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The Necessity of Plastics Education and the Development of a Course Outline as it Pertains to Area Vocational Schools in the State of Utah

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THE NECESSITY OF PLASTICS EDUCATION AND THE DEVELOPMENT OF A COURSE OUTLINE AS IT PERTAINS TO AREA VOCATIONAL SCHOOLS IN THE STATE OF UTAH

by

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ABSTRACT

The Necessity of Plastics Education and the

Development of a Course Outline as it Pertains to Area

Vocational Schools in the State of Utah

by

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Utah State University, 1971

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Purpose of the Study. The purpose of this study was to determine if there was a need in the plastics industries in the state of Utah for plastics education at the area vocational school level.

Source of the Data and Method of Study. A list of companies whose major function was plastics processing was obtained from the Directory of Utah Manufacturers. Additional companies were also identified if they were suspect of having any type of plastics processing function within their company. A questionnaire was sent to those companies identified to determine which companies were directly concerned with plastics education. Once these companies were identified, a second questionnaire was sent. This questionnaire was designed to provide knowledge of the functions performed by the plastics industry in the state, the level of

skill and knowledge required of the workers performing these functions, and the opportunities available for persons trained in the field of plastics.

Findings and Conclusions. Twenty-nine industries were identified as companies being directly concerned with plastics education. Of this number, the majority were found to be in the Salt Lake area. Processes that are representative of the processes performed throughout the nation were found to be performed in the state and all of the major processes were performed. Most companies participating in the study expected growth within the next year and many had worker vacancies at the time of the study. Most companies indicated that personnel with training dealing with plastics could expect higher wages. Their greatest need was for skilled and semi-skilled workers.

It was concluded that the number of industries responding to the study represented a large enough need in terms of projected number of employees, types of processes used, and vacancies at present that a program of instruction could be justified at the area vocational level. Also, it was concluded that skills in areas other than those dominating the processing functions on a national level were of greater importance to the companies performing processing functions with plastics in the state of Utah than they are throughout the total industry.

(136 pages)

CHAPTER I

INTRODUCTION

Origin and Need

In September of 1968, the Society of Plastics Engineers and the Society of Plastics Industries published a report concerning the educational needs of the plastics industries. From their findings they concluded that there was a need for expansion of plastics instruction at all educational levels (Society of Plastics Engineers and Society of Plastics Industries, 1968, p. 1).

The Society of Plastics Engineers and the Society of Plastics Industries report states:

> ... a knowledge of plastics is essential since it is quickly replacing the old standard materials and processing methods. It is effecting major changes in the manufacturing processes used in every industry. ... We must prepare now to meet this challenge and have the engineering talents and the trained work force available to effectively work with this new manufacturing medium. (Society of Plastics Engineers and the Society of Plastics Industries, 1968, p. 7)

The report goes on to say that "this can only be accomplished through educational programs designed to train skilled technical and engineering personnel on all aspects of this relatively new science (Society of Plastics Engineers and the Society of Plastics Industries, 1968, p. 7).

The growth of the plastics industries is progressing at an accelerated rate. It is estimated that the volume of plastic used will exceed the volume

of metals used by 1983. The tremendous growth of the plastics industry has led to an increase of training needs. The availability of trained personnel for the plastics industry is decreasing and the formal sources of trained personnel is remaining about the same--practically non-existent. The Society of Plastics Engineers and the Society of Plastics Industries report implied that the lack of availability of trained personnel was caused by the extensive new growth in the industry and the lack of growth of training institutions concerned with plastics education (Society of Plastics Engineers and the Society of Plastics Industries, 1968, pp. 6-7).

In a recent publication by the Institute of Labor and Industrial Relations and the National Manpower Policy Task Force, it was emphasized that in regard to vocational education, every program should be based on a study of employment supply and demand and consideration of student mobility. The report stated that, in practice, data on employment supply are not available, data on demand are unreliable, and an assumption appears to be that no graduate of the program will ever leave the school district (Evans, Mangum, and Pragan, 1968, p. 54).

The various state education systems have shown little evidence of planning for new and emerging occupations, for the critically short occupations, and initiating training for these occupations in area vocational schools (Mangum, 1968, p. 14). Area vocational schools must be schools offering a unified program of general and vocational training responsive to the needs of the labor market in the area and, in rural districts, area

vocational schools should prepare the youth not only for available off-farm agricultural occupations, but should also equip workers with skills needed in the urban centers to which many will move (U. S. Government Printing Office, 1968, p. 23).

When the various states requested funding for area vocational schools, they were required to submit guidelines for development of area schools, but the facilities constructed appear to have emphasized continuation and expansion along conventional lines. There is little evidence that facilities were planned to house training for new occupations or critically short ones (Mangum, 1968, p. 14). In this respect, the request by the plastics industries for additional programs in plastics education has gone unnoticed.

Statement of the Problem

Although the Society of Plastics Industries and the Society of Plastics Engineers have indicated that there was a need for plastics education at all levels, and in all geographical areas, they did not indicate the degree of need as it related to areas where the plastics industries are sparsely located. The need for education for the plastics industry was not known for the various levels of education. More specifically, there existed a lack of knowledge concerning the need for plastics education which could be handled by the area vocational schools in the state of Utah. This lack of knowledge was augmented by the lack of information concerning the industries that are directly interested in plastics education, the lack of

knowledge of the kinds and levels of skills that are required of plastics workers, and the job opportunities that are available for persons trained in plastics.

Purpose of the Study

The purpose of this study was to determine if there was a need in the plastics industries in the state of Utah for plastics education at the area vocational school level.

Objectives of the Study

The specific objectives of this study were to:

1. Identify the industries that are directly concerned with plastics education in the state of Utah.
2. Investigate the job opportunities for personnel trained in the field of plastics production in the state of Utah.
3. Determine the kinds and level of skill and knowledge required of employees in the plastics industries in the state of Utah.
4. Develop a course outline by which area vocational schools can provide training that will meet the needs of the plastics industries in the state of Utah.

Methods and Procedure of the Study

Two questionnaires were designed. The first questionnaire utilized was designed to identify those industries in the state of Utah which were

concerned with plastics manufacturing or fabrication and which also felt a need for trained employees in the field of plastics (Appendix A). The second questionnaire utilized was designed to investigate the job opportunities and to determine the kinds and level of skills required of employees in the selected plastics industries in the state of Utah (Appendix B).

The first questionnaire was mailed to all companies in the state of Utah whose major product or function dealt with the fabrication or manufacture of plastic products and to all other companies which were suspect of maintaining a plastics function. The second questionnaire was mailed to companies which had indicated a need for training and trained employees in the field of plastics in the first questionnaire. In an attempt to obtain a higher percentage of return, both questionnaires were followed up with a second letter and questionnaire to those companies not responding (Appendix C).

Selection of industries

For this study, the industries were selected from the Directory of Utah Manufacturers prepared by the Utah Committee on Industrial and Employment Planning. The selection method for this study involved analyzing the various products made by groups of industries and determining if these products could possibly use plastics in their manufacture. Many of the industries that would not use plastic for their product manufacture were obvious. For instance, such manufacturers as "rolling mills--hot rolling"

would not use plastics in their product. This type of company was not included on the mailing list. The determination of whether a company was included in the survey was made by the author. Manufacturing areas that produced products where the use of plastic materials was not as easily ascertained were included on the mailing list. If there was any doubt at all, the manufacturing area was included. Large manufacturing areas that were excluded entirely from the study were: food and kindred products; textile mill products; apparel; printing, publishing and allied industries; leather and leather products; and primary metal industries. Over one-third of the manufacturers in the state of Utah were included on the first mailing list.

Additional industries were identified through telephone directories. These industries were selected if they were listed as companies dealing with the manufacture or fabrication of plastic materials. The total number of industries contacted was 454. Fifty-five companies were identified as companies having major products or functions dealing with plastics. The remaining 399 companies contacted were those whose major product or function might include a support area dealing with plastics.

The second questionnaire was sent to companies indicating both job functions or future job functions and training needs in the field of plastics. This indication was obtained from the first questionnaire and the total number meeting this qualification was 51. All 51 of these companies were requested to complete the second questionnaire.

Acquisition of data

Answers to the first questionnaire were obtained from 260 companies. This number represents 57 percent of the companies originally contacted. The first mailing of the questionnaire drew a response from 206 companies. Two weeks after the first mailing, a follow-up letter and questionnaire were sent to 100 of those companies not responding. Fifty-four responses were received from this follow-up letter. This follow-up brought the total number of industries responding to 260. Table 1 is a summary of the number of responses to the first questionnaire.

Table 1. Number of responses to first questionnaire and follow-up

	Number contacted	Response Number returned	Percent total return
Initial Contact	454	206	45.4%
Follow-up	100	54	11.9%
Total Received		260	57.3%

Of the 51 companies included in the mailing of the second questionnaire, 22 were those companies originally identified as having a major function concerned with plastics. Forty-four of the 55 companies identified as having a major function dealing with plastics were accounted for by the return of the first questionnaire. Of this 44, 22 indicated that they either did not have a plastics function within their industry, they did not need

plastics workers who had received previous training in the field of plastics, or that they were no longer in business. These companies were not included on the mailing list for the second questionnaire. Only two companies of this 22 indicated that they had a plastic function but did not need education in the area of plastics.

Three weeks after the initial mailing of the first questionnaire, the second questionnaire was sent. After a period of two weeks, 31 percent of the second questionnaire had been returned. At this point, a follow-up letter and an additional questionnaire form was sent to those companies which had not responded. The first follow-up for this questionnaire provided an additional 29 percent of the total.

After allowing three weeks to elapse, personal contact was made with 14 of the remaining 20 industries that had not yet responded. Of the 14 industries contacted, 10 responded immediately by completing the questionnaire in the presence of the author. Two of the companies contacted personally returned the questionnaire by mail while two others did not respond. The reason for not contacting all of the industries personally was their remote location in the state. Table 2 is a summary of the acquisition of responses to the second questionnaire.

Limitations of the Study

This study was limited to:

1. The knowledge and information obtained at the time of the study which was January through June of 1970.

Table 2. Number of responses to second questionnaire and follow-up

	Number contacted	Response Number returned	Percent total return
Initial Contact	51	16	31.4%
Follow-up	35	15	29.4%
Personal Contact	14	12	23.6%
Total Received		43	84.4%

2. Industries indicating a need for employees trained in occupations concerned with plastics.

3. Industries hiring personnel to perform job functions dealing specifically with plastics.

4. The selected industries within the state of Utah.

5. The industrial personnel's understanding and completion of the questionnaire.

Definition of Terms

Area vocational school

(A) a specialized high school used exclusively or principally for the provision of vocational education to persons who are available for study in preparation for entering the labor market, or

(B) the department of a high school exclusively or principally used for providing vocational education in no less than five different occupational fields to persons who are available for study in preparation for entering the labor market, or

(C) a technical or vocational school used exclusively or principally for the provision of vocational education to persons who have completed or left high school and who are available for study in preparation for entering the labor market, or

(D) the department or division of a junior college or community college or university which provides vocational education in no less than five different occupational fields, under the supervision of the State Board, leading to immediate employment but not necessarily leading to a baccalaureate degree,

if it is available to all residents of the State or an area of the State designated and approved by the State Board, and if, in the case of a school, department, or division described in (C) or (D), it admits as regular students both persons who have completed high school and persons who have left high school. (Public Law 90-576, 1968, p. 7)

Directly concerned

Those companies which employed or projected employment needs for plastics workers and which expressed a need for plastics education are directly concerned.

Semi-skilled

Having or requiring less training (as for a few weeks) and the exercise of less independent judgement than skilled labor and more than unskilled labor. (Webster's Third New International Dictionary, 1968, p. 2065)

Skilled worker

One who has completed an apprenticeship program in a trade or is engaged in a vocation in which technical knowledge and the exercise of judgement are required. (Roberts, 1965, p. 7)

Unskilled worker

A worker involved in an unskilled occupation which is work requiring little or no planned training. (Good, 1959, p. 591)

CHAPTER II

REVIEW OF LITERATURE

For the purpose of this study, the review of literature was centered around literature pertaining to area vocational schools and literature concerned with plastics education.

Area Vocational Schools

The concept of area vocational schools developed over a number of years. Efforts were made to include provisions for such schools in the Vocational Education Act of 1946, but the efforts were unsuccessful. As the move to include the area vocational schools in the educational system increased in strength, additional legislation that would include this type of school was sought. "A bill (S. 4301) was introduced in the 84th Congress relative to the establishment of area vocational schools and programs and comparable separate legislation was introduced early in the 85th Congress" (Swanson, 1966, p. 97). The passage of the National Defense Education Act of 1958 brought into being the federal acceptance of the term "area vocational school" and the term has been in use since.

Although the National Defense Education Act endorsed the concept of area vocational schools, it limited its support to the training of technicians. The Vocational Education Act of 1963, however, expanded the use of federal

funds for the construction of area vocational schools to include training for any non-professional occupation (Administration of Programs, 1968, p. 22).

The term "area vocational school" has caused some concern as to what it actually means and in what respects it differs from regular vocational schools. This confusion has been of enough concern that the recommendations of the 1966 Vocational Education Advisory Council stated that "confusion concerning the meaning of the term area vocational education facilities should be ended by deleting the word area" (Evans, Mangum and Pragan, 1968, p. 71). The word "area" was not deleted, however, and area vocational schools are in existence in most of the states in this nation (Evans, Mangum and Pragan, 1968, p. 29).

