A stage) to a fusible solid-state of limited solubility (B stage). (2) The resin is advanced to the fully cured (C stage), where it becomes a hard solid. By-products are released in going to full cure, and are mainly water. Therefore, reinforcement must be preimpregnated and dried when employed. To force the moisture from the plastic relatively high-molding pressures are required.
Because of the moisture present, water-absorbing reinforcement and fillers are best utilized (1, pp. 76-77; 6, pp. 20-21).

Because of the variety of resins available, many processing techniques are employed in converting them to serviceable products. Powders, short and long fiber reinforcement, filled granules, chopped and woven impregnated fabrics, and liquids of various viscosities are a few of the many forms available.

In addition to water, phenolic resins generate volatile by-products during cure. One is ammonia gas, which is characteristic of the time-stable, high-temperature resistant phenolic compounds. Some resins do not flow readily. Other resins flow with ease and do not require high molding pressures for quality and serviceable end-products (5, pp. 87, 89).

Table II lists the physical characteristics of polyester, epoxy, and phenolic resin systems. Listed are the physical properties that have the greatest influence on the design of thin-wall articles manufactured from the materials. Ranges are given for the four general properties of each material. Each value (such as specific gravity) depends on conditions present during processing. It can be
## TABLE II

**GENERAL PROPERTIES OF POLYESTER, EPOXY, AND PHENOLIC REINFORCED PLASTICS/COMPOSITES**

<table>
<thead>
<tr>
<th>Materials</th>
<th>Specific Gravity</th>
<th>Reinforcement Content (% by Weight)</th>
<th>Tensile Strength (psi)</th>
<th>Compressive Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass mat, perform, sheet, molding</td>
<td>1.35-</td>
<td>25-45</td>
<td>15,000-</td>
<td>15,000-</td>
</tr>
<tr>
<td>compounds</td>
<td>2.1</td>
<td></td>
<td>25,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Glass cloth</td>
<td>1.50-</td>
<td>60-67</td>
<td>30,000-</td>
<td>25,000-</td>
</tr>
<tr>
<td></td>
<td>2.1</td>
<td></td>
<td>70,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Bulk molding compounds (premixes)</td>
<td>1.72</td>
<td>10-50</td>
<td>4,000-</td>
<td>15,000-</td>
</tr>
<tr>
<td></td>
<td>1.72</td>
<td></td>
<td>10,000</td>
<td>26,000</td>
</tr>
<tr>
<td>Asbestos-felt/mat</td>
<td>1.6-</td>
<td>50-80</td>
<td>30,000-</td>
<td>30,000-</td>
</tr>
<tr>
<td></td>
<td>1.9</td>
<td></td>
<td>60,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Epoxy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass mat</td>
<td>1.8-</td>
<td>40-50</td>
<td>14,000-</td>
<td>30,000-</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td></td>
<td>30,000</td>
<td>38,000</td>
</tr>
<tr>
<td>Glass cloth</td>
<td>1.9-</td>
<td>65-70</td>
<td>20,000-</td>
<td>50,000-</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td></td>
<td>60,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Phenolic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass mat, or Glass cloth</td>
<td>1.7-</td>
<td>45-65</td>
<td>5,000-</td>
<td>17,000-</td>
</tr>
<tr>
<td></td>
<td>1.9</td>
<td></td>
<td>60,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Asbestos-felt/mat</td>
<td>1.7-</td>
<td>60-70</td>
<td>40,000-</td>
<td>45,000-</td>
</tr>
<tr>
<td></td>
<td>1.9</td>
<td></td>
<td>60,000</td>
<td>55,000</td>
</tr>
</tbody>
</table>

*Source (11).*
seen from Table II that process control is very critical in producing consistent reinforced plastics/composites (11).

**Finishing Operations**

Rivets, bolts, and threaded fasteners are common in mechanically assembled reinforced plastics products. For satisfactory results the following suggested design rules should be followed:

1. Use only small diameter, soft rivets. The force required to upset large rivets may break down the fibers.
2. Use large flat washers under bolt and rivet heads to distribute the loads over a larger area.
3. To prevent tear-out damage, on-center distances must be at least two and one-half diameters apart and edge margin at least three diameters.
4. No mismatch of holes is permitted. Reinforced plastics are not ductile.
5. Avoid use of screws. Inserts are required when they are necessary (6, p. 75).

