8 POTENTIALS FOR PLASTICS IN GEORGIA

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ATLANTA, GEORGIA
8 POTENTIALS FOR PLASTICS IN GEORGIA

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FOREWORD

This report points up the many excellent opportunities which exist for the manufacture of plastics in Georgia. It presents the findings of an industry-wide survey, undertaken to provide the basic information required to identify applications which are well adapted to this area.

Each of the products or product complexes discussed can now be analyzed in detail to determine more precisely what the market for each will be, what size plants might be established and where they might best be located, what operating costs can be anticipated and what profits might be returned on the investments involved.

The first of the series of follow-up studies which will be completed as part of this project is already underway. These individual studies will be related to other research in progress at the Industrial Development Branch, to the diversification needs of established industry, and to the interest which may be evidenced by business firms, development groups or individuals in the further evaluation of specific opportunities.

Comments on the report and inquiries regarding the follow-up analyses are invited.

Kenneth C. Wagner, Head
Industrial Development Branch
ACKNOWLEDGMENTS

Every report represents the combined efforts of many people; this one certainly is no exception. The complexity of the plastics processing industry has made it necessary for the writers of the report to contact a large number of persons, many of whom have given generously of their time.

The Spencer Chemical Company was especially helpful, providing a great deal of technical information. Mr. Ed Parker of that firm, as well as Mr. Leroy Doar and Mr. Paul Casabone, contributed substantially to certain sections of the report.

Other chemical company personnel who provided information include: Mr. Kevin E. Joyce, Bakelite Division of Union Carbide Corp.; Mr. William E. Erb, Celanese Corporation of America; Mr. W. J. Kelly, Dow Chemical Co.; Messrs. J. P. Broussard and Adam Fisher, E. I. DuPont de Nemours & Co.; Mr. Ralph F. Hansen, Monsanto Chemicals Co.; and Mr. A. Kempton Haynes, Rohm and Haas Co.

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Mr. E. V. Tarnell and the Tarnell Company of New York provided valuable data on the size and profitability of different plastics processing firms.

Dr. James L. Taylor, Acting Director of the School of Textile Engineering, Georgia Institute of Technology, assisted with the textile applications of plastics.

In addition to those whose names appear as being primarily responsible for this report, others in the Industrial Development Branch worked long hours to collect data, interview men in the industry, analyze data, and complete the report. So many individuals were involved that they will not be enumerated in detail here; their contributions are, however, sincerely appreciated.

The plates on pages 6b, 6d, 6f, and 6h were furnished through the courtesy of The Noland Co.
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SUMMARY

Georgia is an ideal location for the development of plastics processing and fabricating. It is at the midpoint of the rapidly expanding southeastern market. And as Map I indicates, there are few processors now in this area. A surplus of labor that is easily retrainable for work in plastics is available.

Plastics is one of the fastest growing industries, with an even more rapid development than the chemical industry as a whole, which is frequently cited for its rapid growth. Both small and medium-sized processing and fabricating operations can be profitably located in Georgia. They are market oriented and can meet the competition of larger companies which may be established. The capital requirements for such plants can run as low as $50,000 to $100,000; in some special cases firms can begin with even less capital. To be sure, there are rather wide variations in this requirement. The specific amount depends upon the size and types of products and processes.

The major chemical companies produce resins or molding compounds and are not in competition with processors. In fact, to help sell resins they offer technical assistance on production problems and will recommend equipment and resins for certain applications. They will even help processors get underway and will act as trouble shooters if difficulties are encountered.

Out of the wide variety of products made, eight broad groups of plastics applications are recommended for development in Georgia. These have been selected and rated according to their sales potentials. In their order of importance to Georgia they are: textile and paper treating and coating; packaging and containers; construction; furniture and cushioning; housewares, toys and sporting goods; piping; boating; and agriculture. (Appendix A explains the ranking method.)

In many of these applications plastics are replacing other materials. They are replacing wood for construction and furniture because they are light, strong, and can be colored and fashioned into very pleasing designs. They are replacing metals in sporting goods and piping.

Plastics offer opportunities for diversification as well as for the establishment of new firms. The textile and paper firms in Georgia will find that plastics offer an excellent opportunity for diversification of their product lines. The basic materials for both industries can be coated or treated for
certain desirable qualities. Many of these plastic-treated products can be sold along with a regular line through the same distribution channels. The experience gained this way will permit these companies to move into other plastic fields.

Plastics are no longer cheap substitutes for other materials but are an excellent material in their own right. Plastics are better and cheaper than paper for many packaging needs. For pipe they are lighter, more durable, and easier to install than metal. Plastics are superior to wood for boats. They are not damaged by water and therefore require little maintenance. They are easier to fashion into compound shapes than wood and metal. Several plastics are unbreakable. They can be designed and fashioned for tableware, at least as well as ceramics. Plastics are indeed "coming out of the kitchen and into the dining room."

The apparent profit situation in plastics today is closely tied to three factors: innovation, growth and quality. It is imperative that the prospective Georgia manufacturer understand the significance of these factors. There are outstanding possibilities for the innovator in product development, production techniques, and marketing. The firm with the vision, creativeness, and resources required for such development will be a leader in the industry's growth in the Southeast.
MAP I. LOCATION OF CUSTOM PLASTICS MOLDING INDUSTRY – 1956

I. INTRODUCTION

The plastics industry offers many business opportunities that have been overlooked in Georgia. The purpose of this report is to analyze these opportunities in order to inform businessmen of the excellent potentials in the State.

Plastics is one of the fastest growing industries today. In the last 11 years, the production of plastics has grown at an average annual rate of 11.5 per cent compared with 6.9 per cent for general chemicals, and 4.2 per cent for industrial production. These comparative growth rates are shown in Chart I. In 1957, plastics production amounted to 3,879,274,000 pounds. This represents sales of over a billion dollars. A conservative estimate derived by projecting a limited growth curve would be 8,118,300,000 pounds in 1965, and 13,318,000,000 pounds in 1975.

Despite this extremely rapid growth, there is virtually no plastics industry in Georgia. Processors and fabricators can be profitably located in Georgia, however. Processors purchase the raw material and then form it into solid shapes. Fabricators print, cut, machine, and otherwise finish the products of the processors. Both types of companies are characteristically small and market oriented. Compounding--the mixing of resins--is not a potential industry for Georgia until processing is further developed.

The raw material manufacturers cannot be expected to locate in the State at the present time. These are the large chemical firms such as DuPont, Dow, Monsanto, Spencer, and Celanese. Location of their plants is principally determined by the sources of their raw materials, primarily petroleum refineries and large natural gas pipelines. To a lesser extent, their location is also determined by the markets for their finished products. As Georgia has neither a significant amount of raw materials nor a market of any importance for these manufacturers, the economical location of resin-producing plants here does not look promising at the present time.

In the plastics processing industry there are many different processes and products. Since firms tend to specialize in one or a few closely related processes, it is virtually impossible to analyze each production potential in detail without first completing an industry-wide study. In this report the plastics processing industry is therefore surveyed as a whole. The report is a non-technical guide to the industry intended for the firm or individual considering going into plastics. It will serve as an aid to the businessman in
CHART I.
INDEXES OF INDUSTRIAL AND CHEMICAL PRODUCTION
(1947-49 AVERAGE = 100)

selecting his most promising opportunities, depending upon his interests, talents, and capital.

These selected opportunities can then be subjected to more detailed analysis for an exacting guide to profitable operations. The first of a series of such detailed feasibility studies is already underway in the Industrial Development Branch.

In this report the markets for those products which are most promising for Georgia and the Southeast are first analyzed. Manufacturing processes are then discussed, since firms are usually organized according to these processes. This should give the reader, in non-technical terms, an understanding of the various processes for different products. The particular opportunities and problems in Georgia are then evaluated.
II. THE PRODUCTS

The most fruitful approach to the study of plastics products is to classify these products by application (construction, agriculture, etc.). Though these classifications do not necessarily represent products of individual processors, they do permit an over-all view of the most promising products. This approach also provides the background for future feasibility studies of the individual firms, where markets, production inputs and processes, and other specific data are being analyzed and developed.

The applications may be divided into two groups, according to the opportunities the various fields hold for Georgia in the years ahead.