According to the American Vocational Association, the term "area vocational school" or "program" represents:

> A school or program involving a large geographical territory usually including more than one local basic administrative unit. It offers specialized training to high school students who are preparing to enter the labor market. It also provides vocational or technical education to persons who have completed or left high school and are available for full-time study. These schools are sponsored and operated by local communities or by the state. (American Vocational Association, 1968, p. 5)

Area vocational programs are highly diversified. The American Vocational Association states that "there is no single pattern to identify the area program except that it embraces more than a single community or school district" (American Vocational Association, 1966, p. 4).

Public Law 90-576 of 1968 defines area vocational schools as:

> (A) a specialized high school used exclusively or principally for the provision of vocational education to persons who are available for study in preparation for entering the labor market, or
>
> (B) the department of a high school exclusively or principally used for providing vocational education in no less than five different occupational fields to persons who are available for study in preparation for entering the labor market, or
>
> (C) a technical or vocational school used exclusively or principally for the provision of vocational education to persons who have completed or left high school and who are available for study in preparation for entering the labor market, or
>
> (D) the department or division of a junior college or community college or university which provides vocational education in no less than five different occupational fields, under the supervision of the State Board, leading to immediate employment but not necessarily leading to a baccalaureate degree,
>
> if it is available to all residents of the State or an area of the State designated and approved by the State Board, and if, in the case of a school, department, or division described in (C) or (D), it admits as regular students both persons who have completed high school and persons who have left high school. (Public Law 90-576, 1968, p. 7)

As can be seen by this definition, area vocational schools not only should provide an opportunity for a wide spectrum of age groups, but they should also have the potential of offering a great variety of training opportunities.

Studies that have been conducted on programs concerning various vocational programs indicate that there is a need for more knowledge of the requirements of the industries in the area served by these schools. Specifically, Garth L. Mangum, in Reorienting Vocational Education, states that since the passage of the 1963 Vocational Education Act" ... the expansion [of vocational education] has been largely in the old occupational

categories except for the addition of a new category of office occupations. Vocational education is not yet adequately responsive to the needs of the labor market ..." (Mangum, 1968, p. 21). Other literature that would support this point of view includes: Education for Employment, Rupert N. Evans, Garth L. Mangum, and Otto Pragan, 1968; Education for a Changing World of Work, Panel of Consultants on Vocational Education, 1963; and "Area Vocational Education Programs," American Vocational Association, 1966.

A statement made by the American Vocational Association in relation to the present trend of society to move from the rural setting to the urban and suburban setting has implications for the state of Utah. With this movement, and with the increased mobility of labor, there arises a need for training that will qualify people for jobs wherever they are available. The whole concept of area vocational programs involves a wider outlook, a broader vision than that of the local community, or even of a county or state (American Vocational Association, 1966, p. 25).

The American Vocational Association goes on to say that "in planning the occupational offerings for an area program the training needs of an entire region and adjacent communities, or an entire state, should be taken into consideration." Also, "provision should be made for upgrading employed workers and for the initial training of unemployed workers and persons desirous of changing their occupations" (American Vocational Association, 1966, p. 25).

Roberts states that "area vocational education programs require facilities, faculties, and curriculums that meet acceptable standards. An advisory committee composed of representatives of labor, management, and education should be constituted in the early planning stages and continue to function during the life of the school ..." He goes on to say that "curriculums should be designed to meet the specific employment requirements of the area served and should be determined from an occupational survey" (Roberts, 1965, p. 321).

Curriculum developments and area requirements are usually in a constant state of change. An area vocational school is not an unchanging technological mechanism; area vocational programs should anticipate changes in the industries of the area. Moving to meet new local demands requires school administrators to anticipate rather than to react later to new facts of life in area industry (Russo, 1966, p. 4).

Plastics Education

An historical review of attempts made to provide for vocational education for the plastics industry is sketchy. Literature has not provided continuous information on the developments of plastics education. An attempt was made to trace the development of plastics education by reviewing the literature, but it was determined that this review would not provide a comprehensive picture of the development. The attempt to trace plastics education was extended to information that could be gained from

the editors of four major periodicals concerned with plastics: Sid Gross, Modern Plastics; John J. Joyce, Western Plastics; John R. Lawrence, Plastics World; and M. W. Riley, Plastics Technology. Also contacted were representatives from the Plastics Education Foundation, the Society of Plastics Engineers, and the Society of Plastics Industries. Although replies were received, specific information concerning the development of plastics education was not obtained to any extent.

Vocational courses for the training of employees for the plastics industry can be identified in the public schools as early as 1934 (Modern Plastics, 1945, p. 108). It is reasonable to assume that this was one of the first vocational plastics programs since, at this time, the plastics industry was in the very early stages of its infancy. Except for phenolics, none of the major plastics had been commercialized in the United States. Other programs can be identified as the years progress, but the efforts to maintain an educational program in this field must be considered as sporadic or poorly documented. Perhaps Mr. C. C. Campbell, Executive Secretary of the Society of Plastics Engineers, sums it up best. He states:

> ... until a body of knowledge has become well enough established to be systematized, to become a science, education in that field is unsophisticated, diverse in method, and tenuous. Our Society, in the early stages of its mission of creating a science and profession of plastics engineering, has found that the making of history takes precedence over the recording thereof. (C. C. Campbell, 1970, personal letter)

Only recently has education begun to recognize the needs of the plastics industry. Even today, most practical plastics education is still on-the-job or industry-funded (Travernicht, 1968, p. 57).

Research done concerning plastics education at area vocational schools in the state of Utah was not discovered. A review of studies conducted at Brigham Young University, the University of Utah, and Utah State University was made. Also, a personal interview with the Associate Director of the Research Coordinating Unit for Vocational Education in the state of Utah, and a search through the Educational Research Information Center Index was conducted. Although studies have not been identified which pertain directly to the state of Utah, reports that have been made concerning plastics education indicate several aspects that are pertinent to this study.

The study, The Need for Plastics Education (Society of Plastics Engineers and Society of Plastics Industries, 1968, p. 11), states that the most difficult level to fill for the plastics industry in general, is at the skilled employee level. For small companies, those with fewer than 250 employees, it was indicated that semi-skilled workers were the second most in demand. Upon review of the Directory of Utah Manufacturers, prepared by the Utah Committee on Industrial and Employment Planning, it was indicated that this smaller size company is the type that is most abundant in the state of Utah.

In a study concerning the Iowa plastics industries (Zook, 1968), the plastics industries were identified, processes were named, and the source of skilled workers was found to be from in-plant training. From his findings, Zook concluded that there is a need for plastics education in area vocational

schools in the state of Iowa; however, he does not develop or suggest any particular course outline to be offered at this level.

In Zook's study, the plastics industries in the state of Iowa were asked to evaluate production processes, materials, fabricating and finishing techniques, related industrial areas and general education requirements as to their importance for skilled plastics workers. He did not include other levels of workers in his study. His findings indicated that injection molding rated the highest in importance as a production process (Zook, 1968, p. 71), but the workers necessary for this process area, other than skilled workers, were not identified. Basically, Zook's study was concerned with the skilled worker needs of the plastics industry as indicated by the size of the industry, the processes used, the product manufactured, and the location of the various plants within the state of Iowa.

In interviews made by Zook, a point was made by several firms concerning the instruction of a plastics program in area vocational schools. He states: "a concern expressed by several of the firms interviewed was the source and capabilities of personnel to teach in the field of plastics in the area schools" (Zook, 1968, p. 157). He also states that " ... one type of training program would not meet the needs of the entire industry. Skilled workers trained in depth in one or two of the major production processes were preferred" Zook, 1968, p. 157).

Among Zook's findings was the fact that plastics industries in the state of Iowa projected an estimated need for over 3,000 workers by the beginning of 1969 (Zook, 1968, p. 163). His conclusion that plastics education is needed at the area vocational schools in the state of Iowa to help meet the training needs of future plastics workers corresponds with the statement made by the Society of Plastics Engineers and Society of Plastics Industries concerning the need for education at all levels, even in states that contain only a minimum number of processors (Society of Plastics Engineers and Society of Plastics Industries, 1968, p. 8).

James Runnalls conducted a study entitled Plastics Technology and Its Reflection in Industrial Arts Teacher Education Programs. His study was conducted by analyzing and describing the various production processes and materials used in industrial production of plastic products and determining the extent to which these processes and materials were related to the instruction given as preparation for industrial arts teachers. Runnalls found evidence that the production materials most frequently presented in the plastics courses were not the same as those used in the greatest quantities by industry. He also found that only a small amount of attention is given to laboratory experiences with production processes in instructional programs in the area of plastics. These findings were, as stated above, in industrial arts education, not vocational education (Runnals, 1966, p. 206).

Summary

The concept of area vocational schools developed over a number of years. Although this term has created some confusion as to how it actually differs from regular vocational schools, efforts to eliminate the term area have not been successful. Basically, there is no single pattern to identify the area program except for the fact that it is intended to offer programs for more than a single community or school district. Studies conducted which concern vocational programs have indicated that there is a need for more knowledge of the industries in the geographical area which the vocational school is serving. Also, the geographical area a school is serving is expanding because of the increased mobility of the present society.

Studies concerning plastics education in the state of Utah were not discovered; however, studies concerned with the national needs as well as a study concerned with the plastics industry in Iowa was identified. The study conducted by the Society of Plastics Industries and the Society of Plastics Engineers, which was concerned with the national needs related to the plastics industry, indicated that those companies with fewer than 250 employees had need for more skilled and semi-skilled workers. The study conducted in Iowa concluded that plastics education at the area vocational level could be of help in meeting the training needs of the plastics industry. Both of these studies have implications that pertain to the state of Utah.

CHAPTER III

RATIONALE AND ANALYSIS OF QUESTIONNAIRES

This study included the mailing and analysis of two questionnaires. In Chapter I, the section on method and procedures discussed the selection of industries and the acquisition of data. This chapter is devoted to the analysis of the two questionnaires.

The analysis of these questionnaires consists of two major parts:

1. The function of the various questions as they relate to the support of the objectives that form the foundation for the content of this report.
2. The representation of responses from industry.

First Questionnaire: Preliminary Identification

Function and rationale

The first questionnaire concerned itself with the first objective of this study--to identify the industries in the state of Utah that would be directly concerned with plastics education. Directly concerned was interpreted to mean those companies which employed or projected employment needs for plastics workers and which also expressed a need for plastics education. In order to identify these industries, three questions were asked:

1. Does your company employ personnel on a full or part-time basis as skilled or semi-skilled workers, in the manufacture or fabrication of plastics materials or products?

2. Do your company's projected plans include the hiring of skilled or semi-skilled plastics workers?

3. Does your company feel a need for employee training in the field of plastics? (See Appendix A)

The function of the first questionnaire was to determine the industries that should be included in the mailing of the second questionnaire. This determination was based on an a priori decision that only those companies would be included in the second mailing which had indicated present employment of personnel dealing specifically in a plastics function, or companies which would, in the future, require personnel trained in plastics functions. These companies must also have stated that they would require employee training in the field of plastics.

Response

The three questions of this questionnaire were presented in the following order:

1. Present employment of plastics personnel.
2. Projected employment of plastics personnel.
3. Need for training in plastics.

Each question was answered in a "yes" or "no" manner. Three combinations of answers indicated a company would be directly concerned with plastics education. Forty-one companies said "yes" to all three questions; four

companies said "no" to the first question but "yes" to the last two questions; and, six companies said "yes" to the first question and "yes" to the last question.

Table 3 shows a breakdown of the total responses to the first questionnaire. The first three columns indicate the responses of those companies which were classified as directly concerned and to whom the second questionnaire was sent.

Table 3. Preliminary identification of directly concerned industries

	Number Responding								Total
	41	4	6	18	4	7	0	165	235
Employ plastics personnel at present	Yes	No	Yes	No	Yes	Yes	No	No	
Projected hiring of plastics workers	Yes	Yes	No	No	Yes	No	Yes	No	
Need for plastics education	Yes	Yes	Yes	Yes	No	No	No	No	

Shaded area represents responses of those companies classified as directly concerned.

Second Questionnaire

The second questionnaire was concerned with all of the objectives of this study. Although it was not specifically designed to identify the plastics industries in Utah, several of the companies receiving this second

questionnaire found that they were not members of the plastics industry. The functions these companies performed were different than the functions performed by the plastics industry. In this respect, the second questionnaire more carefully identified those industries that are truly concerned with plastics. The best example to illustrate this point would be the mill cabinet shops. Several mill cabinet shops responded to the first questionnaire in such a manner as to be included in the mailing of the second questionnaire. However, when the functions and methods used by the plastics industry were more clearly identified, they determined that the application of high pressure laminates to counter tops and door faces did not fit into the spectrum of the various plastics functions but, rather, were considered to be a skill that should be mastered by the journeyman cabinet maker.

The fact that several companies were sent questionnaires, when the questionnaire did not really pertain to the needs of that company, accounts for the development that out of the 51 companies receiving the second questionnaire, only 29 are used in the tabulation of the data. Fourteen of the 22 companies not included in the study were eliminated for reasons similar to the reasons given for eliminating the mill cabinet shops. Of the eight remaining industries, four were contacted personally and elected not to respond to the second questionnaire. The other four were contacted twice by mail but did not respond.