Adhesive bonding is preferred over mechanical fasteners when larger surface areas are in contact. Stress concentrations are reduced and a homogeneous joint is obtained. Most high-strength reinforced plastic adhesives must be
processed under pressure. Ambient temperature cures are not recommended. To achieve a good bond the surface must be clean and the wax removed. The joint must be sanded until a dull surface is obtained. Often, an advantageous method is to pre-impregnate a thin sheet of cloth with adhesive which acts as a carrier, reinforces the joint, helps control the amount of adhesive, and keeps the bond uniform (6, pp. 75-76).

The cutting of reinforced plastics is most economically performed on abrasive wheels. It is the fastest method and produces the smoothest edge. Contours can be cut with a metal cutting bandsaw with coarse, off-set, wide-spaced teeth. The blade-life is short due to the abrasive action of reinforced plastics. Carbide-tipped end mills and router bits are recommended for production work.

Blanking and punching can be performed but the dies must have close-tolerance, with less clearance than for steel punches. A stripper plate must be placed over the blanks because the material expands slightly and seizes the dies after punching. Because of expansion, the dies must be designed to punch oversize (0.002 to 0.009). Blanking dies must be designed to blank undersize (0.001 to 0.005). Again, because of the abrasive action of reinforced plastics, drills
must be carbide or diamond-tipped and they must be used with drill jigs. Electrical discharge machining has proven to be an excellent method of drilling holes in many types of composites (6, pp. 76-77).
CHAPTER BIBLIOGRAPHY


CHAPTER III

REVIEW OF CHECKLIST RESPONSES

The population chosen for the study was primarily in the Dallas-Fort Worth metropolitan area. The companies selected were almost equally divided, with fifteen located in Dallas and the remaining thirteen located in Fort Worth. The junior colleges selected for the study were located in the metropolitan area and surrounding feeder areas of the Dallas-Fort Worth industrial complex (population area was approximately 115 miles in radius). Another criterion besides geographical location for the selection of junior colleges was whether they had technical vocational programs listed in their catalogues. The data were based on catalogues currently available in the North Texas State University library.

Company Checklist

Of the twenty-eight companies contacted, fifteen responded to the checklist. Only four of the responses failed to complete the checklist. The following is a brief summary of the data.
1. The average number of employees ranged from twenty-six to fifty, with seven having twenty-five employees or less.

2. A wide selection of products was manufactured, with six producing two or more products. Five produced reinforced plastics, and the same number fabricated and finished standard stock materials. Four produced high-pressure laminates. The remaining four produced one of the following: plastics materials (formulations), laminates, plastic tooling, vacuum forming, experimental reinforced plastics and thermo-forming.

3. No local reinforced plastics companies interviewed students for jobs at the local high schools or junior colleges. Five hired off the street and the same number utilized private employment agencies. Eight utilized public employment agencies. Three used newspaper advertisements, and the remaining companies hired from within the plastics industry.

4. Only one company had any form of performance tests for applicants seeking employment. The company employed a performance test on the company's equipment.

5. A variety of responses was given for factors in selecting prospective personnel. Seven required on-the-job experience, and only three required any technical or
vocational training. The write-in responses showed the primary factors in selecting personnel were any related job experience, interest in learning job, stability of work history, and manual dexterity.

6. Eight responded that an individual with junior college technical training in plastics would have an advantage in securing a position in their company. Write-in responses indicated junior college training was considered primarily for supervisors and middle management positions rather than plant personnel. There was much indecision as to whether or not the individual would be offered a higher starting salary.

7. Eight companies stated they would sponsor or make contribution to junior college plastic course(s). When it cam to actual contributions, the companies (60 per cent) offered guided tours, guest speakers, and deministrations, but little equipment or laboratory materials.

8. Twelve of the responses indicated that their companies provided in-plant or on-the-job training for their employees. A majority of the responses had either apprentice-type training or on-the-job experience, eight having both forms of training programs available (Appendix A).
Junior College Checklist

Of the twelve junior colleges contacted, six responded to the checklist. The following is a brief summary of the data.

1. Out of the six responses, only one had a plastics technology program. The junior college offered a two-year extensive program (sixty-four semester hours), which led to an associate degree in plastics technology.

2. In the program, a total of eleven courses (forty-one semester hours) are offered for the student.

3. No plastics are included in crafts or leisure-time-orientated courses in any of the junior colleges contacted.

4. In forecasted expansion of technical programs, plastics technology was not included.

5. The program offered was very extensive and all aspects of plastics were covered. No actual laboratory work was offered in high-pressure laminates, or reinforced plastics, but they were covered in the first year initial lecture.