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textile and paper treating and coating</td>
<td>Appliance</td>
</tr>
<tr>
<td>Packaging and containers</td>
<td>Electrical</td>
</tr>
<tr>
<td>Construction</td>
<td>Electronic</td>
</tr>
<tr>
<td>Furniture and cushioning</td>
<td>Machinery</td>
</tr>
<tr>
<td>Housewares, toys, and sporting goods</td>
<td>Transportation</td>
</tr>
<tr>
<td>Piping</td>
<td></td>
</tr>
<tr>
<td>Boating</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
</tr>
</tbody>
</table>

The applications possible under Group 2 depend upon further development of these industries; they do not therefore offer early prospects for Georgia. In all cases these involve industrial customers whose location is a primary consideration. For example, transportation--passenger cars, trucks, airplanes, and rail cars--is one of the principal over-all growth applications in plastics. Yet due to the relatively minor output of these products in this area, this must be considered a secondary application. Appliances, electrical, electronic, and machinery products are in much the same position. Any substantial increase of plastics in these uses in Georgia and the Southeast is unlikely without further regional development of these industries.

Some products that fall under Group 2 do have excellent long run potentials, however. The developing electrical equipment industry is an example. However, in an attempt to cover the entire plastics field, it is necessary to select and investigate the areas offering the most promise for the months immediately ahead.

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The most promising applications for Georgia are listed under Group 1. Each of these is analyzed in detail in a subsequent section. They are presented in order of their estimated potentials.
A. Textiles and Paper

Because of the extent of the activity of the textile and paper industries in the Southeast, the treating and coating of the products of these industries are included among the plastics applications considered most important to Georgia. The figures below show the relative significance of textiles and paper to Georgia, the Southeast, and the South. Both absolute and relative figures are given.

**Textile Production Activity**  

<table>
<thead>
<tr>
<th>Region</th>
<th>Output ($ Millions)</th>
<th>Per Cent of U. S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>13,095</td>
<td>100</td>
</tr>
<tr>
<td>South</td>
<td>7,352</td>
<td>56.1</td>
</tr>
<tr>
<td>Southeast</td>
<td>6,396</td>
<td>48.8</td>
</tr>
<tr>
<td>Georgia</td>
<td>1,120</td>
<td>8.6</td>
</tr>
</tbody>
</table>

**Paper Production Activity**

<table>
<thead>
<tr>
<th>Region</th>
<th>Output ($ Millions)</th>
<th>Per Cent of U. S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>13,608</td>
<td>100</td>
</tr>
<tr>
<td>South</td>
<td>3,788</td>
<td>27.8</td>
</tr>
<tr>
<td>Southeast</td>
<td>1,968</td>
<td>14.5</td>
</tr>
<tr>
<td>Georgia</td>
<td>492</td>
<td>3.6</td>
</tr>
</tbody>
</table>

The applications of plastics to textiles may be roughly subdivided into three major groups of processes: impregnation, coating and lamination, and non-woven materials. These processes are not all-inclusive, but represent the present important uses of resins in conjunction with textile materials. Though textile applications do not show as spectacular a growth rate as do some of the others, present United States consumption of all resins for textile use is well in excess of 100 million pounds annually. While this is a

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1/ Manufacturers Record, Vol. 127, 1958. Included are: for textiles, establishments engaged in scouring and combing, yarn and thread, woven fabrics, knitting, dyeing and finishing, carpets and rugs, hats except cloth and millinery, miscellaneous textiles; for paper, pulp-paper mills, coating and glazing, envelopes, containers.

2/ The "Southeast" for purposes of this report consists of a six-state area: Alabama, Florida, Georgia, North Carolina, South Carolina and Tennessee.
substantial volume, it appears to be only a beginning. The present high volume of consumption has been achieved within the last decade.

"Treating" is here defined as the impregnation of textiles with resins to impart certain characteristics to the fabrics. Typical treatments include those for water, flame, mildew, and wrinkle resistance. This application is of particular significance to Georgia and the southeastern area because of its effect on the cotton industry. Where previously cottons were losing heavily to synthetic fibers, impregnation of cotton fabrics with resins has improved the sales of cottons. The ureas and melamines are the principal resins applied to cottons for wrinkle resistance and crease recovery for "wash-and-wear" finishes. Melamine has a good market in the finishing of cotton, while urea has a smaller market. There has been some use of resins to replace starch in finishing, where, for example, the alkyds are finding a limited application in imparting a stiff "hand" to some of the synthetic fabrics. Although the technical processes for impregnation are rather simple, almost none is now done in Georgia. Treating is for the most part carried out by the finishing plants and most of the finishing operations are located in the East and the Carolinas. Some treatment, imparting water, flame, and mildew resistance to heavy fabrics, is done here. A further move toward wrinkle-resistant work clothing should increase resin consumption for fabric impregnation in Georgia.

Surface coating shares with impregnating the position of the highest volume of resin consumption in the field of textiles. Fabrics are surface coated for special purposes by two basic methods: coating and laminating. Reportedly, over 100 concerns in the country are coating fabrics1/ by such techniques as knife-coating, calender-coating, and spraying. The lamination process involves the application of film or sheets to the material. At present, coating is the more important of the two methods, consuming roughly 50 million pounds of resin annually. Lamination presently consumes between 10 and 20 million pounds of resin and is successfully replacing many coated materials. Which of the two methods will ultimately become more important is difficult to determine. Each has its own advantages.

The uses for surface-coated fabrics extend into many product areas, including wall coverings, table cloths, gloves, shoes, handbags, upholstery,

rugs and carpeting, tarpaulins, luggage coverings, and industrial aprons. Of these, upholstery is the leading consumer—with the automotive markets being the largest and the furniture markets second.

Resins and latexes for rug backings are finding a volume market in the rug industry in Georgia. Latexes compounded with large proportions of filler are found to be relatively inexpensive backing materials. Urethane foams are also becoming important in this market.

The fabrics to which the coatings are applied may be woven, knitted, or webs or non-woven cloths. Non-woven type material has a double role in plastics applications to textiles. As soon above, it can be used as a backing for coatings. It also is a plastic product in itself. Non-woven materials are made by a process similar to that used in paper production. The fibers are laid down and bonding agents applied. The fibers may be cotton or a mixture of cotton and synthetic fibers. This material has been largely developed in Georgia. In addition to backing for coatings the new material is being used for wiping cloths, polishing cloths, hand cloths, casket liners, clothing interlinings and facings, undergarments, and automotive door panels. A large disposable products market also exists for this material.

Miscellaneous plastics applications to textiles include urethane foam interlinings; buttons, buckles, and ornaments; monofilaments; pigment dyeing; and textile printing. Although these uses do not constitute a great proportion of total resin sales, they do offer opportunities for Georgia which should be important enough to be evaluated in more detail.

Paper

There are three broad categories (closely paralleling those used in textiles) into which the applications of plastics to paper may be divided. These are: (1) the use of synthetic fibers for papermaking; (2) plastic surface coating and laminating paper with plastics; (3) the internal treatment of paper with plastic suspensions or emulsions.

The first use is a recent development that has been successful in the production of a relatively expensive, specialized paper. The Technical Association of the Pulp and Paper Industry's publication (Tappi) reports that practically every synthetic fiber has been made into paper at least on a pilot plant scale. Some of these papers are finding early applications in battery separators, air filters, and laminating papers for electrical and
high temperature applications. These papers are being produced by specialty companies in the Northeast and North Central states. They are not made in the South, probably due to the special equipment required.

The internal treatment of paper with plastics resins is of relatively little importance in the Southeast, principally because the bulk of the industry in the area is devoted to the production of kraft paper. This is a low-grade paper not particularly suited for treating, which is a process usually associated with the higher-priced paper varieties.

The coating and laminating of paper offer more promise. Bleached kraft which has been coated with plastics resins is used extensively in the manufacture of small pouch bags, due to its relatively low cost and good printability. Coated unbleached kraft is also finding volume markets as multiwall shipping sacks, single-ply bags and wraps and liners. Another, more recent development is the economical coating of paperboard with polyethylene for packaging. In addition to packaging, coated paper is finding markets in such uses as wallpaper, leather-like papers, and honeycomb structural papers. One plant in the State is presently producing a kraft-coated moisture barrier sheet.

The paper producers are typically more integrated than are textile manufacturers. And this characteristic is becoming more and more pronounced. Therefore, the expansion of the plastics processing of paper in Georgia is probably dependent upon the development of this processing by the paper mills themselves. To them, it offers a fine opportunity for diversification.
B. Packaging and Containers

The study of plastics applications to packaging and containers is discussed under two product groups. "Packaging" includes that group of products manufactured from sheets, film, extruded semi-rigid materials and foams. The second group consists of molded containers and is evaluated separately.

Packaging

The market for packaging in the Southeast is most promising. Large present and potential markets are available here for a wide range of products. Small hardware and industrial parts, toothbrushes, and similar products are packaged by extruded semi-rigid materials. Formed sheeting is used for household and personal items, food products, hardware and industrial parts, toys, drugs, and cosmetics. The packages themselves may take such forms as skin, bubble and contour packs, slide boxes, strip packages, and containers with removable covers. Plastic films are converted to form pouches, bags, wraps, vacuum packs, box and drum liners, and dispenser packages for products like foods, candies, cosmetics, drugs, toys, small parts, housewares, and personal items. The plastic foams are used to protect tools, electronic parts, industrial and military components, food products, drugs, and similar products.