Each question on the second questionnaire had a particular function in terms of meeting the objectives of the study. Each question is analyzed and discussed separately in relation to its function and response.

Question Number One

Please complete the following table:

	Total number of persons employed	Total number employed requiring skill and knowledge in plastics fabrication and/or processing
Now employed		
Expected to be employed within one year from now		
Expected to be employed five years from now		

Function and rationale

The first question concerned itself with the second objective of the study--to investigate the job opportunities for personnel trained in the field of plastics production in the state of Utah. In order to determine the extent of the various job opportunities, it was necessary to determine both the number of employees in the different companies and the number of personnel required to have skill and knowledge in plastics. Of additional interest was information concerning the companies' projected hiring plans, the projected growth of the industry, and the proportionate growth of the plastics functions or personnel within

these industries; these points were considered to be important factors in determining if job opportunities existed for personnel trained in this field.

Response

The first question consisted of three distinct parts concerning the employment of personnel. These parts included:

1. Present employment.
2. Expected employment within one year.
3. Expected employment in five years.

In order to simplify the analysis of these different parts, they will be analyzed separately.

The companies have been classified according to size by using their present total employment as the determinant of the classification. This classification will be the same, for any one company, throughout the analysis of this questionnaire. In the analysis of each part, the following information will be given:

1. The number of companies within each classification by company size.
2. The number of companies in each category responding to each portion of the question.

Part one. Every company responding to the second questionnaire answered the first part of the first question. The greatest majority of companies responding to this questionnaire have between one and 100 employees. This represents almost 90% of the total response.

By reducing the company size classifications into smaller categories, the greatest number of companies are represented in the one to nine employee category. As the size classification increases, the number of companies having the larger number of employees decreases as indicated in Table 4. The last category to contain more than one company is the 50 to 99 classification. All other classifications contain one company only. Although the last three classifications account for the greatest portion of the total employees, they do not necessarily account for the greatest number of employees working in the field of plastics at the present time. Table 4 provides a breakdown and analysis of the present total employment and present plastics employment of those companies responding.

Part two. Table 5 provides a breakdown of the projected total employment and its relationship to the projected plastics employment proposed for the next year. Even though the total number of employees indicated in Table 5 decreased from those listed as presently employed in Table 4, only 20 of the 29 industries used for this study responded to this question. Four company size categories indicated optimism towards total company growth, two did not predict growth in the immediate future, and one declined to answer. In regards to the number of plastics personnel employed, five of the seven categories indicated optimism towards expansion in this area, one company predicted no immediate growth and one declined to respond. Additional information can be obtained concerning the projected growth in one year by observing Tables 5 and 6.

Table 4. Company classification, percentage of response, and support of data as indicated by an analysis of present employment

	Company Size Classification						
	1-9	10-24	25-49	50-99	200-299	300-399	1600
Number of companies per classification	10	8	5	3	1	1	1
Percentage the classification represents of the total companies responding	34.4	27.6	17.2	10.3	3.5	3.5	3.5
Total personnel presently employed	40	134	171	165	225	350	1600
Percentage each classification represents of the total employment	1.5	5.0	6.4	6.2	8.4	13.0	59.7
Percentage of companies responding to the total employment question	100	100	100	100	100	100	100
Total plastics workers now employed per classification	19	81	48	123	119	15	25
Percentage each classification employs of the total plastics workers	4.4	19.0	11.2	28.7	27.9	3.5	5.8
Number of companies responding to the plastics employment question	8	8	4	3	1	1	1

Table 5. Analysis of projected employment--one year

	Company Size Classification						
	1-9	10-24	25-49	50-99	200-299	300-399	1600
Number of companies per classification	10	8	5	3	1	1	1
Total projected employment in one year	89	172	201	120	?	350	1600
Percentage each classification represents of the total projected employment in one year	3.5	6.8	8.0	4.7	0	13.8	63.2
Number of companies responding to the total projected employment question	8	6	5	2	0	1	1
Total projected employment of plastics workers in one year	47	88	68	140	?	17	25
Percentage each classification represents of the total projected plastics employment in one year	12.2	22.8	17.6	36.4	0	4.4	6.5
Number of companies responding to the projected plastics employment question	6	6	3	3	0	1	1

Table 6. Average employment and projected average employment in one year

	Company Size Classification						
	1-9	10-24	25-49	50-99	200-299	300-399	1600
Number of companies per classification	10	8	5	3	1	1	1
Total personnel presently employed	40	134	171	165	225	350	1600
Average employment for companies responding	4	19	34	55	225	350	1600
Total present plastics employment	19	81	48	123	119	15	25
Average plastics employment for companies responding	2.4	10.0	12	41	119	15	25
Expected total employment in one year	89	172	201	120	?	350	1600
Average expected employment in one year from companies responding	11	28.6	40	60	?	350	1600
Expected plastics employment in one year	47	88	68	140	?	17	25
Average expected plastics employment in one year for companies responding	7.8	17.5	22.6	46.6	?	17	25
Percent of projected average growth of plastics employment in one year for companies responding	225	75	88	13.6	?	13	0

The smaller companies indicated the greatest amount of optimism towards growth. The mean average of the number of personnel per company in the one to nine category is four men per company with an average of 2.4 plastics workers per company. The projected growth for these companies, with an 80 percent response on this portion of the question, more than doubled the present work force for the next year. If the average is again given for those companies responding, a total employment of 11 men per company is indicated. If the projected average is given for the number of plastics workers that will be required in one year, in the one to nine category, each company responding estimates a projected average need of eight workers who would be directly concerned with plastics. Sixty percent of the companies in this category responded to this portion of the question. Their responses indicate a growth of over 200 percent per company in the work area of plastics within the next year. Table 6 provides a summary of averages and expected growth with the next year as predicted by the various categories.

Part three. The response to the third portion of the first question, that portion which pertained to a five year projection of employment expectation, indicated that many of the industries anticipated continued growth. On both the prediction of total employment and the prediction of the number of plastics employees required, only 50 percent of the companies responded. In several cases, the number predicted was followed by a question mark, indicating that the reliability of the response is questionable.

Those responding to this portion of the question were generally optimistic and, although what seemed to be a significant increase in the total employment was indicated, the overall response indicating an increase in the total number employed requiring skill and knowledge in plastics fabrication and/or processing comprised a large portion of the expected total employment. With only 50 percent of the companies responding to this question and with three of the largest present employers of plastics workers not responding, the total expected growth indicated by these companies increased 50 percent over the present total employment of plastics workers. If only those companies who responded to both present and future employment are considered for this analysis, these companies have predicted a total growth of over 350 percent within the next five years. This growth exceeds the total employment of the plastics workers at the present time. The companies responding to this portion of the question represent less than one-third of the total plastics employment at present. Table 7 provides a summary of the responses to this portion of the first question.

Question Number Two

Does your company use thermoplastics _____ and/or thermosets _____ in the manufacture of its products?

Function and rationale

The second question of this questionnaire concerned itself with the objective--to determine the kinds and levels of skills required of employees

Table 7. Five year projected employment

	Company Size Classification						
	1-9	10-24	25-49	50-99	200-299	300-399	1600
Number of companies per classification	10	8	5	3	1	1	1
Total presently employed	40	134	171	165	225	350	1600
Projected employment in five years	141	295	520	100	?	400	?
Number of companies responding to the five year projected employment question	4	4	5	1	0	1	0
Plastics workers presently employed	19	81	48	123	119	15	25
Projected plastics employment in five years	148	214	148	85	?	20	?
Number of companies responding to the five year projected plastics employment question	5	4	3	1	0	1	0

in the plastics industries in the state of Utah. More specifically, it was the function of this question to help in the determination of the kinds of skills required by the various industries. By determining the proportion of usage of the various broad classifications of plastics, a determination of the direction in which the various industries have taken could be made. By knowing this direction, an indication of the emphasis that should be placed on various phases of training could be ascertained.

Response

There are three ways in which a company could respond to this question. They could indicate the use of either thermoplastics or thermosets or they could indicate the use of both thermoplastics and thermosets. Table 8 provides an analysis of the response to this question. The response indicated that there were 12 companies using thermosetting plastics and 20 companies using thermoplastics. Of these companies, only eight indicated the use of both thermoplastics and thermosetting plastics.

The size of the various companies seems to be related to the use of the various types of plastics. As shown in Table 8, there are more companies involved with thermoplastics than thermosets. By closer analysis, however, it can be seen that there are actually more plastics workers presently involved with thermosets than with thermoplastics.

The projected growth of the various companies must also be taken into consideration. As indicated, the companies most concerned with thermoplastics

Table 8. Comparison of the usage of thermoplastics and thermosets

	Company Size Classification						
	1-9	10-24	25-49	50-99	200-299	300-399	1600
Number of companies per classification	10	8	5	3	1	1	1
Number of companies responding to the question	7	4	5	3	1	1	0
Average number of plastics workers at the present	2.4	10	12	41	119	15	25
Number of companies requiring thermoplastics only	3	3	3	0	0	0	0
Number of companies requiring thermosetting plastics only	1	1	0	1	1	0	0
Number of companies requiring thermoplastics and thermosets	3	0	2	2	0	1	0

were those which presently employ from one to 50 employees. A review of Tables 5 and 6 will indicate that these three categories project a growth in one year that will bring these companies' employment to a level that represents over 50 percent of the total plastics employment of those companies responding to this study.

Question Number Three

In the list below, check the processes used in your company's manufacturing:

____Blow molding	____Thermoforming	____Foaming
____Compression molding	____Rotational molding	____Coating
____Transfer molding	____Casting	____Extruding
____Injection molding	____Laminating	____Calendering
____Reinforced plastics	____Fabricating	____Other

Function and rationale

This question, like the second question, was concerned with the kinds of skills required of employees in the plastics industries in the state of Utah. There are many processes performed by the plastics industry. The number of these processes that are represented in the state of Utah needed to be known in order to determine the training needs of the industries in the state. By knowing the processes employed in Utah, a general knowledge of the varieties of necessary skills could be acquired, and the extent to which

the different types of plastics were used in producing products could also be gained. The question also served as an identifier for those companies not responding to the second question.

Response

Every company contacted indicated that at least one of the processes listed was a function accomplished by their industry and every company responded to this question. The greatest number of processes performed by any one company was nine. This was accomplished by a repair facility which employed 60 workers having job functions dealing with plastics. As reported, the greatest number of processes performed per number of employees was accomplished by an industry which employs less than ten workers. This company listed eight processes as processes performed by the company.

The process which received the greatest endorsement from the various companies was fabricating. Most of the companies indicating a fabricating function also indicated some other type of process as being accomplished. For instance, several of the companies which dealt with the construction of signs also had a thermoforming capability.

Laminating was the process which drew the second largest response as to the number of companies accomplishing this function. There are two major classifications of the laminating process--high pressure lamination and low pressure lamination. Low pressure lamination includes such

processes as impregnating reinforcing materials (usually glass cloth or mat) with a resin. Thirteen of the 17 companies responding to this process classification also responded to the classification of reinforced plastics. This would suggest that the greatest majority of the laminating process was the low pressure type.

A substantial number of responses were received by several of the other processes--reinforced plastics, thermoforming and foaming. Both reinforced plastics and thermoforming were performed by 13 companies and foaming was performed by 12 companies. The number of employees these companies represent and, hence the importance of these processes, are summarized in Tables 9 and 10.

Every process listed on the questionnaire was identified as a function performed by at least one company. Of all the processes identified, calendering received the fewest responses. One company claimed to perform the calendering process. The processes which received the next fewest responses were transfer molding, rotational molding, and extrusion. Each of these processes received a response from two companies. Blow molding and compression molding received three and four responses respectively, and all other processes received seven or more responses from companies accomplishing these particular functions.

Since all of the companies contacted responded to this question, some indication of the types of plastics used could be gained from those companies which had not responded to the second question. By analyzing the processes

Table 9. Analysis of process utilization by number of companies, present employment, and projected employment[a]

Process	Number of companies concerned with process	Number of plastics employees in companies presently concerned with process	Number of companies indicating present employment	Projected employment within one year of companies presently concerned with process	Number of companies indicating employment in one year
Blow molding	3	7	2	18	2
Compression molding	4	75	4	79	3
Transfer molding	2	12	2	12	1
Injection molding	7	105	6	116	5
Reinforced plastics	13	333	12	263	9
Thermoforming	13	175	12	196	8
Rotational molding	2	29	2	37	2
Casting	7	119	7	149	6
Laminating	17	354	16	273	11
Fabricating	19	219	17	287	13
Foaming	12	179	10	230	7
Coating	7	95	6	105	3
Extruding	2	4	1	0	0
Calendering	1	1	1	0	0

[a]Number of employees in a company, both at present and future projection, does not indicate the number of personnel involved with any one process.