6. In the plastics technology program offered, an industrial advisory committee consisted of members drawn from local industry.
7. Besides the advisory committee, local industry provided equipment, materials for laboratory work, technical and informative literature, guest speakers, and demonstrations.

8. The advisory committee was consulted in regard to course organization, content, and general curriculum materials.

9. The enrollment has been between twenty-six and fifty students in the last two years. Between fifty-one and seventy-five students are presently enrolled. The first graduates are expected in May, 1972 (Appendix B).
CHAPTER IV

INDUSTRY VERSUS JUNIOR COLLEGE RESPONSES, AND A COMPARISON WITH THE 1967 NATION-WIDE SURVEY

Industry Versus Junior College Responses

In order to determine if the area junior colleges were meeting the needs of the responsive companies, a comparison of data from the two checklists was made. Job qualifications, training, coordination of junior college and industry, and status of employment possibilities were considered the most pertinent information and were used for the comparison.

The column on the left of Table III was the method used to compare the two sets of data. The data for comparison was rather limited, for there was only one program in the survey area.* From the four relative points presented, an overall view was drawn.

---

*Survey conducted by the Society of Plastics Engineers in conjunction with the Society of the Plastics Industry in October, 1967.
<table>
<thead>
<tr>
<th>Point of Comparison</th>
<th>Industry's Response</th>
<th>Junior College's Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Qualification</td>
<td>Previous related work experience</td>
<td>Laboratory experience with all plastics except reinforced plastics</td>
</tr>
<tr>
<td>Training provided</td>
<td>Extensive in-plant and on-the-job training</td>
<td>Eleven courses offered (41 hours) 64 total semester hours for an associate degree</td>
</tr>
<tr>
<td>Communications channel between schools and local industry</td>
<td>Advisory committee</td>
<td>Committee consulted in regard to course organization, content, and general curriculum materials</td>
</tr>
<tr>
<td>Status of employment possibilities</td>
<td>Stable work force—no expansion in immediate future</td>
<td>No new plastics technology programs or enlargement of present program forecasted</td>
</tr>
</tbody>
</table>
The Society of Plastics Engineers-The Society of Plastics Industry Survey

In the "Related Studies" section of Chapter I, the nation-wide survey (1, pp. 1-19) conducted by the Society of Plastics Engineers-the Society of Plastics Industry joint Education Committee in October, 1967 was reviewed. A further discussion of that study will be presented at this time.

From the results of the survey it was apparent that industry needs and wants specialized and broad training programs in the field of plastics technology at secondary and post-secondary levels. At the time of the survey (1967), there was a serious shortage of all types of personnel. The most acute shortage was in skilled employees. According to the study, there will be a continual shortage, increasing in direct proportion to the growth of the industry (1, p. 2). It was stated that skilled personnel were the most difficult to hire, and this statement varied slightly with company size and geographical location. It was noted that the smaller companies as well as larger companies reported there was a shortage of engineers. In addition, 20 per cent of the responses showed technicians with junior college training difficult to hire (1, p. 11).
Each company had its own titles for the positions which needed filling. Basically, the responsibilities were common to all. The following is a brief list of these positions.

1. Supervisors and foremen (tool room, processing, and finishing).
2. Mold and product designers and draftsmen.
3. Mold set-up technicians.
4. Production engineers (cycle and material technicians).
5. Inspectors and quality-control technicians.
6. Processing, accessory, and finishing machinery specialists.
7. Color and material mixing specialists (1, p. 12).

The most critical shortage of the skilled technicians was the tool and die maker.

The technical education for plastics technicians of all types was practically non-existent. Eleven of the companies contacted were currently supporting training programs, with fifteen willing to support local programs if they were available. Again, it cannot be stressed enough that industry was more than willing to support local programs with equipment,
materials for laboratory work, technical and informative literature, guest speakers, and demonstrations.

Table IV is a comparison of the nation-wide survey with the local study. The questions from the company checklist have been paraphrased and listed at the left.