Both formed sheeting and converted film should find substantial markets in the Southeast. Both types of packaging offer wide open fields for the businessman able to exploit the potentialities of plastics. In films, the areas of special interest to Georgia business include feed and seed bags, fertilizer bags, fruit and vegetable packages, meat and poultry packages, packages for textile products, and dry cleaning bags.

A major chemical company estimates that United States film consumption for packaging will increase from a 1957 level of 145 million pounds to 325 million pounds in 1962. Feed, seed, and fertilizer bags are relatively new fields for plastics film that offer great potential here. Increased meat and poultry production in Georgia and the Southeast will further expand these markets. Film is used extensively also in packaging flat goods, shirts, blouses, and other textile products.
The following are estimates of United States consumption of resin for packaging films in 1962 (in million of pounds):

<table>
<thead>
<tr>
<th>Category</th>
<th>Consumption (in million of pounds)</th>
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</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>1</td>
</tr>
<tr>
<td>Candy</td>
<td>5.5</td>
</tr>
<tr>
<td>Meat and poultry</td>
<td>10</td>
</tr>
<tr>
<td>Snacks and frozen foods</td>
<td>15</td>
</tr>
<tr>
<td>Dry cleaning bags</td>
<td>70</td>
</tr>
<tr>
<td>Fresh produce</td>
<td>110</td>
</tr>
</tbody>
</table>

Indeed, the potential for plastics in packaging appears virtually unlimited. Markets are being opened up at an increasing rate as producers investigate new fields and work out the problems involved in each. For example, a new 50-pound polyethylene fertilizer bag has been developed which has advantages over paper goods now used. One company recently announced the successful development of a polyethylene bread wrapper which is 25 to 35 per cent cheaper than cellophane bread wraps. A 100 million pound annual market is seen for this application alone in the foreseeable future.

In the field of plastics packaging applications, it is important to distinguish the three types of activity involved—processing, fabricating, and finishing. There is a tendency at present for these activities to be carried out by separate firms. All three have substantial potentials in the southeastern area. The leading growth firms will probably be those engaged in the processing, fabrication, and finishing of film. Here is another opportunity for diversification for some of Georgia's established industries.

**Molded Containers**

There is but a limited opportunity for molded plastic containers in the Southeast at the present time. These containers are necessarily produced by automatic equipment, requiring a large volume to support equipment costs. Also, established molded container manufacturers generally offer a great deal of design and technical assistance to customers—a service requiring large resources and volume. The market in the Southeast for most such containers does not assure the large volume required.

The packaging of food, dairy and similar products, offers a limited market in this area. Containers for this purpose may be standardized, thus reducing financial risk. However, unless a new firm were prepared to devote a great deal of time and money to develop uses for additional products, it is doubtful if increased production capacity in this area could be economically justified at present.
C. Construction

Of the eight categories of synthetic resin applications selected for individual consideration in this report, construction applications were found to have the greatest long-term growth potential. These applications are on the verge of a period of rapid expansion in which new technology and product innovations promise unusual profit opportunities.

Estimates on present United States consumption of plastics by the construction industry range from 400 to 500 million pounds annually. This represents approximately one-tenth of the total resin consumption in 1957. Yet one authority suggests that if only 30 per cent of the potential uses for plastics in construction were taken advantage of, this application would consume 5 billion pounds of resin—one billion pounds in excess of the present total resin consumption! Of further significance, the potentials for production in Georgia are at least equal to those of any of the other applications.

Technical Advantages

There are two substantial reasons why the expected expansion of plastics in construction applications should be realized. First and most obvious are the physical properties possessed by plastic materials which make them particularly well suited to the construction industry. These technical features, including high strength-to-weight ratios, low heat transmission and durability, have already been influential in the displacement of other materials by plastics. This displacement will undoubtedly continue at an increasing rate as improved resins, processes, and forms are developed. The decreasing price pattern that synthetic resins have displayed in the past, if continued, will be an equally significant consideration.

Of even more importance than the substitution of plastics for existing materials are the capabilities possessed by plastics that heretofore have not been available (at least economically) in any other material. Color range and design versatility are among the more important of these. Improvements over the types of design possibilities which exist for conventional materials and, particularly, innovations in the direction of prefabrication methods promise further sales. Plastics may be the answer to the problem

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raised by Glenn H. Beyer when he said: "As long as prefabricated homes continue to be manufactured from wood in any form (including plywood) the true benefits of mass production cannot be derived." Work is presently being done on modular units, such as bathrooms, in which plumbing and electrical fixtures are molded in as parts of walls, floors, and ceilings. Monsanto Chemical Company has constructed an all-plastic house and has incorporated modular rooms in the design. Such applications will be important contributions to solution of the problem of rising building costs.

Location Factors

Expansion of construction activity in the Southeast points up the potentials for plastics in this field. The rate of expansion in Georgia in the past four years--16 per cent--has been three times that of the Southeast as a whole. Because construction products are large in weight and size, the industry is market oriented. This is especially true for plastic construction materials because the molding compound is so easily transported in comparison with wood, metal, and other construction materials. Therefore, transportation costs are of major importance in plant location.

In the case of plastics, power and energy requirements do not restrict the industry. In addition, there is no weight loss in the processing of plastics. This fact and the relatively low transportation costs of the raw materials favor locations close to the markets.

The Products

Brief consideration of the types of construction materials involved indicates the scope of this application of plastics. It also provides a framework for evaluating the large number of products that should be considered. One of the most important of the long-term prospects for plastics in construction involves further developments in structural members. Technological advances which allow increases in unit sizes of plastics materials, along with design improvements, point toward the development of large structural parts capable of supporting heavy loads. The low weight and cost, and the durability of plastics are of decided value in these uses.

Much of the present development has come from the missiles field, particularly in new approaches to composite structures and "sandwich" materials.


2/ A "sandwich" consists of two thin high-strength faces with relatively thick, low-density core material between them.

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Present structural materials include composite structures, sandwich materials, and laminates. The problem of the support of heavy loads has not yet been solved, however. This application, though involving great potential, is probably more of a long-term prospect. Processors in this field can expect to incur considerable expense in the design and development of structurally strong shapes requiring a minimum of material.

Small structurals, fittings, and hardware molded and extruded from plastics are more immediate potentials. Reinforced panels for roofs, windows, louvres, and room dividers; honeycomb structures for ceilings, floors, and doors; lighting fixtures; architectural trim; baseboards; guttering and screens are a few of the present applications that are increasing. The growth of present applications will undoubtedly be accelerated by further innovations.

Other applications include coatings and coverings. Durability and color are important to these fields. A third feature, ease of maintenance, is also important. Vinyl floor coverings already offer a volume market that consumes in excess of 82 million pounds of resin annually. Counter and wall surfacings will find a continuing major market in the construction industry. Plastics are able to add many characteristics to other materials that will increase the markets for all. In the areas of coatings, one company has recently announced a new material which, when applied to aluminum, is claimed to perform better and cost less than anodizing.

Insulation consisting of foam sandwich materials and plastics foamed in place is another major application. Foamed plastics production in 1957 was approximately twice that in 1956, and construction applications should play a leading part in further expansion.

Films have also come into increased use in construction. United States consumption, estimated at 15 million pounds in 1956, is expected to reach 50 to 60 million pounds per year within two or three years. The primary characteristic that plastic film has to offer the construction industry is moisture resistance. This important attribute is supplemented by the other significant factors of ease of handling, strength, tear-resistance, and durability. The principal applications are moisture barriers in homes and commercial buildings, concrete form linings and curing covers, and protective coverings for

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materials, machinery, and buildings under construction. Phenomenal growth potentials exist in each of these areas.

The application given above, covering virtually the entire range of plastics forms and resins, are among the most significant that are presently being applied. Some insight is thus furnished into the range of applications that are available in plastics applied to construction. Full development of these applications offers almost unlimited growth potentials. Sufficient to say here, that the first firms to enter this area should find its profits substantial.
D. Furniture and Cushioning

The furniture applications of plastics may be classified as reinforced plastic furniture pieces, plastic-to-metal laminates, drawers, monofilaments, and such miscellaneous products as molded legs. Here again, it is found that the properties possessed by plastics make them almost certain to gain substantial markets as further developments occur. Exclusive of the reinforced plastic pieces, the industry is at present anticipating a market approaching 100 million pounds of resin per year.