Table 10. Frequency distribution of processes performed as related to company size

	Company Size Classification							
	1-9	10-24	25-49	50-99	200-299	300-399	1600	Total
Blow molding	3	0	0	0	0	0	0	3
Compression molding	2	1	0	1	0	0	0	4
Transfer molding	1	0	1	0	0	0	0	2
Injection molding	2	2	1	1	0	1	0	7
Reinforced plastics[a]	2	3	3	3	1	0	1	13
Thermoforming[a]	4	3	3	2	0	1	0	13
Rotational molding	1	0	0	0	0	0	1	2
Casting	2	1	2	2	0	0	0	7
Laminating[a]	5	4	3	3	1	0	1	17
Fabricating[a]	7	4	5	2	0	0	1	19
Foaming[a]	5	3	1	3	0	0	0	12
Coating	3	2	1	1	0	0	0	8
Extruding	0	1	1	0	0	0	0	2
Calendering	1	0	0	0	0	0	0	1

[a] Indicates processes most commonly used.

being performed, the eight companies not responding to the second question can be classified in the following manner as to the type of plastics used. Three of the eight companies must use both types of plastics in order to perform the functions accomplished by their industry. Two of the companies use thermoplastics only. Three of the companies, because of the nature of the processes accomplished, cannot be classified because of insufficient information.

Question Number Four

Do you have vacancies at the present time that require workers who are knowledgeable in the field of plastics? Yes____ No____ If "yes," how many?____

Function and rationale

This question was an attempt to receive reliable data on the employment demand of the plastics industry. Criticism concerning the knowledge sought by vocational programs regarding the employment needs of the various industries for which these programs are training men has been expressed on page two. The function of this question was to furnish an opportunity for a reliable source, the companies, to provide data that would indicate the employment demand at the present time. This knowledge is related to the objective that pertains to the job opportunities for personnel trained in the field of plastics in the state of Utah.

Response

Eleven of the 29 companies responding to this question indicated present openings for workers who were knowledgeable in the field of plastics. Of these 11, nine indicated a specific number of workers they would hire if available. This number, collectively, totals 30 employees. One company indicated that it would only be interested in hiring personnel trained to a skilled or semi-skilled level in a particular processing area.

A review of Table 11 reveals that the company size is not a determinant of the number of vacancies presently available. There is not a significant difference between various company size classifications and the vacancies they claim to have open. This table also shows that the number of vacancies, if filled, would still not fill the vacancies these companies expect to have within the next year.

Table 12 presents a breakdown of the present vacancies as they relate to company size and processing functions. The number of vacancies indicated for the companies performing the various processes follow the same pattern that was encountered when classifying the utilization of the various processing techniques. As was indicated in the analysis of question number three, fabrication, laminating, thermoforming, reinforcing and foaming represent the processes that are performed to the greatest extent within the state. These same processes are those performed by companies which have indicated present vacancies for trained employees.

Table 11. Job vacancies per company size classification

	Company Size Classification						
	1-9	10-24	25-49	50-99	200-299	300-399	1600
Number of companies per classification	10	8	5	3	1	1	1
Companies presently having vacancies	2	4	3	2	0	0	0
Present total plastics employment for companies having vacancies	3	40	42	60	0	0	0
Vacancies per classification	5	12	6	7	0	0	0
Companies not indicating number of vacancies	0	1	0	1	0	0	0
Projected plastics employment in one year for companies presently having vacancies	3	40	60	75	0	0	0

Table 12. Plastics manufacturing processes performed by companies having job vacancies

Process	Company Size Classification				
	1-9	10-24	25-49	50-99	Total
Blow molding	1	0	0	0	1
Compression molding	0	1	0	0	1
Transfer molding	0	0	1	0	1
Injection molding	0	1	0	0	1
Reinforced plastics	1	2	2	2	7
Thermoforming	0	2	3	1	6
Rotational molding	0	0	0	0	0
Casting	0	0	2	1	3
Laminating	1	2	2	2	7
Fabricating	2	1	3	1	7
Foaming	1	2	1	2	6
Coating	1	2	1	0	4
Extruding	0	1	0	0	1
Calendering	1	0	0	0	1

Question Number Five

If short courses were available in plastics technology, would they be of value to your company? Yes____ No____

Function and rationale

The extent to which area vocational schools train personnel for a particular job is largely dependent on the amount of time that students spend in actual training. Area vocational schools are organized in such a manner as to admit high school students who usually attend a two or three hour block of time or full time students who have graduated from or left high school. The function of this question was to determine if courses that were shorter in length, compared to those courses that were extensive and of considerable depth, would be of benefit to the various companies.

Response

The response indicating the value of short courses for the various companies was almost totally positive. Only four out of the 29 companies responding indicated that they did not think short courses would be of value.

There were several additional comments made concerning this question. One company which indicated a positive response to this question stated that they would like to see courses directed towards the theoretical aspects of plastics. This company's needs, as was stated on the questionnaire, were

centered around their demand for foremen knowledgeable of many processes, and who could make decisions concerning the proper processes to use for new production items. Another company indicated that short courses would be of benefit only if they related to the processes that company was performing at the present time. One company that answered this question with a negative response indicated an interest in hiring only skilled or semi-skilled workers in one particular processing area. This company's response indicated that they did not think short courses would provide enough training to bring these students to a level of proficiency that would allow them to be classified as skilled or semi-skilled workers.

Question Number Six

If students were to receive training in a high school vocational program concerned with plastics, would your company be willing to pay higher wages for workers with this pre-employment training? Yes____ No____

Function and rationale

The acceptance or support of a program should be indicated by the willingness of the companies concerned to reimburse the personnel who have taken the time and expended the effort to train in that occupation. The function of this question was to determine if the companies responding were willing to pay personnel who had been trained in plastics at the high school level a higher wage than those persons who had not been trained in

plastics. By making this determination, it was thought that an indication would be present that would either support or deny the support of a need for plastics education for the plastics industries at the area vocational level in the state of Utah.

Response

Twenty-two of the 29 companies responding to this question responded in a positive manner. They would be willing to pay higher wages to workers who had received training in a high school program. Of the seven companies responding in a negative manner, five qualified their response by either writing a stipulation on the questionnaire or by expressing some type of condition when personally interviewed.

The stipulations that were expressed could be met in a vocational program. For instance, one company indicated that courses in general plastics were a beginning, but that training in a specific process was required before this company could justify paying higher wages. This company was interested in hiring skilled and semi-skilled workers, as was indicated by the response on a previous question. This company's response, although negative, would be positive if a vocational program were to provide adequate training in the particular process performed by this company. Another company indicated that the wages would not be higher than those trained on the job. The manner in which this statement was made suggested that personnel receiving high school vocational training would receive higher pay than those who did not

have training, but this company would not put the high school trained personnel on a higher wage scale than those trained on the job.

A method for determining the salary of personnel, for one facility contacted, was accomplished by testing; for this reason, the question received a negative response. The person completing the questionnaire for this facility stated that although high school training would not directly increase wages, it might provide sufficient background and knowledge to allow a person to score higher on the entrance test. This would allow a person to start at a higher rate of pay.

Question Number Seven

Would your company be interested in providing a representative to an advisory committee that would make recommendations concerning plastics education? Yes___ No___

Function and rationale

Although the functions and duties of advisory committees are expanded in some areas and limited in others, it can generally be said that advisory committees are used to implement the organization and administration of the vocational education program of Federal, state, and local levels (Roberts, 1965, p. 149). It is the duty of the various vocational programs to keep informed as to the needs and demands of the industries for which they are concerned. A method of obtaining this information is through the use

of an active and representative advisory group from the various industries the vocational program represents. The function of this question was to identify a representative group which would be interested in serving in an advisory capacity to develop a program that would delineate the needs expressed by the industry.

Response

Twenty-seven of the 29 companies responded to this question. Of those companies responding, 14 indicated a willingness to provide a representative to serve on an advisory committee. Thirteen companies declined the opportunity to provide this type of help.

The processes performed by the various companies which have indicated a willingness to provide advisory assistance has a high correlation with the representation of the major processes utilized within the state. Extrusion is the only process performed within the state in which a company was not interested in providing a representative to an advisory committee. Fabricating represented the process performed by the greatest number of companies willing to provide advisory help. Laminating, thermoforming, reinforced plastics, foaming, and all other processes were represented in proportion to their usage in the state.

Question Number Eight

This question asked the employer to indicate, by marking the proper box, the degree of skill that was important to the jobs performed by his

employees. See Appendix B for the question as written on the questionnaire.

Function and rationale

Once a knowledge of the various types of processes used within the state had been established, it was necessary to break down these processes to their more specific functions. This breakdown provided a more complete indication of the actual practice that was being accomplished within each broad process classification, and also provided a knowledge of the various levels of skills that were required by particular processing operations. It was the function of this question to provide a more accurate and detailed representation of the kinds and levels of skills required in this state.

Response

The total response to this question indicated that the skilled employee was the worker most in demand by the plastics industry in Utah. A compilation of the responses by the various industries shows that within the 29 companies responding to this question, 299 processing functions required skilled workers. Many of the processing functions are probably the same but performed by different companies.

The semi-skilled workers were the next most important in terms of demand. The total response indicated that there were 173 processing functions within these industries that required semi-skilled workers. Of

least importance, and significantly so, was the unskilled worker. The total processing functions that were said to be filled by this level of worker was only 40.

As the need for skilled, semi-skilled and unskilled workers is distributed into the company size classifications, it can be seen that with only one exception the categories show a greater need for skilled employees than the other skill levels. In only one company size category did the number of functions performed by semi-skilled workers exceed the number performed by skilled workers. This occurred in the ten to 24 employee classification. In all cases, the need for skilled and semi-skilled far exceeds the need for unskilled workers. Table 13 presents an overview of the number of functions performed by skilled, semi-skilled and unskilled workers.

In question three, questions were asked concerning the processes used by the various industries in the state. Eight of the processes for which information was sought consist of several methods by which the process can be accomplished. Question eight provided information as to which of these variations were used and it provided an indication of the skill level the companies required of the employee involved in the various processing techniques. The remaining analysis is concerned with the response to individual processes.

Table 13. Functions performed by skilled, semi-skilled and unskilled workers

	Company Size Classification							
	1-9	10-24	25-99	50-99	200-299	300-399	1600	Total
Skilled workers	86	51	81	27	21	16	17	299
Semi-skilled workers	39	68	36	22	0	7	1	173
Unskilled workers	8	6	21	5	0	0	0	40

Molding processes

Injection molding. Of the companies accomplishing molding processes, more companies indicated positions requiring skilled workers than the semi-skilled or unskilled worker. Within the molding processes, companies utilizing injection molding represent the greatest number of companies having job functions at the semi-skilled and unskilled levels. In all cases, those companies accomplishing the injection molding process which had job functions performed by unskilled workers also had job functions that required both semi-skilled and skilled workers. Only one company indicated that their injection molding process was accomplished by semi-skilled workers and no others. Two companies signified that the functions accomplished with injection molding were done by skilled personnel only and the remaining company required both skilled and semi-skilled as shown in Table 14.

Table 14. Molding processes--number of companies indicating degree of skill important to jobs performed

Process	Skill Level: Skilled only	Skilled semi-skilled	Semi-skilled only	Skilled semi-skilled unskilled	Companies responding
Transfer molding	0	0	1	1	2
Blow molding	2	0	0	0	2
Injection molding	2	1	1	3	7
Extrusion	0	1	0	0	1
Compression molding	3	1	1	1	6
Calendering	1	0	0	0	1
High pressure lamination	2	0	0	0	2

Transfer molding. Two companies signified positions existed within their company that required skilled, semi-skilled, or unskilled workers. One of the companies denoted that only semi-skilled workers were required to perform their transfer molding operation. The other company, however, indicated it needed workers at all levels as indicated in Table 14.

Compression molding. Of the five companies indicating a need for skilled workers for compression molding, three of the companies indicated

that this was the only level of worker required by their firm to perform this process. The two remaining companies which employed skilled workers signified that semi-skilled workers were also needed, and one indicated a need for unskilled workers. The only other company that performed the compression molding process suggested that semi-skilled personnel were necessary to execute their compression molding capability.

Reinforcing processes

Matched molds. Although the matched molding technique of producing reinforced articles assumes a position of lesser importance than the hand lay-up process and the spray-up process, it should be mentioned that all those companies utilizing the matched molding technique, without exception, are also involved with production capabilities in which the other forms of reinforcement are used. Three of the companies indicating the use of the matched molding technique denoted that only skilled workers could be utilized to accomplish this process within their company. One company suggested that positions for both skilled and unskilled workers were necessary to perform this function, while the remaining company only required semi-skilled workers as shown in Table 15.

Hand lay-up. All companies designating the reinforcing process as a production process for their company indicated that the hand lay-up process was one of the methods they utilized to achieve reinforcement. Only one company indicated that it was the only reinforcing process

Table 15. Reinforcing processes--number of companies indicating degree of skill important to jobs performed

Process	Skill Level						
	Skilled only	Skilled semi-skilled	Semi-skilled only	Skilled semi-skilled unskilled	Skilled unskilled	Unskilled only	Companies responding
Matched molds	3	1	1	0	0	0	5
Hand Lay-up	6	3	3	1	1	0	14
Spray-up	4	4	3	0	1	1	13
Filiment winding	1	0	0	0	0	0	1

process performed. The skilled employee was indicated as being most in demand. Six companies signified that the skilled employee filled all positions within the company where the utilization of the hand lay-up process was made. The five other companies showing positions for skilled workers disclosed the existence of other positions within their company. While only one company indicated positions within that company as being existent for skilled, semi-skilled, and unskilled workers, four of the companies signified that two levels of workers were needed. Of these four, three implied that both skilled and semi-skilled workers were necessary, and one suggested that only skilled and unskilled were needed. The three remaining companies accomplishing the hand lay-up process revealed that the positions within their companies concerned with hand lay-up were filled with semi-skilled workers. These facts are supported by Table 15.