Even with the small population, the local companies compared favorably with the nation as a whole. In several areas the local companies surpassed the companies which participated in the nation-wide survey. Willingness to contribute to local programs and types of training available were two of the outstanding points in question. As a whole, the nation-wide survey showed that companies contributed more materials and equipment than the local companies.
<table>
<thead>
<tr>
<th>Statement</th>
<th>Dallas-Fort Worth</th>
<th>SPE-SPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of plant employment</td>
<td>No comparison could be made</td>
<td>No comparison could be made</td>
</tr>
<tr>
<td>Product(s) manufactured</td>
<td>Good representation</td>
<td>Local compared favorably with nation-wide companies</td>
</tr>
<tr>
<td>Source of personnel recruitment</td>
<td>All sources except schools and colleges</td>
<td>Majority recruited from schools and colleges</td>
</tr>
<tr>
<td>Performance tests</td>
<td>No comparison could be made</td>
<td>No comparison could be made</td>
</tr>
<tr>
<td>Factors in personnel selection</td>
<td>Experience in field and high school diploma</td>
<td>High school diploma and plastics training</td>
</tr>
<tr>
<td>Higher starting salary with plastics training</td>
<td>Indecision</td>
<td>Yes</td>
</tr>
<tr>
<td>Contributions and sponsorship of local plastics programs</td>
<td>60 per cent</td>
<td>55 per cent</td>
</tr>
</tbody>
</table>

*Survey conducted by the Society of Plastics Engineers in conjunction with the Society of Plastics Industry in October, 1967.*
TABLE IV (Continued)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Dallas-Fort Worth</th>
<th>SPE-SPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of support to local programs</td>
<td>60 per cent guided tours and speakers</td>
<td>Between 70 and 90 per cent based on program and its worth to industry</td>
</tr>
<tr>
<td>Type of training currently undertaken by industry</td>
<td>80 per cent in-plant or on-the-job experience</td>
<td>42 per cent in-plant or on-the-job experience</td>
</tr>
</tbody>
</table>
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CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The study was a comparison of a junior college plastics curriculum in Dallas County and the requirements of the reinforced plastics industry in the Dallas-Fort Worth area. Through the use of two checklists, an overall view of reinforced plastics education and the educational needs of the local reinforced plastics industry was obtained. One checklist was sent to reinforced plastics manufacturers in the Dallas-Fort Worth area. The other checklist was sent to the junior colleges in Dallas, Tarrant, and surrounding counties which offered technical-vocational programs. To complement the information provided by the informants through the checklists, five plastics manufacturers in the Dallas and Mid-Cities (Arlington and Grand Prairie) area were contacted. Two areas of interest were covered by personal interview—the first being employment possibilities with junior college plastics training and the second was whether any form of expansion programs was under way at any of the companies.
Findings

The findings of this study are divided into two parts. They are as follows.

**Industry Checklist Findings**

1. The average number of employees of the companies ranged from twenty-six to fifty.

2. Six of the manufacturers produced two or more products. Five manufactured reinforced plastics and fabricated standard stock materials. Four of the companies produced high-pressure laminates. The remaining companies were engaged in production of plastics materials, laminates, plastic tooling, vacuum forming and experimental reinforced plastics.

3. Sources of personnel recruitment included the following: Five hired off the street and the same number utilized private employment agencies. Eight utilized public employment agencies. Three utilized newspaper advertisements, and the remaining companies hired from within the plastics industry.

4. Factors used in the selection of personnel included on-the-job training used by seven of the manufacturers and technical training by three or less of the companies.
Write-in responses indicated that related job experience, interest in learning the job, stability of work history, and manual dexterity were criteria in selecting personnel.

5. It was indicated by eight of the companies that an individual with junior college plastics training would have an advantage in securing employment in the local industry.

6. Eight of the participants stated they would contribute to local program(s) if there were specific courses offered that would directly meet their needs.

**Junior College Checklist Findings**

1. Only one of the junior colleges offered a plastics technology program. An extensive (sixty-four semester hour) program which lead to an associate degree in plastics technology was offered.

2. No plastics training was offered in the form of crafts or leisure-time-orientated courses by any of the responding junior colleges.

3. The existing program covered all areas of the plastics field. The one exception was laboratory experience with reinforced plastics and high-pressure laminate materials.

4. Local industry contributed to the one program offered through an advisory committee which was consulted
in regard to course organization, content and general curriculum materials. Also equipment, supplies for laboratory use, technical and informative literature, guest speakers, and demonstrations were contributions of local industry.

Conclusions

The following conclusions were drawn from a comparison of the needs of the local reinforced plastics industry for technical personnel to the output of the plastics technology program in area junior colleges.

1. It was apparent that the existing program was adequately providing for the present needs of the local reinforced plastics industry, the one exception being actual experience in working with the materials of the field.