Furniture Pieces

Complete furniture pieces, when considered in the light of the potential they offer, are the most interesting of the furniture applications. A substantial foothold has already been established in the institutional markets, principally chairs. Today's emphasis on casual living and the decline of formality in the American home open this market to plastics which offer color, comfort, and freedom of design. Of equal importance is the fact that plastic furniture pieces also lend themselves to mass production techniques. Molded reinforced plastic furniture for home use has been available for about three years. The major problem is designing a plastic product acceptable to consumers. As materials and processes are further developed and improved this task will be made easier.

Plastic Drawers

Plastic drawers are currently receiving considerable attention from the industry. Consumption of resin for drawers in the United States was estimated at one and a half million pounds in 1957, a 650 per cent increase over the amount consumed two years earlier. The substantial advantages which plastics enjoy over wood--dimensional stability, permanent finishes, easy cleaning, strength, and versatile styling--will probably be discovered in the drawer market, which will pave the way for other furniture applications.

The drawers themselves offer excellent potential in the displacement of conventional woods. The most important markets for drawers are for use in homes, offices, home trailers, ships, and school buildings. To be sure, this facet of the industry is not without major technical problems. The present volume of production is, nevertheless, a tribute to the basic superiority of the characteristics of plastics.
A recent study of 24 furniture manufacturers, reported by *Modern Plastics*, revealed that 1,992 different drawer sizes were made in 1957. Yet at the beginning of that year plastic drawers were available in only seven sizes! The industry hopes for some degree of standardization to help relieve this situation, for some quarter of a million drawers must be sold to amortize the cost of the mold for each individual size.

**Monofilaments**

Monofilaments are another expanding product line. Trends toward "outdoor living" in recent years have developed a tremendous market in lawn furniture. The monofilaments are woven and attached to aluminum frames to provide chairs and lounges which are light and durable. Other applications include insect screening and industrial screening. Monofilament production requires a substantial amount of equipment and considerable technique. Taking the product off the machine is a major problem, for it requires an expenditure for equipment approximately equal to that of the cost of the extruder.

Of particular interest for the Southeast is the fact that the reported leader in the monofilament field is a textile firm which has diversified into plastics processing. Most of the monofilament producers are located in the South.

**Cushioning**

Cellular plastics sales are expanding at a tremendous rate. In addition to construction and boating applications, the cushioning market offers promise of further advances for these materials. The two largest segments of the United States cushioning market, automotive seating and furniture, are expected to consume in excess of 100 million pounds annually of urethane and vinyl resins within the next few years. In 1956, the flexible foams produced for cushioning required only an estimated 11 to 13 million pounds of these resins.

The plastic cushioning potential grows primarily out of the displacement of foam rubber, currently produced at the rate of 250 million pounds per year. As in other applications, the plastics have both property and price advantages which can expect to take a sizeable portion of the market away from rubber. Technical problems have plagued the flexible plastic foam producers for years, but it is evident that these problems are in no way insurmountable, since the rubber foam producers (such as Dayton Rubber, Goodyear, U. S. Rubber, and Goodrich) have now entered the plastic foam field.

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In summary, the future pattern of development for plastic furniture applications can be expected to follow a course similar to that of structural members in construction applications. A great deal of technical development and experimental work remains to be done. Styling will be of major importance in the case of furniture pieces. In foams, strong patent positions have been developed by such companies as DuPont and Mobay Chemical. Time and resources must be devoted to gaining market acceptance. There are many problems to be overcome, but when they are, firms in the field may look forward to exceptional profits.
E. Housewares, Toys, and Sporting Goods

Housewares, toys, and sporting goods applications are discussed here as a group because of their great similarities in product processes, in marketing and distribution channels, and in product characteristics.

Production

The products involved in these applications are for the most part molded shapes. The machinery presently being used for the production of these shapes is of such a nature that the small producer can readily enter this part of the industry.

However, the prospective producer must keep in mind the nature of the products and markets. An industry official has stated that in the case of toys and housewares the processor is "selling creativeness." If the manufacturer does not devote considerable effort to design and color, he cannot hope to compete in these markets. He must be adaptive to changes in consumer tastes. Even so, some designs can be expected to be failures, since there is no sure way to determine product acceptability. To provide for these failures while seeking the unusual profits from the successes, a firm producing a line of housewares, toys, and/or sporting goods should be strong financially.

The Markets

As with most of the other applications discussed in this report, the market information is limited. Modern Plastics\(^1\) estimates that plastics used in housewares in 1956 exceeded 150 million pounds. At the same time plastics are the fastest growing products in the housewares field. The present wholesale value of plastic toys is estimated at $150 million. The forecasts for toys, based upon an increase in child population, an increase in disposable income, and the present emphasis on buying better quality and higher priced toys, point to a rapidly expanding market for these products. A similar outlook exists for the sporting goods industry.

While transportation cost is a secondary factor in the sale of these products, it certainly cannot be discounted entirely. Freight accounts for about 8 per cent of gross sales of housewares (though molders are presently working to reduce both the rates and the percentage). A producer who is able

\(^1\) "Housewares = 75,000 Tons of Plastics," Vol. 35, p. 110, Oct. 1957.
to compete successfully with respect to the other primary factors would, of course, have a competitive advantage in this geographical area. Present production is predominantly carried out in the North and on the West Coast.

Sales Management's estimate of effective buying income for 1957\(^1\) shows that Georgia and the surrounding geographical area have the following buying power (expressed as a per cent of the U. S. total):

- Georgia: 1.6548
- Florida: 2.1696
- North Carolina: 1.8317
- Tennessee: 1.4311
- Alabama: 1.2568
- South Carolina: 0.8402

Total Southeast: 9.1842
Total South: 24.4693

If these indicators are taken as a measure of the ability to buy the products under consideration in these applications, it is evident that the market available in the South is of significant proportions. Applying these percentages to the rough estimate\(^2\) of total plastic housewares retail sales of $300 million, the figures below are developed as an estimate of the market available for housewares.

- Georgia: $5,000,000
- Florida: 6,500,000
- North Carolina: 5,500,000
- Tennessee: 4,300,000
- Alabama: 3,800,000
- South Carolina: 2,500,000

Total Southeast: $27,600,000
Total South: $73,400,000

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2/ The method of estimating the retail value of plastic housewares sold should be noted. The Monsanto Chemical Company (Plastic Housewares, Monsanto Chemical Company, Plastics Division, Springfield, Massachusetts) has analyzed the polyethylene and styrene housewares market and has determined an average retail price per pound for each in 1955. When weighted by their relative importance, the average retail price per pound for both materials was estimated at $2.00 for that year. Assuming this figure to be representative of all
Using a similar technique, an estimate of the toy market at wholesale prices may be made based upon the figure of $150 million given above. This produces rough figures of $2.5 million for Georgia, $13.8 million for the Southeast, and $36.7 million for the South.

The markets in this area appear to be quite substantial. These markets are not being served by southern producers to any significant degree. Here is an opportunity for a new firm or for diversification by an established firm. Firms located in Georgia would have the advantage of being located in the center of a great market.

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plastic housewares and applying the figure to present estimated annual consumption of resins in housewares, 150 million pounds, the total retail value of $300 million was determined. This agrees with the estimate that would be obtained by taking 10 per cent of the National Housewares Manufacturer's Association estimate of total retail sales of housewares (Modern Plastics, Vol. 35, July 1958, p. 75). This figure of 10 per cent is one major producer's estimate of plastics' share of the total housewares market (Modern Plastics, Vol. 35, January 1958, p. 115).
F. Piping

As in other plastic product applications, plastic pipe owes its present success and future potential to two factors. First, its characteristics make it superior to many present pipe materials and provide a tremendous market as a substitute for metal, cement, clay, and other materials. Second, its characteristics open up new market opportunities for pipe.

The importance of plastic pipe displacement of existing materials can be seen by examining the list of polyethylene and vinyl pipe producers. Several of the rubber companies, together with ferrous product manufacturers, such as Republic Steel, Wheeling Steel, and U. S. Steel, have entered the field.

Characteristics and Markets

Plastic pipe can generally be characterized as tough, light weight, corrosion resistant, acid and alkali resistant, relatively inexpensive, and economical to install. The installation advantages of plastic pipe over conventional pipe are evident from the fact that a 400-foot roll of 3/4 inch polyethylene pipe weighs only about 50 pounds and can be laid down by machinery in a continuous trenching-and-laying operation.

Plastic pipe has limitations which must be recognized, however. Such factors as the brittleness of PVC pipe at low temperatures and the stress and fatigue problems encountered by polyethylene may present difficulties. As for cost, plastics have the advantage of a downward price trend compared, for example, with the upward movement of metal prices.