Spray-up. Much like the hand lay-up process, the spray-up process was denoted as being performed mostly by skilled workers. Of the nine companies denoting positions for skilled workers, four stated that only positions for skilled workers were existent within their companies. Four other companies indicated that while positions for skilled workers existed, there was still a need for the semi-skilled worker. The remaining company showing a position for skilled workers indicated that unskilled workers were also employed by this company.

The remaining companies performing the spray-up process did not denote a need for skilled workers. Three of the four companies indicated

that the entire process of spray-up was carried out by semi-skilled workers; the other companies proposed that it was performed by unskilled workers.

Foaming processes

Foam in place. With the exception of one company, every company indicated the foaming process was performed by only one level of worker within any given company. All levels of skill are disclosed as positions existent within the companies presently performing the foam in place function. The one exception, that company indicating positions filled by more than one skill level, indicated that both semi-skilled and unskilled personnel were utilized by their company to perform the foam in place procedure. Table 16 summarizes the skill levels for the foaming processes.

Table 16. Foaming processes--number of companies indicating degree of skill important to jobs performed

Process	Skill Level			Number of companies responding
	Skilled	Semi-skilled	Unskilled	
Steam probe	0	0	0	0
Autoclave	0	0	0	0
Steam chest	0	0	0	0
Foam in place	5	6	3	13
Continuous process slab	0	0	0	0
Spray foam	1	2	1	3

Spray foam. The application of a foaming material by spraying is another process where agreement of the required skill level is not to be found. Of the three companies indicating positions in which functions concerned with spray application were to be found, one company indicated that skilled and semi-skilled workers were required; the second company revealed that only semi-skilled employees were needed; and, the third company suggested that only unskilled workers were needed.

Casting processes

An analysis of the response to the casting processes can easily be determined by observing Table 17. Only one process, simple casting, needs further explanation. The skill level required by the companies performing the various processes can be determined by comparing the number of companies responding to the various functions with the number of companies denoting positions in the various skill levels. See Table 17.

Table 17. Casting processes--number of companies indicating degree of skill important to jobs performed

Process	Skill Level			Number of companies responding
	Skilled	Semi-skilled	Unskilled	
Simple casting	2	5	1	6
Dip casting	1	1	0	2
Rotational casting	0	1	0	1
Slush casting	0	1	0	1
Encapsulating	1	1	0	2
Embedment	3	2	0	5

The seven companies utilizing simple casting as a production process most often indicated the semi-skilled level as providing the necessary work force to perform this process. Four companies revealed that this was the only level of worker concerned with simple casting. The two companies denoting that positions existed for skilled workers also signified that other levels of workers were necessary. One of these companies implied that semi-skilled workers were employed and the other company disclosed that unskilled workers were employed to perform this process.

Coating processes

Table 18 is entirely self-explanatory in describing the skill level requirements of those companies performing coating functions. Without exception, all companies performing a coating process designated only one skill level for which a position was filled in that company. Note that there was no indication of using unskilled employees for any function dealing with the coating processes.

Thermoforming processes

Three companies performed all of the functions listed under the thermoforming heading on the questionnaire. Three other companies performed all but one function. In two cases that function was blow forming. The other company did not accomplish matched die forming. Four companies listed only one process as being accomplished in the thermoforming classification.

Table 18. Coating processes--number of companies indicating degree of skill important to jobs performed

Process	Skill Level			Number of companies responding
	Skilled	Semi-skilled	Unskilled	
Painting	2	2	0	4
Dip coating	2	2	0	4
Fluidized Bed coating	2	1	0	3
Spread coating	3	1	0	4
Roller coating	2	3	0	5
Vacuum metalizing	0	0	0	0
Electro plating	0	0	0	0

Three of the four companies signified that vacuum forming was accomplished while the fourth company implied that plug and ring forming were done. The remaining four companies not yet discussed had one common element--all four indicated that vacuum forming was accomplished. Otherwise, the processes performed become diversified. Two companies perform matched die forming, two employ drape forming, and one accomplishes the vacuum snap-back process. See Table 19.

With the exception of two companies, all companies indicated the thermoforming procedure as being done by only one level of worker for that company. One exception to this revealed that both skilled and semi-skilled workers filled positions in the company that dealt with thermoforming, and this

Table 19. Thermoforming processes--number of companies indicating degree of skill important to jobs performed

Process	Skill Level: Skilled only	Skilled semi-skilled	Semi-skilled only	Unskilled only	Companies responding
Pressure forming (matched die)	3	1	3	0	7
Drape forming	4	1	3	0	8
Vacuum snap-back	6	1	0	0	7
Plug and ring forming	6	1	0	0	7
Vacuum forming	6	2	4	1	13
Blow forming	2	1	1	0	4

company indicated that all thermoforming functions listed were accomplished by that company. The one other company divulging a need for more than one level of skill for those workers concerned with thermoforming accomplished the vacuum forming process only. This company indicated that skilled and semi-skilled workers were necessary to perform this function.

Fabricating processes

Nineteen companies indicated on question number three that fabricating functions were accomplished by their industry. However, as the specific functions of fabrication were identified, additional companies saw fit to indicate that fabrication was a function performed by their industry. Twenty-four of the 29 companies responding to this question indicated that some function of fabrication was accomplished. Sawing, sanding, polishing and cementing represent the most prominent functions for which companies presently have positions relating to fabrication. Table 20 indicates the skill levels important to the jobs performed in the fabricating functions.

Related industrial areas

A determination of the related industrial areas as they concern the plastic processing techniques was not made. Methods of correlating the related areas with the plastics functions was not provided. The indications that are supplied furnish knowledge of the processes performed within the companies accomplishing production with plastic materials. Whether these related areas are directly related to the knowledge that is required of a plastics workers has not been determined.

The response by industries performing similar functions relating to plastics does not indicate that related functions in other areas are necessarily required. For instance, 14 companies indicated that hand lay-up

Table 20. Fabricating processes--number of companies indicating degree of skill important to jobs performed

Process	Skill Level					
	Skilled only	Skilled semi-skilled	Semi-skilled only	Unskilled only	Skilled semi-skilled unskilled	Companies responding
Machining	6	3	3	0	1	13
Sawing	9	2	6	2	1	20
Welding	4	0	3	0	1	8
Cementing	7	0	4	3	1	15
Heat sealing	3	0	3	2	0	8
Sanding	7	0	0	6	3	18
Polishing	8	1	5	2	1	17
Dielectric heat sealing	1	0	2	1	0	4
Ultrasonic welding	3	0	1	1	0	5

was accomplished within their industry. Of these 14, six signified that their company had functions performed within their company that related to the industrial area of metals. Eight indicated they did not have such a related area. With this same 14 companies, nine revealed that various drafting skills were required somewhere in their company; five did not so indicate. Twelve of the 14 companies indicated that various wood skills were required by personnel within their company, but only five companies of the 14 disclosed that printing and decorative trim processes were used by their company.

Problems arise in trying to establish if these areas mentioned above actually relate to the plastic processes. Twelve of the 14 companies accomplishing the hand lay-up process are also performing functions with foam. Perhaps the related processes mentioned above are performed in conjunction with the foaming processes; perhaps they have nothing to do with any plastics process. The same problems arise when trying to compare any of the specific plastic processes with the related processes. Information concerning the relationship between various related industrial areas has not been gained.

The related industrial areas seemingly occupy a position of significance in relation to their overall importance to the industries performing plastic functions. Twenty-four of the 29 companies responding indicated at least one of the related areas as being important to their company.

Combined, the related areas represent 130 of the 299 work areas filled by skilled workers and 53 of the 173 work areas filled by semi-skilled workers. The companies showing the levels of skills needed for the related areas suggested that those levels were almost exclusively at the skilled and semi-skilled levels. See Tables 21, 22, 23, and 24.

Table 21. Metals--skill levels for related industrial areas

Skill Area	Skill Level: Skilled only	Skilled Semi-skilled	Semi-skilled only	Skilled semi-skilled unskilled	Companies responding
Arc welding	8	0	3	0	11
Inert gas welding	5	0	2	0	7
Oxy-act. welding	6	0	2	0	8
Heat treating	2	0	2	0	4
Sheet metal	3	1	1	1	6
Lathe	9	1	1	0	11
Foundry	1	0	1	0	2
Milling machine	7	1	0	0	8
Shaper	3	1	0	0	4
Precision grinding	9	0	1	0	10

Table 22. Drafting--skill levels for related industrial areas

Skill Area	Skill Level: Skilled	Semi-skilled	Skilled Semi-skilled	Companies responding
Orthographic projection	3	1	1	5
Isometric drawing	4	3	0	7
Design	10	1	1	12
Blueprint reading	10	2	2	14
Sections	5	1	2	8
Sketching	8	4	0	12

Table 23. Wood--skill levels for related industrial areas

Skill Area	Skill Level: Skilled only	Semi-skilled only	Skilled semi-skilled	Unskilled only	Companies responding
Pattern making	10	4	0	0	14
Lamination	3	3	1	0	7
Machine operations	5	4	0	1	10

Table 24. Printing and decorative trim--skill levels for related industrial areas

	Skill Level				
Skill Area	Skilled only	Semi-skilled only	Skilled semi-skilled	Unskilled only	Companies responding
Hot stamping	2	1	0	1	4
Offset printing	4	1	0	0	5
Letterpress printing	2	1	0	0	3
Silk screen printing	4	0	2	0	6

CHAPTER IV

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Summary

Introduction

The growth of the plastics industry has led to an increase of training needs for the plastics industry. A study conducted by societies concerned with the plastics industry had indicated that education in the field of plastics was needed at all levels and in all states, even those states that have a minimum number of processors.

Current criticism of vocational education has been based on the fact that vocational educators and administrators have not adequately surveyed the labor market to determine the supply and demand of workers in the various job categories of the geographical area being served. This study surveyed the needs of the plastics industry in the state of Utah.

Problem and objectives

The problem identified was that a lack of knowledge existed concerning the need for plastics education in area vocational schools in the state of Utah. It was the writer's opinion that this knowledge would be enhanced by:

1. identifying the industries directly concerned with plastics education;

2. determining the job opportunities for personnel trained in the field of plastics;

3. discerning the kinds and levels of knowledge and skills required of employees working in this field; and

4. by developing a course of study that would be applicable to the plastics industry and area vocational schools in the state of Utah. These four points were the objectives of this study.

Procedure

A list of companies whose major function is plastics processing was obtained from the Directory of Utah Manufacturers. Additional companies were also identified if they were suspect of having any type of plastics processing function within their company. A questionnaire was sent to those companies identified to determine which companies were directly concerned with plastics education. In all, 454 companies were contacted.

Fifty-one companies responded to the first questionnaire in such a manner as to be classified as directly concerned with plastics education in the state of Utah. To these 51 companies, a second questionnaire was sent. The second questionnaire was designed to provide knowledge of the functions performed by the plastics industry in the state of Utah, the level

of skills required of the workers performing these functions, and the opportunities available for persons trained in the field of plastics. Forty-three companies returned the second questionnaire. Of the 43 returns, 29 could be used as questionnaires representative of the industries directly concerned with plastics education. These returns provided the information that was the foundation of the conclusions and recommendations that have been made.

Findings

1. Twenty-nine industries were identified as being industries directly concerned with plastics education.

2. The majority of companies concerned with plastics education were found to be in the Salt Lake City area.

3. A majority of the companies directly concerned with plastics education expect a growth in employment of plastics workers within the next year.

4. Over 30 vacancies are presently available to workers knowledgeable in the field of plastics.

5. Companies indicated that students receiving training in a high school vocational program concerned with plastics could expect to receive higher wages than those who do not receive training.

6. The number of companies performing functions with thermoplastics exceed the number using thermosetting plastics.

7. The number of personnel required to work with thermosetting plastics is presently greater than the number required to work with thermoplastics.

8. Fabricating, laminating, reinforced plastics, thermoforming and foaming were the processes accomplished by the largest number of processors within the state.

9. The skilled and semi-skilled worker were indicated as being in greatest demand in terms of the needs of the plastics industry as it is represented in the state of Utah.

10. Most plastics processing companies indicated that short courses in plastics technology would be of value to their company.

11. All major processing functions are accomplished to some extent within the state of Utah.

12. The companies responding to this questionnaire indicated that the methods they used to achieve the various major processing functions are diversified.

13. Companies completing all processing functions, with the exception of extrusion, have indicated a willingness to provide representatives for an advisory committee.

Conclusions

From the data collected and analyzed, the writer has made the following conclusions:

1. It was concluded that the 29 industries identified as being directly concerned with plastics education are representative of the number of plastics industries that would be expected to function in the types and sizes of communities found in Utah.

2. With the number of vacancies presently in existence, and with the projected growth taken into consideration, it is concluded that vocational training in the field of plastics in the state of Utah could be justified to a limited extent. Such training would be considered beneficial by the plastics industry in the state.

3. Based on the percentage of usage of the thermosetting and thermoplastic materials, it appears that skill and knowledge concerning either of these plastic classifications would be an asset to both the worker and the employer; skill and knowledge of both classifications are more desirable.

4. In terms of actual training for particular processes, the processes that should obtain the greatest emphasis are fabricating, reinforcing, thermoforming and foaming. These processes should not provide the total emphasis of the course, however. Other aspects of the plastics industry should be provided so that a well rounded curriculum is experienced.