2. An over-supply of trained personnel was indicated by the informants in this study. The write-in information was validated by direct contact of five plastics manufacturers in the Dallas and Mid-Cities (Arlington and Grand Prairie) area. The companies were neither expanding their work force nor making any large capital investments. Not one of the companies was taking applications, much less arranging interviews for prospective employees.
3. Data indicated that to make any material contribution, a local plastics program should offer training in reinforced plastics directly related to the individual needs of the manufacturers contacted in this study.

Recommendations

The following statements are recommendations for further study of the plastics field in the Dallas-Fort Worth area.

1. A follow-up study would be highly recommended. The study should cover the complete plastics industry of the Dallas-Fort Worth area.

2. The proposed study would be necessary to make recommendations for changes in the only plastics technology program now offered by a Dallas-Fort Worth area junior college.

3. The proposed study would also be necessary as the basis for future programs to be established by other junior colleges surveyed in this study.
DeWayne H. Gier

Sponsored by:

Pat N. McLeod, Professor of Industrial Arts
Directions: Check your response to the following questions. Note: More than one answer may be checked.

1. Number of employees in your company.
   A. 0-25
   B. 26-50
   C. 51-100
   D. 101-200
   E. 201-500
   F. 500-1000
   G. 1000 or more

2. Product(s) manufactured by your company.
   A. Plastics materials (formulations)
   B. High-pressure laminates
   C. Laminates
   D. Reinforced plastics
   E. Fabrication and finishing
   F. Other (please specify)

   A. Off the street
   B. Public employment agencies
   C. Private employment agencies
   D. Within the industry
   E. Interviews at local schools (public high schools and colleges)
   F. Newspaper advertisement
   G. Other (please specify)

4. Does your company have performance tests or other forms of testing procedures for applicants seeking employment?
   YES
   NO

5. If the answer to (4) was YES, what form of test(s) are utilized?
   A. Performance test(s) with company equipment
   B. Written test
   C. Other (please specify)
6. If the answer to (4) was NO, what other factors are employed in selecting prospective personnel?

A. High school graduate
B. Technical or vocational training (public)
C. On-the-job experience
D. Other (please specify)

7. Would the applicant with technical training in plastics obtained in junior college have an advantage in applying for a position with your company?

YES
NO

8. Would the applicant in (7) be offered a higher starting salary with these qualifications?

YES
NO

9. Would your company contribute or help sponsor present and/or additional junior college plastics course(s) if they were available locally?

YES
NO

10. If the answer to (9) was YES, in what way or form would you contribute to a local junior college plastics program?

A. Equipment
B. Materials for laboratory work
C. Technical and informative literature
D. Guest speakers or demonstrations
E. Guided tours
F. Other (please specify)

11. Do you have in-plant or on-the-job training programs at your company?

YES
NO
12. If the answer to (11) was YES, what form of programs are available?

A. Apprentice-type training
B. On-the-job experience
C. In-plant programs.
D. Other (please specify)__________________________

13. Would you like a summary of the results of this study?

YES   NO
Dear Sirs:

I am a graduate student at North Texas State University majoring in industrial arts and presently conducting a study of the reinforced plastics industry of the Dallas-Fort Worth area and the local junior college programs. The major objective of the study is to determine if the area junior colleges are meeting the manpower needs of the local plastics industry.

To help accomplish the objective, the enclosed checklist has been designed to determine what is presently offered in plastics and what programs are being formulated for future expansion to include plastics in local junior colleges. All data gathered by the checklist will be treated statistically so, feel free to make any suggestions or criticisms. Please feel free to contact me if there are any questions in regard to the checklist and study.

Sincerely yours,

DeWayne H. Gier

Sponsored by:
Pat N. McLeod, Professor of Industrial Arts
Directions: Check your response to the following questions. Note: More than one answer may be checked.

1. In your technical vocational program is plastics technology offered as a course(s)?
   YES NO

2. If YES was the response, is there more than one course offered?
   YES NO

3. If YES was the response to (2), how many?

4. Is plastics included in crafts or leisure time orientated courses in your program?
   YES NO

5. If NO was the response to (1) and (4), is plastics technology included in forecasted expansion of your program?
   YES NO

6. Would you like a summary of the results of this study?
   YES NO

If NO was the response to the above questions and no future expansion is known at this time, which includes plastics, it will not be necessary to complete the remaining portion of the checklist.