Vinyl pipe finds its principal markets in such process industries as paper, textiles, food, chemicals, and petroleum. Polyethylene pipe also commands a substantial volume market in industrial applications, but its principal uses are found outside this field.
The following are estimates of 1957 and 1960 United States polyethylene consumption (in millions of pounds of resin).

<table>
<thead>
<tr>
<th>Application</th>
<th>1957</th>
<th>1960</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm water lines</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Household piping</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Jet well lines</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Lawn watering lines</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Swimming pools and skating rink piping</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Corrosion and petroleum product piping</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Irrigation and sub-irrigation lines</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Mine piping</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Uses

The above estimates indicate that farm water lines, household piping, jet well lines, and lawn watering systems are expected to have an annual increase of approximately 33 per cent. This would mean a jump from 29 to 52 million pounds from 1957 to 1960. Each of the products mentioned is an important market for this geographical area. Farm water lines provide a growing market in Georgia. Relatively low cost, flexibility, and light weight make polyethylene pipe particularly popular as a water carrier in farm applications.

Temperature and pressure limitations sharply restrict the use of polyethylene in household piping. Yet in 1957 consumption estimates for this application are given as eight million pounds. Further expansion of this market is expected in uses where temperature and pressure requirements are not critical. The future development of plastic materials which would economically meet these requirements would open a tremendous market.

Plastic piping is rapidly taking over many well line applications. A large regional pipe wholesaler has stated that over 95 per cent of all present pump sales involve accompanying sales of plastic pipe. Lawn watering systems for private homes, golf courses, cemeteries, parks, and similar uses offer still another good market. If such systems were installed in only one per cent of the one- and two-family homes being constructed each year, about 20 million pounds of resin would be consumed by this application alone.

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Plastic hose, a flexible pipe product, should be considered as a part of a discussion of pipe. Thus far polyvinyl chloride hose is the only garden hose which has a large sales volume. Seven million pounds of resin were consumed in 1957 by this product. A separate report has been initiated by the Industrial Development Branch in which the feasibility of plastic hose production in Georgia is evaluated. Therefore, no further treatment of this product will be attempted here.

The outlook for plastic pipe can be briefly summarized as follows: Present United States sales, in excess of 50 million pounds of resin, provide a firm basis for further expansion of this application. To be sure, certain difficulties stand in the way of immediate realization of the tremendous potential which the properties of this pipe clearly indicate. But continuing technical and marketing improvements will further increase the present rapid growth rate. A Georgia producer could serve the southern market now and, in a short time, compete in the national market. The potentials seem almost unlimited for an aggressive firm.
G. Boating

During the five-year period 1953-1957, reinforced plastic boat production has experienced a phenomenal advance. Modern Plastics\(^1\) magazine estimates United States production for the period 1946 through 1953 at 4,000 units. In the single year 1954, 16,000 units were produced--four times the previous seven-year total. Production estimates for 1957 stand at approximately 58,000 units. The principal fiber producer in this field has predicted 1958 sales of from 70,000 to 75,000.

The Market Prospects

Two growth rates are of interest in evaluating plastic boat sales, for plastic boats are actually experiencing a growth within a growth. Total outboard boat sales have increased 44 per cent over the past four years. At the same time, plastic boat sales, as a per cent of total outboard boat sales, have advanced dramatically. In 1954 plastic boats represented only 7 per cent of total outboard boat sales. At present (1957 estimate), reinforced plastic boats account for approximately 18 per cent of total outboard boat sales. And one authority recently predicted that within 5 years, plastic boats will secure 60 to 70 per cent of this market. This explains why, in 1957, when total outboard boat sales experienced a decline of 74,000 units, reinforced plastic boats showed an increase in production of approximately 18,000 units.

There can be little doubt that the plastic boat market offers a tremendous potential. At present over 150 firms in the United States are manufacturing such boats and are consuming over 25 million pounds of reinforced plastics per year. The following physical properties are major advantages which the plastic boats enjoy:

1. They are not subject to corrosion, rust, or rot.
2. Little painting and maintenance are required.
3. They are impervious to marine borers.
4. They can be left in the water indefinitely.
5. There are no fasteners to work loose.

These advantages are important technical considerations, and they form a solid foundation for the predicted growth trends.

Estimated outboard boat sales for Georgia and the Southeast were arrived at by correlating boat sales to outboard sales. They are given below:

Southeast 1954 1955 1956 1957
Georgia 24,300 29,600 35,700 39,500
3,500 3,600 4,500 5,000

These estimates correspond closely with the figures obtained by using the industry's rough measure of outboard boat sales, i.e., by taking one-half of the motor unit sales.

Analysis of these figures indicates that during the period 1954-1957 outboard boat sales in Georgia and the Southeast maintained a growth at least equal to that of the country as a whole.

Given the nationally equalized raw material prices, the strong market orientation is the result of the high cost of shipping the finished product. The high degree of market orientation of this segment of the plastics industry is readily apparent when the organizational structure of its manufacturing firms is examined. Though this is a new field, some of the important producers have moved rapidly toward branch plants. The Lone Star Boat Company of Texas has established plants in Florida and Indiana. Glasspar Company, a California producer, has branch production facilities at Nashville, Tennessee; Olympia, Washington; and Petersburg, Virginia.

This strong market orientation, combined with the sales opportunities for plastic boats in Georgia and the surrounding states, makes this product a bright prospect for further development here.

There are several significant aspects of the plastic boat field that deserve consideration. Plastic boat manufacturing may be entered with as little as $1,000 capital. This low capital requirement, along with the fact that large-scale production does not bring significant economies, indicates the possibility of a number of small single-plant operations. Yet larger firms apparently control the bulk of the market. The reasons for this situation are found in the factors of styling and quality. Styling has been one of the chief reasons for the growth of plastic boat sales. Stern fins, for example, are prevalent today. Plastics are capable of being formed into intricate lines that cannot be achieved in the construction of wooden boats. The style leaders have set the growth pattern for the industry.

Two recent technological developments should be noted. A spray gun has been developed for applying synthetic resin to the boat mold; as a result, production efficiency should increase. This development is representative of
the technological improvements that will undoubtedly play an important role in the growth of the plastic boat industry.

Of more fundamental significance is the promise of molded hulls. Replacement of the present hand production methods of molding operations would create economies of scale that would permit a still larger market area. Production cost reductions would further accelerate the present expanding plastic boat market. An evaluation of future technological innovations in this application will be an important part of the further study of this particular product.

Plastics have made inroads into the boating field in other than the reinforced plastic hulls themselves. Among the products which are presently enjoying substantial sales volumes are: acrylic windshields, nylon fittings and propellers, ornamental plastic parts, butyrate identifying letters and numerals, polyethylene boat and motor covers, vinyl upholstery, nylon and polyethylene cordage, and polystyrene foam flotation material.

As the boom in the boating field continues, such products will be profitably produced in volume in this area. Georgia has already been selected as a prime location by a number of boat manufacturers. Expansion into the plastics application here would appear to be "a natural."
H. Agriculture

In the opinion of many industry representatives, the rate of growth of agricultural applications of plastics materials over the next few years probably will lead all other applications, except for construction. With respect to absolute growth, however, agricultural applications will not be quite so impressive. The estimated national production of resins for agricultural films did not exceed 300,000 pounds in 1956, while an estimate of resins for construction applications in the same year is more than 1,000 times that figure. Then, too, the innovations that plastics have to offer in the agricultural field are markedly more limited than in some of the other applications. A final consideration is that uses in the South probably will not come up to the United States average.

Uses

Film and sheeting are the dominant forms of plastics materials that are finding uses in agriculture. (Low pressure water piping for rural areas is presently consuming far more resins than is agricultural films, but since piping is not strictly agricultural in nature, this application has been discussed separately.) Polyethylene and vinyl lead all other resins used in films for agriculture.

Because film is the dominant plastics form in this application, transportation costs are not as important in agricultural uses as they are in boating. However, present technological processes do not lead to economies of scale in film production. Furthermore, there is no product differentiation. Hence, as competition intensifies, transportation costs will become an important factor.

The uses discussed below are the most prominent in agriculture. Other uses, less significant individually, include: wrapping for plants for shipment; machinery covers; covers for cotton bales, haystacks, etc.; wrapping for cut flowers; covers for fumigating of stored crops and soils; and insulation for inexpensive farm out-buildings. The last application would find a volume market in Georgia, particularly in the case of chicken houses. An important horticultural market is being developed in artificial flowers of

molded polyethylene and vinyl. Estimates indicate that this use now represents an annual United States market for plastic resin of approximately $3 million.¹

**Mulches**

Mulching is employed by the agricultural industry to keep soils around plants soft and moist, to lower the labor content of crops, to increase production, and to bring about significantly lower costs. Such materials as peat moss, buckwheat hulls, salt straw, and newspapers have been used as mulch in the past with some success. Now plastic film appears to offer the advantages of both lower cost and greater effectiveness. Experiments conducted under the direction of Dr. E. M. Emmert of the University of Kentucky Agricultural Experiment Station² have established that black polyethylene film performs the mulching functions better and more economically than any other mulch ever tried.