5. Assistance from an advisory group should be readily available since the plastics industry, as represented in the state of Utah, is willing to provide advisory assistance in formulating a program that will meet their needs.

6. It is difficult for industries to predict their need for employees beyond one year; therefore, programs should be based on short range goals subject to annual evaluation.

7. The plastics industry in the state of Utah, much like the plastics industry throughout the nation, has its greatest need for workers at the skilled employee level; therefore, training should be aimed at providing the experiences necessary for the worker to approach this level of competency.

Recommendations

Based on the findings and conclusions, the writer makes the following recommendations:

1. A pilot program at the secondary level to train personnel in the area of plastics should be initiated by those agencies concerned with vocational education in the state of Utah.

2. It is recommended that the division of vocational education at the state level designate a school in the Salt Lake area to initiate a plastics program, and assist the school in formulating an advisory committee to express further the needs for training in specific areas and to review any curriculum before implementation.

3. The course outline for personnel training in the field of plastics should follow the basic curriculum as outlined in Chapter V. This curriculum is based on the needs of the plastics industry as it presently exists in the state of Utah. The course content should change as the industry progresses in the state and the offerings should be based on the types of experiences that will allow the student to proceed to the skilled or semi-skilled level of competency.

4. It is recommended that a study be conducted within two years to determine if the plastics industry has grown as predicted and to determine if any shift has occurred as to the importance of the various processing functions.

5. Upon implementation of a program, follow-up studies should be conducted to determine the success of personnel trained in a vocational plastics program to obtain employment and to work effectively in this field.

CHAPTER V

SUGGESTED COURSE OUTLINE

Introduction

This suggested course outline for an educational program to train personnel to a degree of competence in the field of plastics has been developed to assist in meeting the needs of the plastics industry as it is represented in the state of Utah. The course outline has been prepared to aid the planning and development of programs at area vocational schools. The emphasis of the outline is directed towards courses which pertain explicitly to plastics.

Realizing that a student attending area vocational schools is doing so on a limited basis, usually two or three hours a day being spent in vocational classes, this course outline has been developed to provide the maximum exposure to the most critical areas as seen by the plastics industry within the state. As a convenient breakdown, the school year has been arbitrarily divided into eight segments, and the courses suggested are spread over a two-year period. The philosophy this writer has maintained throughout the development of this outline has been one of providing saleable skills as soon as possible, not just when the entire curriculum has been completed. As the courses progress, the technicality

as well as greater familiarity with a variety of techniques will increase.

Objectives of the suggested program

This outline is designed to assist the instructor in planning the course content for a plastics training program. The broad objectives of the following outline are identified as follows.

Broad objectives.

1. To encourage the development of occupational competency and high standards of workmanship.

2. To encourage the development of reliable workers and good citizens.

3. To foster students' understanding of the functions and functional relationships of jobs in the plastics industry.

Goals of the suggested program

As this program is designed to meet the needs of the student, there are at least four major goals which can be identified as follows:

1. Upon the completion of the course the student will have developed the fundamental skills associated with the production of plastic commodities.

2. Upon the completion of the course the student will understand and exercise safe methods of work performance.

3. Upon completion of the course the student will demonstrate a knowledge of the importance of accuracy and the use of standards in production.

4. Upon completion of the course the student will have acquired, through demonstration and practice, an understanding of the use and care of equipment and materials.

The extent to which these goals are met shall be determined as the needs and capabilities of the individual student are recognized.

Suggested course outline

Training courses in plastics vary in content and method of operation. This course outline is not meant to be a limiting factor as to what is or is not taught. The rationale for the emphasis on the various areas is derived from a study that was conducted which concerned the plastics industry in the state of Utah. It is not the intent of this course outline to limit or define in absolute terms what should or should not be included in a plastics program. To implement a program that will meet the needs of the students and the employers of those persons participating in such a program, the school putting such a program into effect should be cognizant of their needs as they exist at that time. This outline is constructed to help meet the needs of the plastics industry as it presently exists (1971) in the state of Utah. As the needs change, new areas should be added and those areas which become less significant should be deleted. The program should be in a constant state of change as industry continues to change.

Basically, the program suggested is broken down into eight major phases. Each phase is designed to be taught for one-half of a semester

period; however, fixed times are not essential. Mastery of the material by the individual should be the determining factor as to when the next phase of instruction is attempted. The major phases of instruction include the following:

1. Introduction to plastics
2. Fabrication of plastics materials
3. Reinforced plastics
4. Thermoforming
5. Molding thermoplastics
6. Molding thermosetting plastics
7. Casting, coating, and foaming
8. Related industrial areas.

Each of the phases of instruction are discussed below. For this discussion, an introduction is provided for each phase as well as general curricular objectives. A course outline follows the curricular objectives. This outline is divided into two parts: part one for each phase is concerned with the essential learning (skill and knowledge) that should take place; and, part two is concerned with the scope of instruction (suggested content).

Phase 1. Introduction to Plastics

Introduction

An introduction to plastics is provided to allow the student to become familiar with the opportunities in the plastics industry, to become conversant

with terms that are commonly used or are unique to the field of plastics, and to become basically familiar with the materials and techniques that pertain to the plastics industry. This phase of instruction provides a comprehensive overview of the safety considerations, terminology, materials, and processes used within the industry.

General curricular objectives

Upon completion of Phase 1, Introduction to Plastics, the student will:

1. Be capable of discussing and relating to his own needs and interests the various opportunities that exist in the field of plastics.

2. Demonstrate knowledge of the basic structure and properties of thermoplastics and thermosetting plastics.

3. Exhibit understanding by performing functions dealing with the major molding, forming and casting processes and explaining how they relate to material and economic considerations.

4. Be conversant with terms that are commonly used or are unique to the field of plastics.

5. Exhibit safe working habits in the use of materials and equipment.

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
Opportunities in the plastics industry	Areas to which plastics are making inroads. Plastics impact on:

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	Automotive industry Appliances Construction Transportation Packaging Aerospace Leisure equipment
	Growth of the industry. Employment possibilities: Opportunities in the local community Opportunities in the state Opportunities in the nation
Characteristics and properties of plastics	Thermosetting plastics Structure of thermosets Plastics within classification Thermal properties Physical properties Chemical properties Electrical properties
	Thermoplastics Structure of thermoplastics Plastics within classification Thermal properties Physical properties Chemical properties Electrical properties
Basics of plastics production processes	Purpose, operation and use of: Blow molding Calendering Casting Coating Compression molding Extrusion Fabrication

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	Foaming Injection molding Laminating Reinforcing Rotational molding Thermoforming Transfer molding
Safety in the production facility	Basic principles of safety related to all phases of plastic production
	Correct attitude towards safety
	Unsafe acts: Failure to follow instructions Improper use of equipment Failure to control temper Misconduct
	Unsafe conditions: Allowing floors to remain wet Obstructed work aisles Badly located equipment Exposed elements or electrical wires
	Methods of eliminating accident hazards: Personnel training Engineering revision
	First aid procedures: Minor cuts Bruises Burns
	Artificial respiration

Phase 2. Fabrication of Plastic Materials

Introduction

The fabrication of plastic materials assumes an important position in the training of personnel within the state of Utah. Whereas many specific processes are performed by the various industries in the state, fabrication of some type is performed by almost every company involved in the study which forms the basis of this suggested outline. This phase of instruction should provide for an in-depth study of the various methods of cutting, joining, and finishing plastics.

General curricular objectives

Upon completion of Phase 2, Fabrication of Plastic Materials, the student will:

1. Be able to set up and operate the various pieces of equipment necessary to perform fabricating functions.

2. Be capable of determining the types of fabricating functions that can be performed on the varieties of plastic materials.

3. Demonstrate the proper use of the various cutting, joining and finishing techniques.

4. Perform functions involving the design, set-up and use of jigs and fixtures for fabricating processes.

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to use, manipulate and care for:	Purpose, operation and use of:
Standard hand tools	Measuring and layout tools
	considerations explicit to plastics care and maintenance of equipment safety considerations operating procedures
	Scrapers and files
	considerations explicit to plastics care and maintenance of equipment safety considerations operating procedures
Standard power tools	Band saw, Jig saw, Circular saw, Router, and Shears
	considerations explicit to plastics care and maintenance of equipment safety considerations operating procedures
	Buffers and Belt and Disc sanders
	considerations explicit to plastics care and maintenance of equipment safety considerations operating procedures
	Gauges and Flame polishing equipment
	considerations explicit to plastics care and maintenance of equipment safety considerations operating procedures
	Drill press, Engine lathe, and Milling machines
	considerations explicit to plastics care and maintenance of equipment

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	safety considerations operating procedures
Plastic tools and equipment	Heat Sealers
	care and maintenance of equipment safety considerations operating procedures
	Hot Gas Welder
	care and maintenance of equipment safety considerations operating procedures
	Ultrasonic Welder
	care and maintenance of equipment safety considerations operating procedures
	Dielectric Heat Sealer
	care and maintenance of equipment safety considerations operating procedures
How to join plastics	Cohesive joining method:
	Solvent Cementing
	application evaluation
	Heat Sealing
	application evaluation
	Hot Gas Welding
	application evaluation

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	Ultrasonic Welder application evaluation Dielectric Heat Sealers application evaluation Adhesive joining methods: Types of adhesives Application Evaluation Mechanical joining methods: Types of fasteners Application Evaluation
How to cut plastics	Sawing and Routing plastics Applications Special design considerations Problems and solutions Shearing plastics Applications Special design considerations Problems and solutions Drilling plastics Applications Special design considerations Problems and solutions

Phase 3. Reinforced Plastics

Introduction

The reinforcing process is one of major concern and a primary processing technique to those companies in the state of Utah which are performing functions dealing with plastics. As a result, it is also of importance to those individuals interested in becoming proficient in jobs related to the plastics industry in the state. Several major techniques have been identified as methods of accomplishing the reinforcing process. These techniques not only are representative of the processes that are utilized in Utah, they are also representative of the standard processes used throughout the nation. Basically, this phase of instruction is dealing with those processes that would also be considered as low pressure lamination. Other processes that are out of this category, but are still considered as reinforcing processes, are to be found in other sections of this program structure. For example, high pressure lamination is covered in the phase concerned with molding thermosetting plastics.

This phase of instruction provides an in-depth study of the reinforcing processes including methods of reinforcing, preparation and construction of molds, properties of reinforced products, and care and maintenance of equipment.

General curricular objectives

Upon completion of phase 3, Reinforced Plastics, the student will:

1. Be able to select the proper reinforcing technique to obtain pre-determined characteristics in a desired product.

2. Be capable of constructing and preparing molds to perform the various reinforcing processes.

3. Demonstrate proficiency in the care and maintenance of materials and equipment necessary to the reinforcing process.

4. Perform functions involving the set-up and use of the various reinforcing processes.

5. Exhibit safe working habits in the use of materials and equipment.

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to use, manipulate and care for:	Purpose, operation, use and care of:
Tools	Hand tools
Equipment	rollers squeegees brushes scrapers and files saws and knives
	Power tools
	sanders grinders saws buffers
	Reinforcing equipment

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	spray units vacuum pumps pressure pumps chopper guns filiment winding units
How to produce reinforced products: Hand lay-up Bag molding Spray-up Matched molds Filiment winding	Preparation of molds: Cleaning molds Application of mold releases Application of resins and reinforcing materials Gel Coats types preparation application Resins types preparation application Reinforcing types preparation application Removal of part and final trim Methods of removal Methods of trim

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to construct molds for producing reinforced products	Design and construction using various mold materials
	Wood
	design considerations
	applications
	limitations
	construction
	use
	Plaster
	design considerations
	applications
	limitations
	construction
	use
	Plastic
	design considerations
	applications
	limitations
	construction
	use

Phase 4. Thermoforming

Introduction

With the sophistication incorporated into present day machinery and thermoforming techniques, the thermoforming process is assuming a position of importance throughout the nation. The importance of this process in the state of Utah, although much higher than the importance on a national scale, has determined that this process should receive a

significant amount of attention. This phase of instruction provides for an in-depth study of the various thermoforming production techniques utilized, problems related to materials and processes, construction of molds, and the care and maintenance of materials and equipment.

General curricular objectives

Upon completion of Phase 4, Thermoforming, the student will:

1. Be able to set up and operate the various pieces of equipment necessary to perform thermoforming functions.

2. Be capable of selecting the proper plastic materials to use in accomplishing the various thermoforming techniques.

3. Be able to select the proper thermoforming technique to obtain pre-determined characteristics in a desired product.

4. Be capable of constructing molds to perform the various thermoforming processes.

5. Demonstrate proficiency in the care and maintenance of materials and equipment necessary to the thermoforming processes.