Thank you for your assistance in making this study.
7. If YES was the response to (1), (2), and (3), what material and information is included in the course(s)?

A. Plastics materials (formations)
B. Molding
C. Extrusions
D. Thermoforming
E. Films and Sheets
F. High-pressure laminates
G. Laminates
H. Reinforced plastics
I. Coatings
J. Fabrication and finishing
K. Other (please specify)________________________

8. If YES was the response to (4), what material and information does the unit(s) on plastics include?

A. Jewelry and Knick-knacks
B. Coatings and overlays
C. Recreation equipment (archery equipment, fishing poles, etc.)
D. Other (please specify)________________________

9. Does local industry participate in your plastics course(s)?

YES       NO

10. If local industry participates, in what way?

A. Equipment
B. Materials for laboratory work
C. Technical and informative literature
D. Provide speakers or demonstrations
E. Other (please specify)________________________

11. Are local plastics manufacturers and processors contacted in regard to course(s) organization, content, and general curriculum materials in your program?

YES       NO
12. How many students have enrolled in your plastics course(s) and what is the current enrollment?

<table>
<thead>
<tr>
<th>Number</th>
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APPENDIX C

LIST OF PLASTICS MANUFACTURERS OF DALLAS AND FORT WORTH AREA OF REINFORCED PLASTICS AND LAMINATES

Dallas
Associated Plastics Co., Div. of C. P. Waggoner Sales Co. Inc., 233 S. E. 14th Grand Prairie
Dallas Plastics Industries Inc. 8100 Chancellor
Decorative Laminates Co. 1350 Chemical
Fiber Resin Corp. 528 Continental Bldg.
Filon Fiberglass Greenhouses 5607 E. University Blvd.
General Electric Co. Laminated Products Division 6500 Cedar Springs
Laminated Plastics of Dallas 2340 Valdina
K & L Distributing Co. 5521 Maple Ave.

Natex Fiberglass Corp. 1731 S. Broadway Carrollton
Paultate c/o Syntahne-Taylor Corp. P. O. Box 1530 Grand Prairie
Texas-Tennessee Ind. Inc. 1205 Ave. E East Grand Prairie
Texstar Plastics P. O. Box 1530 Grand Prairie
Frank Turner Plastics 2512 W. Marshall Grand Prairie
Wattco Inc. 4111 Platinum
Williams Products Inc. 3402 McFarlin
Fort Worth

A-l Plastics
1723 Layton

Deep Flex Plastic Molds Inc.
2740 Lipscomb

Bidco Inc.
2732 Ludelle

Ellefson Co.
201 S. Calhoun

EMC Co.
3817 Rutledge

Enjay Fibers and Laminates Co.
1100 107 St.
Arlington

Ferro Corp.
601 Great Southwest Pkwy.
Arlington

Fiberglass Products Co.
4109 Evans Ave.

Laminates Plastics of Texas
Hwy. 79 E.
Taylor

Plas Trend Corp.
9801 Jacksboro Hwy.

Southwest Plastics Co.
2738 Pioneer Parkway W.
Arlington

Tech-Tool Plastics
230 C-2
S. Grand Lane

Wilson Products Corp.
5705 Azle
APPENDIX D

SELECTED TECHNICAL EDUCATIONAL INSTITUTIONS LOCATED IN

DALLAS, TARRANT AND SURROUNDING COUNTIES

Cisco Junior College
Technical Vocational Department
Route 3
Cisco, Texas 76437

Eastland Junior College
Technical Occupational Division
3737 Motley Dr.
Mesquite, Texas 75149

Mountain View Junior College
Department of Plastics Technology
4849 W. Illinois Ave.
Dallas, Texas 75211

Grayson Community College
Technical Vocational Division
Denison-Sherman, Texas 75020

Hill Junior College
Technical Vocational Division
Hillsboro, Texas 76645

Kilgore Junior College
Division of Technical Vocational Department
Kilgore, Texas 75662

Paris Junior College
Division of Technical Occupational Education
Paris, Texas 75460

Tyler Junior College
Director of Department of Technology
Tyler, Texas 75701
Tarrant County Junior College, South Campus
Department of Technology
5301 Campus Drive
Fort Worth, Texas 76119

Tarrant County Junior College, Northeast Campus
Department of Technology
Hurst, Texas 76053

Weatherford College
Technical Vocational Division
Weatherford, Texas 76086
BIBLIOGRAPHY

Books


Unpublished Materials


Booklets