The plastic film is an excellent moisture barrier, which prevents evaporation of ground moisture. It protects the soil from being compacted and baked by driving rain and heat. It protects the fruit of plants that grow above ground from harm caused by contact with the soil. And the opaque film cuts off sunlight, thereby stopping weed growth. These are only some of the major advantages that the film offers the farmer.

In addition to its technical advantages, plastic film offers cost advantages. An inexpensive machine which is available for laying the film mulch can be attached to a conventional cultivator. When handled with care, this mulch can be used through several plantings. Variations of the film are available, including pre-cut holes and grid-printing to facilitate better spacing.

It has been estimated that some 8 million acres³ of farm land in the United States could use film mulching. It is further estimated that about 25 per cent of polyethylene and vinyl film for agricultural uses will go into mulching. The southeastern market should offer a considerable volume of plastic film mulching as a means of making row crop production more efficient and profitable.

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Greenhouses

For greenhouses, in addition to cost advantages, there are other gains possible through use of film, notably in the yield and quality of crops. The greater moisture retention and lower heat loss at night in a plastic greenhouse give the plastic a quality advantage over the glass variety.

Primarily, however, cost considerations have brought about the acceptance of plastic films for greenhouse construction. Though the film must be replaced each year, it has been estimated that a plastic greenhouse may cost as little as one-tenth as much as a glass greenhouse. Construction is simple, since the films are nailed, stapled, or otherwise easily fastened to a simple wooden frame. As a case in point\(^1\) a plastic greenhouse, 8 x 120 feet was built in 1955 at an approximate cost of $500 for labor and materials. Estimated annual film replacement cost was figured at $150. This figure is in marked contrast to the $3,000 that would be needed to cover labor and materials for a comparable conventional greenhouse.

The market in the United States may be estimated from figures on the number of greenhouses presently standing--approximately 17,000 in 1957, covering about 5,000 acres of land. As the urban areas of the Southeast increase in importance, the practice of growing flowers and crops under greenhouse cover can also be expected to expand. Greenhouse operators in this region will want to take advantage of the cost savings made possible by the use of film.

Silo Covers and Caps

The expected growth of Georgia's cattle industry should further increase the importance of silage in the State. The advantages offered by silage as fall and winter cattle feed are well known. It is estimated that two acres of feed crop properly ensiled are equal to three acres of the same crop made into hay.

Plastic film is a simple and economical cover for a trench silo or for stacked feed. In addition, the film can be used as a cap for standard silos. Conventional equipment for silo facilities costs thousands of dollars. By comparison, the cost of plastic trench silo covers is very small. Moreover, the savings made possible by reduced spoilage often substantially exceeds the cost of the cover. Modern Plastics magazine\(^2\) points out that the spoilage

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\(^{1}\) "Film on the Farm," Modern Plastics, Vol. 34, Sept. 1956, p. 112.

\(^{2}\) Ibid.
of 400 to 500 tons of silage stored in an unprotected trench measuring 16 x 90 feet would normally represent a loss of about $335. In contrast, it would only cost about $150 to cover the trench completely with vinyl film.

Irrigation Ditches and Pond Liners

The moisture barrier characteristic of plastic film can solve one of the principal problems in the storage and transportation of water for farm uses. It is estimated that one-third of all water used for irrigation is lost by seepage through the soil. The same problem is encountered in stock-watering ponds. Plastic pond and irrigation ditch liners can reduce these water losses through seepage to a negligible amount.

Plastic sheeting has also been employed as a "portable ditch." Flexible irrigation tubes fabricated of plastic can be used as irrigation ditches and, when not in use, rolled up for storage. Over one million feet of flexible vinyl irrigation tube is already in application in the United States.

As the need for more effective and efficient utilization of land increases these applications of plastics should increase also. It has been estimated that 25 million acres of land today require irrigation, and an equal amount would be more productive if properly irrigated.
III. PROCESSING AND FINISHING

Because plastics firms are usually organized according to the manufacturing method used, a businessman planning to enter the field must know something about production. He should be able to anticipate some of the technical production problems. Certainly it is important for him to know the complex of products that can be made with the same equipment. This chapter is a non-technical description of basic production methods and includes only those aspects of production essential to a man entering the plastics business. Because processing and finishing are most likely to be established in Georgia, these are the production methods discussed.

Processing

Processors purchase the resins from the raw material manufacturers or in some cases from independent compounders. Typical forms of resin are granules, powder, pellets, flake, and liquids. The processor's function is to form the resin into solid shapes. These are generally small firms. (The distribution of firms by number of employees in 1954 is shown in Table I.) It will be noted that 66 per cent of the firms had fewer than 20 employees and that none had more than 2,500 employees. The number of small firms is related to the fact that there are no significant economies of scale in processing and that the firms are market oriented, as indicated earlier. The major chemical companies do not compete because they are more interested in the production of the raw material than in processing. Despite these facts there are very few processors in Georgia. This means that there should be a profit opportunity for such firms in the state.

Processing includes many different types of manufacturing. Firms usually specialize in one type because the production techniques and products are so different that it is difficult for one firm to cover a wide range of processes. The major types are molding, extruding, high-pressure laminating, coating, and reinforced plastics manufacturing. Each process will be discussed in turn.

Molding

There are many different types of molding. The type to be used depends upon the product and the volume to be produced. The equipment required is quite varied. The major types are compression, injection, and blow molding.
Table I

SIZE OF PLASTIC PROCESSING FIRMS

1954

<table>
<thead>
<tr>
<th>Number of Employees Per Firm</th>
<th>Number of Firms</th>
<th>Total Number of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 4</td>
<td>807</td>
<td>1,980</td>
</tr>
<tr>
<td>5 - 9</td>
<td>419</td>
<td>2,974</td>
</tr>
<tr>
<td>10 - 19</td>
<td>384</td>
<td>5,573</td>
</tr>
<tr>
<td>20 - 49</td>
<td>430</td>
<td>13,801</td>
</tr>
<tr>
<td>50 - 99</td>
<td>200</td>
<td>13,928</td>
</tr>
<tr>
<td>100 - 249</td>
<td>132</td>
<td>20,211</td>
</tr>
<tr>
<td>250 - 499</td>
<td>40</td>
<td>13,824</td>
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<tr>
<td>500 - 999</td>
<td>24</td>
<td>15,616</td>
</tr>
<tr>
<td>1,000 - 2,499</td>
<td>3</td>
<td>4,058</td>
</tr>
<tr>
<td>Total</td>
<td>2,439</td>
<td>91,965</td>
</tr>
</tbody>
</table>

Compression is the oldest and simplest, and can be used for a wide variety of products, such as housewares and toys. The equipment consists of a press and a mold. The resin in the form of molding compound is placed in the mold. With pressure and heat the product is formed to the shape of the mold. This description is, of course, simplified. In many cases the mold and press have many automatic features. Often the compound is preheated and even preformed before going into the mold.

Injection molding can be used for substantially the same products as compression molding. But generally it is used for smaller products with a larger volume, since it has more automatic features and therefore is faster.

In injection molding the compound is placed into a hopper from which it is fed into a heating cylinder. Temperature control in the cylinder is obtained by wrap-around electric heating units or by some other method. The cylinder is equipped with a piston which forces the material through a nozzle and into the mold. The piston operates in such a way as to force the correct amount of plastic into the mold with each "shot." The temperature of the mold is lower than the softening point of the material and thus the mold rapidly absorbs heat from the soft plastic, causing the material to harden.

The finished product is removed from the mold automatically or by an operator. The molding cycle is extremely rapid, with an average time of 10 to 30 seconds. By the time the product is removed from the mold, a new charge of material has been softened in the heating cylinder and the cycle is ready to be repeated.

Blow molding consists of forming a shell of semi-molten plastic material against a female mold. Air is used to force the material against the sides of the mold, much as one would inflate a balloon. After the material solidifies, the mold is opened and the finished product removed. This type of molding is used primarily for squeeze bottles and other types of containers.