6. Exhibit safe working habits in the use of materials and equipment.

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to use, manipulate and care for equipment	Purpose, operation, use and care of: Heating devices types controls and indicators safety considerations

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	Pumps
	Vacuum
	types regulating devices gauges and indicators safety considerations
	Pressure
	types regulating devices gauges and indicators safety considerations
	Thermoforming presses
	types operating considerations regulating devices safety considerations maintenance
How to produce thermoformed products	Selection of process
	Plastic distribution characteristics Design considerations Economic considerations
Vacuum forming Pressure forming Drape forming Vacuum snap-back	
Plug and ring forming Blow forming Slip-ring forming	Tool and process variables
	Preparation and mounting of tools
	Types of equipment
	Application of pressures
	vacuum blow mechanical combinations

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	Trimming operations
How to construct molds for producing thermoformed products	Design and construction of molds:
	Wood
	design considerations applications limitations construction
	Plaster
	design considerations applications limitations construction
	Plastic
	design considerations applications limitations construction
Care and maintenance of molds	Metal
	design considerations applications limitations construction

Phase 5. Molding Thermoplastics

Introduction

Injection molding, blow molding, calendering, and extrusion represent those processes considered as molding processes for thermoplastics. As

such, these processes represent processes by which the majority of thermoplastics materials are processed in the United States. Although these processes are not accomplished to a great extent in the state of Utah, personnel trained in plastics would be at a distinct disadvantage if some background were not provided in the molding processes. To acknowledge the mobility of our present society, and at the same time limit a vocational program to only those functions accomplished in the immediate geographical area, would be a shortcoming of the vocational program.

General curricular objectives

Upon completion of Phase 5, Molding Thermoplastics, the student will:

1. Be capable of operating the various types of thermoplastic molding equipment available to him.

2. Perform functions involving the set-up and use of the various thermoplastic molding equipment.

3. Demonstrate proficiency in the basic care and maintenance of materials and equipment necessary to the thermoplastic molding process.

4. Be capable of discussing the advantages and disadvantages of the various basic types of molding equipment.

5. Exhibit safe working habits in the use of materials and equipment.

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to operate and care for thermoplastic molding equipment	Principles of operation
	Types of equipment Advantages and disadvantages
Injection molders Extruders Calendering equipment Blow molding equipment	Set-up and operation of equipment
	Energizing heat sources, power drives, and take-off equipment
	Basic adjustments
	pressures heats take-off equipment cooling devices time cycles trimming devices
	Production operating procedures and adjustments
	mold and die set-up installation and operation of:
	cooling and heating devices mandrels and afterforming devices ejection devices trimming apparatus
	Care of equipment
	Preventative maintenance
	Cleaning and purging processes
	equipment compounds
	Mold and die removal and care

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to operate and care for ancillary thermoplastic molding equipment	Principles of operation and maintenance
	Weighing equipment
	types of equipment process considerations set-up and operation maintenance procedures
	Blending equipment
	types of equipment process considerations set-up and operation maintenance procedures
	Hopper Loaders
	types of equipment process considerations set-up and operation maintenance procedures
	Ovens and Driers
	types of equipment process considerations set-up and operation maintenance procedures
	Scrap Grinders
	types of equipment process considerations set-up and operation maintenance procedures
	Gate Cutters
	types of equipment process considerations set-up and operation maintenance procedures

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	Insert Feeders types of equipment process considerations set-up and operation maintenance procedures
How to select materials for the various processes	Material characteristics as related to: Extrusion primary materials ancillary materials Calendering primary materials ancillary materials Injection Molding primary materials ancillary materials Blow Molding primary materials ancillary materials

Phase 6. Molding Thermosetting Plastics

Introduction

Compression molding, transfer molding, and high pressure lamination represent those processes considered as the basic molding processes for thermosetting plastics. These processes represent the methods by which

the majority of thermosetting plastics are processed in the United States. For this reason, these processes are important for the plastics worker to know. As stated earlier, the geographical area should not be the sole determinant as to whether certain phases of a given occupation are provided. Although these processes are accomplished by industries in the state of Utah, and this is justification for providing training in this area, a more stable justification might be obtained from the degree of importance these processes have in relation to the total plastics industry throughout the nation. Personnel trained in plastics would again be at a distinct disadvantage if some background were not provided in the thermoset molding processes.

General curricular objectives

Upon completion of Phase 6, Molding Thermosetting Plastics, the student will:

1. Be capable of operating the various types of thermoset molding equipment available to him.

2. Perform functions involving the set-up and use of the various thermoset molding equipment.

3. Demonstrate proficiency in the basic care and maintenance of materials and equipment necessary to the thermoset molding process.

4. Be capable of discussing the advantages and disadvantages of the various basic types of molding equipment.

5. Exhibit safe working habits in the use of materials and equipment.

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to operate and care for thermoset molding equipment.	Principles of operation
Compression molders Transfer molders High pressure laminating equipment	Types of equipment Advantages and disadvantages
	Set-up and operation of equipment
	Energizing heat sources, power drives, and take-off equipment
	Basic adjustments
	pressures heats take-off equipment cooling devices time cycles trimming devices
	Production operating procedures and adjustments
	mold set-up
	installation and operation of:
	cooling and heating devices ejection devices
	Care of equipment
	Preventative maintenance
	Cleaning and purging processes
	equipment compounds
	Mold removal and care

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to operate and care for ancillary thermoset molding equipment	Principles of operation and maintenance
	Pre-forming or pelleting machines
	types of equipment process considerations set-up and operation maintenance procedures
	Preheaters
	types of equipment process considerations set-up and operation maintenance procedures
	Ejector Mechanisms
	types of equipment process considerations set-up and operation maintenance procedures
	Cooling Jigs
	types of equipment process considerations set-up and operation maintenance procedures
	Loading Fixtures
	types of equipment process considerations set-up and operation maintenance procedures
	Valve Systems and Piping
	types of equipment process considerations set-up and operation maintenance procedures

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to select materials for the various processes	Material characteristics as related to:
	Compression molding
	primary materials ancillary materials
	Transfer molding
	primary materials ancillary materials
	High pressure lamination
	primary materials ancillary materials

Phase 7. Casting, Coating and Foaming

Introduction

Casting, coating and foaming functions are accomplished by industries primarily concerned with plastics products, as well as industries that have only a limited need for the processes dealing with plastics. Generally speaking, this phase of the plastics industry, as it is accomplished in the state of Utah, requires very few special pieces of equipment. Knowledge concerning the characteristics of the various materials involved, as well as skills and knowledge concerned with the pieces of standard equipment, would be beneficial to the workers in a variety of areas.

General curricular objectives

Upon completion of Phase 7, Casting, Coating, and Foaming, the student will:

1. Be capable of operating the various types of equipment necessary to perform the various casting, coating and foaming processes.

2. Perform functions involving the set-up of the various pieces of necessary equipment.

3. Demonstrate his ability in preparing and constructing molds to perform the casting and foaming processes.

4. Demonstrate proficiency in the basic care and maintenance of materials and equipment to the casting, coating and foaming processes.

5. Exhibit safe working habits in the use of materials and equipment.

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to select materials for the casting process	Material characteristics Casting resins and materials physical properties chemical properties thermal properties electrical properties
How to set-up, operate and maintain casting processes and equipment Simple casting Dip casting Rotational casting Slush casting Encapsulating Embedment	Preparation of molds Cleaning procedures Types and application of mold releases Operating procedures for various casting processes Applications

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	Types and operation of equipment Loading materials Removal of parts Safety considerations Care and maintenance of equipment
How to construct molds for producing cast products	Design and construction using various mold materials
	Flexible molds
	material variations design considerations applications limitations construction use and care
	Molds by electrodeposition
	design considerations applications limitations construction use and care
	Sprayed metal molds
	design considerations applications limitations construction use and care
How to set-up, operate and maintain coating processes and equipment	Preparation of materials for coating
	Cleaning procedures Types and application of primers Selection and preparation of coating materials
Painting Dip coating Fluidized bed coating Spread coating Roller coating	Operating procedures for various coating processes

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
	Applications Types and operation of equipment Safety considerations Care and maintenance of equipment
How to set-up, operate and maintain foaming processes and equipment Foam in place Spray foam	Selection of foaming materials Types Characteristics and properties Preparation of molds Cleaning procedures Types and application of mold releases Operating procedures for various foaming processes Applications Types and operation of equipment Measuring and loading materials Removal and/or trim of parts Safety considerations Care and maintenance of equipment
How to construct molds for producing foamed products	Design and contruction using various mold materials Flexible molds material variations design considerations applications limitations construction use and care Wood and other rigid materials design considerations applications limitations construction use and care

Phase 8. Related Industrial Areas

Introduction

Very few occupations, if any, are based strictly on processes or techniques that are entirely unique to that area. There are usually many related areas that can be applied in order to achieve a better understanding and ability to perform well in a specific area. Personnel concerned with the techniques utilized to perform plastics processing functions are not an exception to this. Knowledge and basic understandings of numerous related subjects would be of benefit in making the plastics worker more effective. The subsequent suggestions for related processes could be expanded to a large extent. Obviously, with only limited time available, the degree of skill that will be attained by the student will also be limited. For this reason, this phase of instruction is designed only as an introduction to the various related areas that have been assigned some importance by industries involved in plastics production in the state of Utah.

General curricular objectives

Upon completion of Phase 8, Related Industrial Areas, the student will:

1. Be capable of making basic set-ups on equipment that is related to the production processes.

2. Demonstrate an understanding of the related processes by being able to discuss the basic ramifications that are involved in performing these processes.

3. Be capable of discussing the relationships between the related processes and the major plastics production processes.

4. Exhibit safe work habits in the use of related materials and equipment.

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to set-up, operate and maintain related metal processes	Principles of operation
	Types of equipment
Welding processes	welding-arc, oxy-act, inert gas
Machining processes	machine-lathes, mills, shapers, grinders
Fabricating processes	fabrication-sheet metal, bench work
	Advantages and disadvantages
	Process considerations
	Set-up and operation of equipment
	Basic adjustments
	Operating procedures
	Safety considerations
	Care and maintenance of equipment
How to read and construct pictorial representations	Drafting equipment
	Types of equipment
Sketching	Principles of operation
Orthographic projections	
Isometric drawings	Drafting principles and techniques
Blueprints	
Sectional views	Basic constructions
Designs	Dimensioning
	Reading drawings and blueprints

Essential Learning (skill and knowledge)	Scope of Instruction (suggested content)
How to set-up, operate and maintain printing and decorative trim processes	Principles of operation
	Types of equipment
	Advantages and disadvantages
Hot stamping	Process considerations
Offset printing	Applications
Letterpress printing	
Silk screen printing	Set-up and operation of equipment
	Basic adjustments
	Operating procedures
	Safety considerations
	Care and maintenance of equipment

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APPENDIXES

Appendix A

First Questionnaire and Letter of Request

T. H. BELL
Superintendent

DIVISION OF
RESEARCH AND INNOVATION

ROWAN C. STUTZ
Administrator

TAH STATE BOARD OF EDUCATION

0 UNIVERSITY CLUB BUILDING • 136 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

January 30, 1970

Dear Sir:

Your answers to three brief questions on the enclosed card will be very helpful in identifying training needs in the state of Utah. This identification is a portion of a study that is being conducted by the Industrial and Technical Education Department at Utah State University in cooperation with the Research Coordinating Unit for Vocational and Technical Education, a unit of the State Department of Education.

The study is being conducted to determine the number of Utah industries that are concerned with the field of plastics, and to determine the industrial needs for trained personnel in the field of plastics. The questionnaire is to determine if your company should be contacted for additional information. The additional information sought will be concerned with your needs; your needs must be known so that the proper instructional programs can be developed to provide knowledgeable workers for various manufacturing operations.

Your cooperation is desired in completing the enclosed card and returning it at your earliest convenience. Thank you for your consideration.

Sincerely,

Austin G. Loveless

Dr. Austin G. Loveless
Associate Director
Utah Research Coordinating Unit

Denis A. Potter
Industrial & Technical Education
Utah State University
Logan, Utah 84321

Does your company employ personnel on a full or part-time basis as skilled or semi-skilled workers in the manufacture or fabrication of plastics materials or products?
Yes_____ No_____ If "yes," how many?_____

Do your company's projected plans include the hiring of skilled or semi-skilled plastics workers?
Yes_____ No_____ If "yes," how many?_____

Does your company feel a need for employee training in the field of plastics?
Yes_____ No_____

Who may be contacted for additional information?
(optional)_____

Appendix B

Second Questionnaire and Letter of Request

T. H. BELL
Superintendent

DIVISION OF
RESEARCH AND INNOVATION

ROWAN C. STUTZ
Administrator

TAH STATE BOARD OF EDUCATION

00 UNIVERSITY CLUB BUILDING • 136 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

February 20, 1970

Your company has indicated a need for trained employees in the field of plastics.

A study is being conducted to determine the kinds and levels of skills required of employees in the plastics industries in the state of Utah, and to investigate the job opportunities for personnel trained in the field of plastics production.

Your cooperation is requested in completing the enclosed questionnaire and returning it by March 5, 1970. The information contributed by your company will be a valuable contribution to the study. The information gained will be used to develop a course of study by which area vocational schools can provide training that will meet the needs of the plastics industries in the state of Utah.

This study is being conducted by the Industrial and Technical Education Department at Utah State University in cooperation with the Research Coordinating Unit for Vocational and Technical Education, a unit of the State Department of Education.

All information will be confidential; comparisons of named industries will not be made. A summary of the findings will be sent to all participants.

Thank you for your assistance and cooperation in making this study complete.

Sincerely,

Dr. Austin G. Loveless
Associate Director
Research Coordinating Unit

Denis A. Potter
Industrial and Technical Education
Utah State University
Logan, Utah 84321

Enc.