These are the major types of molding. There are others for specialized purposes. Jet molding is similar to injection molding but uses a special nozzle with a small aperture. After each shot the nozzle is quickly cooled to prevent overheating the material in the cylinder behind it. Otherwise the process is the same as injection molding. Two other types, shell and plastisol molding, will not be discussed here, since they are less commonly used.
Extruding

Extruders produce elongated plastic products such as pipe, sheets, film, wire-covering, and some types of fibers and monofilaments. Many architectural shapes are extruded and then cut to the desired length. Normally the process consists of placing the compound in a hopper. The material feeds from the hopper by gravity and is then taken by a screw through a cylinder. After heating in the cylinder it is forced through a die and onto a take-off conveyor.

There are many variations in this process. The screws taking the material through the cylinder have a wide variety of pitch and design. Some applications use two parallel screws, either meshed or nonmeshed. The process is continuous. Because of the economies it offers, it is favored by manufacturers and is one of the fastest growing processes.

High Pressure Laminating

Laminating is used to produce sheets, rods, and tubes. Table tops and packages for frozen foods are typical products. The process consists of impregnating the basic material, such as wood, paper, or cloth, with a liquid resin. The impregnated material is stacked between polished steel plates in a hydraulic press. Heat and pressure cause the resin to flow and then harden, thus forming the sheets into solid structures. By using curved instead of flat steel sheets, various shapes can be made by a type of compression molding.

Coating

Materials are sometimes coated with plastic for decorative effects, preservation, and corrosion prevention. The material coated may be textile, paper, leather, metal, wood, or even other plastics. The final product may be upholstery, rainwear, packaging, floor tile, wall covering, or special textiles. Some of the processes are simple, as when the plastic coating is applied by brushing, spraying, or dipping. In other cases the process is more complicated.

This phase of the plastics processing industry offers possibilities for the diversification of the textile industry, because many of the materials for coating are textiles. Textile companies can diversify into plastics by coating the raw materials which they now produce.
Reinforced Plastics Manufacturing

Reinforced plastics products are notable for their great strength, light weight, and ability to be molded into large shapes. They are made with a combination of resins and reinforcing materials, such as glass fibers, cloth, sisal, and hemp fibers. These products include boats, furniture, transportation equipment, and construction materials. The technology is extremely simple. Many of the plastics used cure at room temperature and pressure. Large shapes are not difficult to produce. The process involved is lamination at low pressure.

Fabricating and Finishing

This category of plastics production activity consists of firms that work with the output of the processors and fashion finished products. Included in this group are the vacuum formers who mold sheeting into such shapes as signs, housings, and containers. Such items as flashlight cases and stick deodorant containers are fabricated from tubes. Rods are further fashioned into towel racks. Included among the finishers are the printers and embossers who finish film, sheet, and other plastic materials.

Like the processors, the fabricators and finishers are market oriented. They are characteristically small firms, though large in number. Some 3,000 such firms are listed by The Society of The Plastics Industry. Opportunity definitely exists for the expansion of this facet of the industry in Georgia.
IV. WHY PLASTICS IN GEORGIA?

The outstanding reason why the plastic processing and fabricating industry would be profitable in Georgia is that the industry is market oriented. Freight on raw materials is prepaid by the suppliers with no geographical price differential.

Once the production process is set up, relatively unskilled labor can operate the machines. Yet the finished product, especially if it is large or calls for special packaging or handling, may require a rather high cost for transportation to the final consumer. This is especially true for boats, which are transported on trailers similar to automobile carriers.

Processors and fabricators generally do not have significant economies of scale in production. Most of the firms are small: in 1954 about half the companies had less than 10 employees. This, then, is an industry which locates near the market.

Site requirements are not restrictive to any degree. About the only requirement is adequate transportation facilities for shipment of raw materials and the finished products. For this reason suburban and even rural locations may be quite suitable. The industry certainly has possibilities for Georgia's low-income counties.

Market Situation

Georgia is in the center of a large market which includes a half dozen or more states. The finished product does not have to be shipped long distances to serve this market. Since Georgia is in the heart of the market but at some distance from the eastern and western industrial sections, there is no major competition from firms in those areas. Georgia already has a well-developed distribution and transportation system for numerous other products in the Southeast. This system can readily accommodate plastics.

Labor and Diversification

Also, Georgia has an abundant labor supply. Farm labor is easily trained for jobs of the type found in plastics production. Textile workers can probably be quickly retrained for the unskilled or semi-skilled jobs which prevail in plastics work. It should be relatively easy for both
textile managers and workers to switch over to plastics processing. The main reason is that these industries are similar in character. Production in both industries is by small units which work in parallel. In the textile industry it is by looms and spindles; in plastics processing it is by molds and extruders. In both industries the operator sees and often touches and handles the product. This is in contrast with the chemical and petroleum refinery industries where the only contacts of many operators with the product are recording instruments, dials, and valves.

In addition to the adaptability of labor, some of the plastics products are particularly suited for textile diversification. In specific applications such as coating and laminating, for example, the textile industry would be able to use its present marketing channels effectively.

The Plastics Industry Now in Georgia

From Map I presented earlier in the summary of this report, it is apparent that the plastics industry is almost nonexistent in Georgia and the Southeast. The small portion of the industry in Georgia includes only about 20 firms whose products consist primarily of plastics. Many other Georgia firms are not primarily in the plastics industry but produce plastics as a supplementary line. For example, one company in the textile machinery industry manufactures some of its parts from plastics. If these firms are included, the number of firms in the plastics industry in this state is raised to 75.

Capital and Competition

Capital requirements are relatively small for the firm interested in plastics processing and fabricating. The wide variety of products involved quite naturally results in large differences in capital requirements; nevertheless, some generalizations can be made. The average balance sheet for 1,800 processing companies, shown in Table II, shows the nature of the existing capital structure of this phase of the industry. While this balance sheet represents predominantly established firms, many spokesmen believe that a firm can successfully enter the industry with an investment of approximately $40,000.

1/ A directory of these firms was compiled in 1955. In this directory over half of the firms had 25 employees or less. A complete and up-to-date directory is not available but is being compiled by the Industrial Development Branch.
Table II

THE PLASTIC MOLDING AND EXTRUSION INDUSTRY - PROTOTYPE COMPANIES
Balance Sheets, December 31, 1955

<table>
<thead>
<tr>
<th>Assets</th>
<th>Injection Industry</th>
<th>Injection Net Worth under $100,000</th>
<th>Injection Net Worth above $100,000</th>
<th>Compression</th>
<th>Extrusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>$59,000</td>
<td>$10,000</td>
<td>$72,000</td>
<td>$124,000</td>
<td>$56,000</td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>122,000</td>
<td>22,000</td>
<td>166,000</td>
<td>204,000</td>
<td>125,000</td>
</tr>
<tr>
<td>Inventory</td>
<td>138,000</td>
<td>17,000</td>
<td>199,000</td>
<td>222,000</td>
<td>135,000</td>
</tr>
<tr>
<td>Total Current Assets</td>
<td>$319,000</td>
<td>$49,000</td>
<td>$437,000</td>
<td>$550,000</td>
<td>$316,000</td>
</tr>
<tr>
<td>Fixed assets net of depreciation</td>
<td>$210,000</td>
<td>$42,000</td>
<td>$324,000</td>
<td>$297,000</td>
<td>$181,000</td>
</tr>
<tr>
<td>Other assets</td>
<td>25,000</td>
<td>4,000</td>
<td>39,000</td>
<td>30,000</td>
<td>25,000</td>
</tr>
<tr>
<td>Total assets</td>
<td>$554,000</td>
<td>$95,000</td>
<td>$800,000</td>
<td>$877,000</td>
<td>$522,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liabilities and Net Worth</th>
<th>Injection Industry</th>
<th>Injection Net Worth under $100,000</th>
<th>Injection Net Worth above $100,000</th>
<th>Compression</th>
<th>Extrusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts payable</td>
<td>$69,000</td>
<td>$16,000</td>
<td>$91,000</td>
<td>$87,000</td>
<td>$80,000</td>
</tr>
<tr>
<td>Bank loans</td>
<td>19,000</td>
<td>2,000</td>
<td>35,000</td>
<td>8,000</td>
<td>29,000</td>
</tr>
<tr>
<td>Other loans</td>
<td>18,000</td>
<td>7,000</td>
<td>19,000</td>
<td>42,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Other current liabilities</td>
<td>64,000</td>
<td>7,000</td>
<td>91,000</td>
<td>122,000</td>
<td>56,000</td>
</tr>
<tr>
<td>Total current liabilities</td>
<td>$170,000</td>
<td>$32,000</td>
<td>$236,000</td>
<td>$259,000</td>
<td>$177,000</td>
</tr>
<tr>
<td>Long term debt</td>
<td>$65,000</td>
<td>$12,000</td>
<td>$121,000</td>
<td>$62,000</td>
<td>$45,000</td>
</tr>
<tr>
<td>Net Worth</td>
<td>$319,000</td>
<td>$51,000</td>
<td>$443,000</td>
<td>$556,000</td>
<td>$300,000</td>
</tr>
<tr>
<td>Total liabilities and net worth</td>
<td>$554,000</td>
<td>$95,000</td>
<td>$800,000</td>
<td>$877,000</td>
<td>$522,000</td>
</tr>
</tbody>
</table>

Source: Tarnell, "The Plastics Molding Industry"
This raises the question of competition and its consequent effects on profits. Offsetting the advantage inherent in small investment requirements is the possibility that a large number of firms may enter the field, with resulting pressures on profit margins. The apparent profit situation in plastics today is closely tied to three factors: innovation, growth, and quality. It is imperative that the prospective Georgia manufacturer understand the significance of these factors.

**Research and Development**

The growth of the plastics industry has been characterized by an increasing rate of new product development and improved manufacturing and marketing technique. The properties possessed by plastics may be taken advantage of through the development of entirely new products, through the displacement of existing materials, and through the combination of plastics with other materials. Those firms which are aggressive in developing these innovations will realize the greatest profits. A great deal of research and development will be required if construction, furniture, and packaging applications, for example, are to realize their potentials. The leaders in product development will be among the firms that reap the exceptional profits that are possible in plastics.

Technical innovations are of similar importance. Machinery and methods that will reduce the amount of labor in production processes through the continuous mass production of goods are important needs at present. The recent development of a "spray-up" method of working with reinforced resins is, for example, an improvement which probably will be of tremendous value in boats, swimming pools, and construction applications.

In some product areas, product development has moved far ahead of market development. The firm able to open up channels for the flow of these products will be in a highly advantageous position as the growth of the plastics industry continues. In furniture, a major consumer-education program is needed. Construction applications are presently available which could be expanded rapidly if builders and contractors were aware of their advantages. Agricultural products have lagged far behind their present potential because of the slow development of these markets.
Profit Potentials

There are, in short, outstanding profit possibilities for the innovator in product development, production techniques, and marketing. The firm with the vision, creativeness, and resources required for such development will be a leader in the industry's growth. As products become accepted and large markets are created, the businessman can expect extensive competition to develop. At some stage in the growth curve of the product, the innovator may want to begin devoting his efforts toward other channels. Alternately, and perhaps in most cases, he will want to take advantage of his commanding position and attempt to maintain it. His choice will be based on the particular circumstances involved.

In any event, as a product begins to gain wide acceptance, and as large numbers of producers enter the field, the leading firms have characteristically moved toward quality emphasis with concurrent attempts at establishing brand names. Boats and pipe are excellent examples of this process. Over 150 firms are presently manufacturing plastic boats. Investment cost is small, transportation cost high, and designs are fairly easily copied. The products of the leading firms are easily distinguishable from those of the bulk of the manufacturers, however. These leaders produce a well-finished boat and pay continuing attention to styling and color. So while a large number of firms can be listed as boat manufacturers, the competition for the greater part of the market is considerably more restricted.

This pattern, as it relates to quality, is found to be quite similar in the case of pipe. Again investment cost is low, and almost 200 firms are competing in the market. Polyethylene pipe, the most important of plastic pipes, is illustrative. Many of the producers have made continuous reductions in their product's quality to increase their sales volume. Other firms are devoting considerable effort toward the establishment of enforceable standards. In the meantime, they are maintaining their market positions through emphasis on quality. As standards are enforced the companies producing the better grade pipe will emerge in even more favorable positions.

Major Problems

Two problems are of particular significance to the prospective Georgia plastics producer. While many workers in the plastics firm are unskilled, highly skilled men are needed to direct the work, to set up the molds and
presses and to carry out other essential tasks. Needed are trained en-
gineers and technicians who are not generally available in this region. The companies now operating in the State have brought in these key men from other areas.

The second problem involves the shortage of capability in mold and die production in the Southeast. With but a small plastics industry in the Southeast, there is a shortage of tool and die men to make molds. This situation will continue until there is sufficient demand for tool and die work and the men can be trained or attracted to this region. In the meantime, plastics processors in Georgia must get molds from other sections of the country. Although it is inconvenient, especially since molds must be tested and frequently retested, present processors in the State operate successfully under these conditions.

**Entering the Industry**

A company can grow into the plastics industry by diversifying its current operations. It can enter through the development of either production or distribution. For example, textile and paper firms have an opportunity to diversify into the production of plastics. Or, although plastics products related to the established line are usually good products for diversification, completely new plastics products can also be added. Eventually, as the market grows, these new products could completely replace the old. With the current rapid growth in the sale of plastics, either diversification or the manufacture of new products offers a great opportunity.

Entry through the development of new markets and distribution channels and diversification of present production have been found attractive by some tire and rubber companies. Thus, some are now in the plastic housewares field. Their work with rubber and molds is so similar to work with plastics that production problems cause little difficulty. But new channels of distribution and merchandising methods must be developed.

If a company does not have the production know-how, it may also enter the industry by contracting with other companies to custom mold the product while it develops the markets. Custom molders are organized for this type of operation and are quite interested in serving distributors.

To meet competition, as said earlier, the producer must always be alert to opportunities for the creation and development of new products. Therefore, he will find it to his long-run advantage to enter into distribution as well.
as production. Through direct contact with his customers he will best learn their reactions to his products and his customers may often supply him with new ideas about his products and their merchandising.

If he enters both areas, the producer must, of course, have more capital. He must build a sales and distribution group, and he must take on the additional responsibilities forced upon him by his own efforts to succeed as his own merchandiser. But these costs, big and small, usually pay off well in the end.

Already in progress, as noted earlier, is a series of follow-up reports which will focus on individual products or groups of products discussed under the eight applications covered in this industry-wide survey. Each will present a detailed analysis of a product or product complex recommended for manufacture in Georgia.
Appendix A

COMPARISON OF OPPORTUNITIES

For comparison of the various opportunities for the industry in Georgia a ranking system was devised. Three factors were selected as criteria for the evaluation:

1. Present market,
2. Future market potential,
3. Competition.

Each of these criteria was then graded for each application. Grades ranged from one through four with work descriptions of "uncertain," "satisfactory," "good," and "very good." Grades correspond to the desirability of the factor and not the strength of the factor. For example, if the present market is large, it is given a high rating, but if there is a large amount of competition, it is given a low rating.

Weights should be given to the factors. In some situations future market potential is probably more important than competition. In the absence of any evidence of the proper weights to assign, however, each factor is given an equal weight. Also there are interrelations among factors. Nevertheless the three factors are added for a total score.

The total scores provide a method for ranking the various applications. Textile and paper treating and coating tie with packaging and containers for the first place. Agriculture has the least potential. Other opportunities lie between these extremes.

Thus all applications can be ranked according to their potential for development in Georgia. The fact that four product groups, construction, furniture and cushioning, housewares, toys and sporting goods, and piping, receive a "two" rating and are close contenders for first place is clearly indicative of the opportunities in plastics. The results are shown in Appendix Table I.

The grades assigned, the factors selected, and their equal weights are subjective and are made by the researchers from their knowledge of the industry. This means that the system can result in different rankings of the various applications, depending upon the judgments made.
Among other factors, the ranking necessarily depends upon the type of prospective entrepreneur. A person with a small amount of capital to invest is looking for a different business opportunity than a person or firm with substantial capital. One with well-established business and marketing channels may be looking for a specific opportunity that will complement his other operations. Nevertheless, the researchers agree on the ranks assigned and believe that others familiar with the industry would probably arrive at substantially the same ranking, regardless of variations in the type of entrepreneur and other factors. Therefore, even with a minimum of objective evidence, this ranking appears to be reliable.

It will be noted that four product applications tie for second place—construction, furniture and cushioning, housewares, toys, and sporting goods, and piping. Their score is so close to that for first place, that it may well be that these four applications have a potential equal to those listed first. This means that many different plastic applications have about equal opportunities. Applications might therefore be selected to complement other business activities and to suit the personal interests and inclinations of the entrepreneur. Success will belong to those who are aggressive in developing the business, especially the merchandising function.
Appendix Table I

PLASTIC APPLICATIONS
RANKING OF OPPORTUNITIES

<table>
<thead>
<tr>
<th></th>
<th>Textile and Paper Treating and Coating</th>
<th>Packaging and Containers</th>
<th>Construction</th>
<th>Furniture and Cushioning</th>
<th>Housewares, Toys, and Sporting Goods</th>
<th>Piping</th>
<th>Boating</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Market</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Future Market Potential</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
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<tr>
<td>Competition</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
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<td>8</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Ranking</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>