1. Please complete the following table:

	Total number of persons employed	Total number employed requiring skill and knowledge in plastics fabrication and/or processing
Now Employed		
Expected to be employed within one year from now		
Expected to be employed five years from now		

2. Does your company use thermoplastics ___ and/or thermosets ___ in the manufacture of its products?

3. In the list below, check the processes used in your company's manufacturing:

____ Blow molding	____ Thermoforming	____ Foaming
____ Compression molding	____ Rotational molding	____ Coating
____ Transfer molding	____ Casting	____ Extruding
____ Injection molding	____ Laminating	____ Calendering
____ Reinforced plastics	____ Fabricating	____ Other _____

4. Do you have vacancies at the present time that require workers who are knowledgeable in the field of plastics?

   Yes _____ No _____ If "yes," how many? _____

5. If short courses were available in plastics technology, would they be of value to your company?

   Yes _____ No _____

6. If students were to receive training in a high school vocational program concerned with plastics, would your company be willing to pay higher wages for workers with this pre-employment training?

   Yes _____ No _____

7. Would your company be interested in providing a representative to an advisory committee that would make recommendations concerning plastics education?

   Yes _____ No _____

8. On the reverse side are boxes in which you should indicate the degree of skill that is important to the jobs performed by an employee in your plastics department.

   Please be certain to mark all job categories, if the job category does not apply to your company, mark NOT APPLICABLE.

   If more than one level of skill is required for any given area, mark as many boxes as is appropriate.

Appendix C

Follow-up Letters

T. H. BELL
Superintendent

DIVISION OF
RESEARCH AND INNOVATION

ROWAN C. STUTZ
Administrator

TAH STATE BOARD OF EDUCATION

00 UNIVERSITY CLUB BUILDING • 136 EAST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84111

February 13, 1970

Dear Sir:

Two weeks ago a letter was mailed to your company concerning your needs for trained personnel in the field of plastics. Perhaps you didn't receive it. It requested that you fill out a brief questionnaire, a duplicate of which is enclosed in this letter. The study is being conducted to determine the number of Utah industries that are concerned with the field of plastics.

It is possible that your company does not deal with plastics--this information is as important as if you do. The trends and needs of industry must be known so that the proper manpower training takes place.

This identification is a portion of a study that is being conducted by the Industrial and Technical Education Department at Utah State University in cooperation with the Research Coordinating Unit for Vocational and Technical Education, a unit of the State Department of Education. Your cooperation is desired in completing the enclosed card and returning it at your earliest convenience.

Thank you for your consideration.

Sincerely,

Austin G. Loveless

Dr. Austin G. Loveless
Associate Director
Utah Research Coordinating Unit

Denis A. Potter
Industrial & Technical Education
Utah State University
Logan, Utah 84321

March 6, 1970

Two weeks ago you should have received a questionnaire concerning your needs for trained personnel in the field of plastics. Perhaps, due to some error on our part, you did not receive it. Since you have indicated a need for employees trained in the field of plastics, we are certain you would want to make known your specific needs in this area.

Enclosed is a duplicate of the questionnaire. Originally, March 5, 1970, was the cut-off date for receiving the return of these questionnaires, but we have not received a response from you and several other companies. Your response is extremely important; a complete and accurate determination of the needs of the plastic industry in the state of Utah is sought.

Please complete the enclosed questionnaire and return it by March 18, 1970. All information will be confidential and comparisons of named industries will not be made. A summary of the findings will be sent to all participants.

This study is being conducted by the Industrial and Technical Education Department at Utah State University in cooperation with the Research Coordinating Unit for Vocational and Technical Education, a unit of the State Department of Education.

Thank you for your assistance and cooperation in making this study complete.

Sincerely,

Dr. Austin G. Loveless
Associate Director
Research Coordinating Unit

Denis A. Potter
Industrial and Technical Education
Utah State University
Logan, Utah 84321

Enc.

Appendix D

Glossary of Plastics Terms

Blow Forming--Method of sheet forming in which the plastic sheet is clamped in a stationary frame, heated, and blown down by air into a mold.

Blow Molding--A method of fabrication in which a parison (hollow tube) is forced into the shape of the mold cavity by internal air pressure.

Calendering--To prepare sheets of material by pressure between two or more counter-rotating rolls.

Casting--To form a "plastic" object by pouring a fluid monomer-polymer solution into an open mold where it finishes polymerizing.

Compression Molding--A technique of thermoset molding in which the molding compound (generally preheated) is placed in the open mold cavity, mold is closed, and heat and pressure (in the form of a downward moving ram) are applied until the material has cured.

Dielectric Heat Sealing--The plastic to be heated forms the dielectric of a condenser to which is applied a high-frequency (20 Hz. to 80 MHz.) voltage. Dielectric loss in the material is the basis. Process used for sealing vinyl films and preheating thermoset molding compounds.

Dip Casting--Applying a plastic coating by dipping the article to be coated into a tank of melted resin or plastisol, then chilling the adhering melt.

Drape Forming--Method of forming thermoplastic sheet in which the sheet is clamped into a movable frame, heated, and draped over high points of a male mold. Vacuum is then pulled to complete the forming operation.

Encapsulating--Enclosing an article (usually an electronic component or the like) in a closed envelope of plastic, by immersing the object in a casting resin and allowing the resin to polymerize or, if hot, to cool.

Extruding--The compacting of a plastic material and the forcing of it through an orifice in more or less continuous fashion.

Fabricating--To work a material into a finished form by machining, forming, or other operation or to make flexible film or sheeting into end-products by sewing, cutting, sealing, or other operation.

Filament Winding--Roving or single strands of glass, metal, or other reinforcement are wound in a predetermined pattern onto a suitable mandrel. The pattern is so designed as to give maximum strength in the directions required. The strands can either be run from a creel through a resin bath before winding or preimpregnated materials can be used. When the right number of layers have been applied, the wound mandrel is cured at room temperatures or in an oven.

Fluidized Bed Coating--A method of applying a coating of a thermoplastic resin to an article in which the heated article is immersed in a dense-phase fluidized bed of powdered resin and thereafter heated in an oven to provide a smooth, pin-hole-free coating.

Foaming--The deposition or application of physical or chemical foaming agents that generate inert gases on heating, causing the resin to assume a cellular structure.

Foam-In-Place--The deposition of foams which requires that the foaming machine be brought to the work which is "in place" as opposed to bringing the work to the foaming machine.

Heat-Sealing--A method of joining plastic films by simultaneous application of heat and pressure to areas in contact. Heat may be supplied conductively or dielectrically.

High Pressure Laminates--Laminates molded and cured at pressures not lower than 1000 p.s.i. and more commonly in the range of 1200 to 2000 p.s.i.

Injection Molding--A molding procedure whereby a heat-softened plastic material is forced from a cylinder into a relatively cool cavity which gives the article the desired shape.

Laminating--A process consisting of superimposed layers of a synthetic resin-impregnated or resin-coated filler bonded together, usually by means of heat and pressure, to form a single piece.

Low Pressure Laminates--Laminates molded and cured in the range of pressures from 400 p.s.i. down to and including pressures obtained by the mere contact of the plies.

Matched Molds--Method of molding reinforced plastics between two close-fitting molds mounted in a hydraulic press.

Plug and Ring Forming--Method of sheet forming in which a plug, functioning as the male mold, is forced into a heated plastic sheet held in place by a clamping ring.

Pressure Forming--A thermoforming process wherein pressure is used to push a sheet to be formed against the mold surface as opposed to using a vacuum to suck the sheet flat against the mold.

Reinforced Plastics--A strong inert material bound into a plastic to improve its strength, stiffness, and impact resistance. Reinforcements are usually long fibers of glass, sisal, cotton, etc.--in woven or nonwoven form. To be effective, the reinforcing material must form a strong adhesive bond with the resin.

Roller Coating--Used for applying paints to raised designs or letters.

Rotational Molding--A method used to make hollow articles from plastisols and latices. Plastisol is charged into hollow mold capable of being rotated in one or two planes. The hot mold fuses the plastisol into a gel after the rotation has caused it to cover all surfaces. The mold is then chilled and the product stripped out.

Slush Casting--Method for casting thermoplastics, in which the resin in liquid form is poured into a hot mold where a viscous skin forms. The excess slush is drained off, the mold is cooled, and the molding stripped out.

Spray Foam--See Spray-up.

Spray-up--Covers a number of techniques in which a spray gun is used as the processing tool. In reinforced plastics, for example, fibrous glass and resin can be simultaneously deposited in a mold. In essence, roving is fed through a chopper and ejected into a resin stream which is directed at the mold by either of two spray systems. In foamed plastics, very fast reacting urethane foams or epoxy foams are fed in liquid streams to the gun and sprayed on the surface. On contact, the liquid starts to foam.

Spread Coating--A method of coating a substrate in which the substrate is coated with a material whose thickness is controlled by an adjustable knife or bar set at a suitable angle to the substrate. There are a number of variations of this basic technique and they vary according to the type of product required.

Thermoforming--Any process of forming thermoplastic sheet which consists of heating the sheet and pulling it down onto a mold surface.

Thermoplastics--A material that will repeatedly soften when heated and harden when cooled. Typical of the thermoplastics family are the styrene polymers and copolymers, acrylics, cellulosics, polyethylenes, vinyls, nylons, and the various fluorocarbon materials.

Thermosetting Plastics--A material that will undergo or has undergone a chemical reaction by the action of heat, catalysts, ultra-violet light, etc., leading to a relatively infusible state. Typical of the thermosetting plastics are the aminos (melamine and urea), most polyesters, alkyds, epoxies, and phenolics.

Transfer Molding--A method of molding thermosetting materials in which the plastic is first softened by heat and pressure in a transfer chamber, then forced through high pressure through suitable sprues, runners, and gates into closed mold for final curing.

Vacuum Forming--Method of sheet forming in which the plastic sheet is clamped in a stationary frame, heated, and drawn down by a vacuum into a mold. In a loose sense, it is sometimes used to refer to all sheet forming techniques, including drape forming, involving the use of vacuum and stationary molds.

Vacuum Snap-Back--A variation of the vacuum forming process which prestretches the plastic by applying a vacuum to a sheet of plastic that is sealed against a vacuum box. A male plug is then lowered into the plastic sheet and a vacuum is applied through the plug. This allows the plastic to snap back onto the plug.

Appendix E

Companies Participating in Study

Allstate Foam Corp.
870 West 2600 South
Salt Lake City, Utah

Associated Design Group, Inc.
2200 South Main
Salt Lake City, Utah

Bird Plastics, Inc.
118 Vine Street
Murray, Utah

Braun & Company
3061 South 2nd West
Salt Lake City, Utah

B & H Plastics, Inc.
225 Cross Road Square
Salt Lake City, Utah

Cebesco, Inc.
9450 South State
Sandy, Utah

Chart-A-Matic, Inc.
374 North State Street
Orem, Utah

Dimension Plastics, Inc.
168 West 4800 South
Salt Lake City, Utah

Fluidics Plastics Division
Fluidics Production and Sales Inc.
365 West Gregson Avenue
Salt Lake City, Utah

Four D West Inc.
Plastic Pipe and Fitting Manu.
490 East 300 North
Morgan, Utah

Hanson, Homer W.
2442 South 450 East
Bountiful, Utah

Hercules, Inc.
Freeport Center
Clearfield, Utah

Hill Air Force Base
Ogden, Utah

Hydroswift Corp.
3045 West 21st South
Salt Lake City, Utah

MNK Enterprises, Inc.
1655 South State Street
Orem, Utah

Marquardt Corp.
1000 West 33rd Street
Ogden, Utah

Marvson, Inc.
3532 Riverdale Road
Ogden, Utah

Plastics Fabricating and Supply Inc.
3571 South 2 West
Salt Lake City, Utah

Plastics Products Company of Utah
2340 West Temple
Salt Lake City, Utah

Plastics Specialties
215 24th Street
Ogden, Utah

Rider Plastics, Inc.
150 West Stratford Avenue
Salt Lake City, Utah

Seaflite Corporation
3363 South 6th West
Salt Lake City, Utah

Thiokol Chemical Corp.
Brigham City, Utah

Vision Clear Corneal Lens Company
167 East 9th South
Salt Lake City, Utah

Western Creative Corp.
1627 South Pioneer Road
Salt Lake City, Utah

Western Metal & Plastic Manu.
358 North 3rd West
Salt Lake City, Utah

Western Manufacturing, Inc.
Freeport Center
Clearfield, Utah

Wilson Ernect Company, Inc.
3380 South Redwood Road
Salt Lake City, Utah

Aladdin Enterprises, Inc.
150 West 2950 South
Salt Lake City, Utah

VITA

Denis Arthur Potter

Candidate for the Degree of

Master of Science

Thesis: The Necessity of Plastics Education and the Development of a Course Outline as it Pertains to Area Vocational Schools in the State of Utah

Major Field: Industrial and Technical Education

Biographical Information:

Personal Data: Born at Oakland, California, May 14, 1943, son of Arthur E. and Freda R. Potter; married Julie R. Olson September 9, 1967.

Education: Attended elementary school in Castro Valley, California; graduated from Castro Valley High School in 1960; received the Bachelor of Science degree from California State Polytechnic College, San Luis Obispo, California, with a major in Industrial Technology in 1968; did graduate work in education at California State Polytechnic College, 1969; completed requirements for the Master of Science degree in Industrial and Technical Education at Utah State University in 1971.

Professional Experience: 1966 to 1969, part- and full-time instructor in the Industrial Technology Department at California State Polytechnic College; 1961 to 1964, Fire Control Technician, United States Navy.