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ABSTRACT

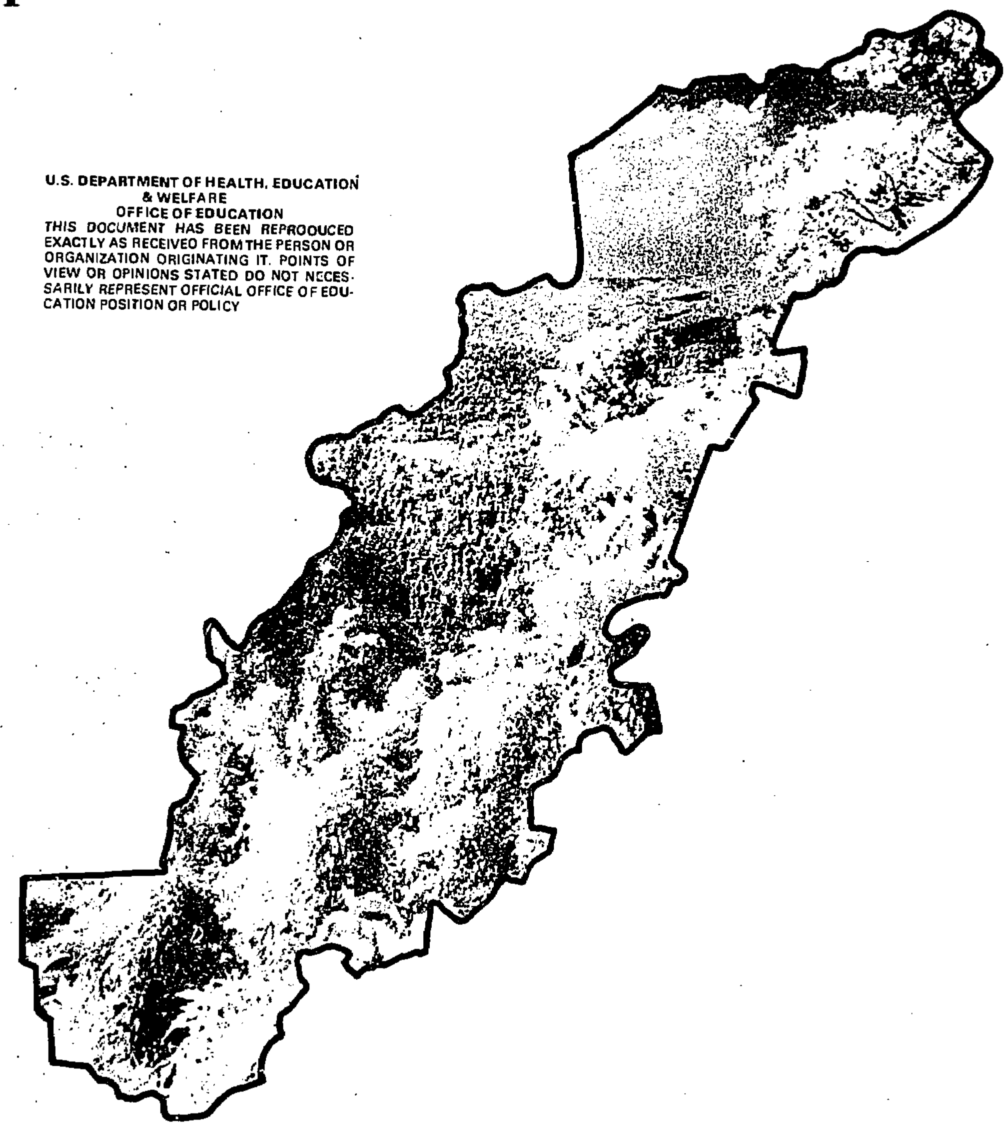
Nine industrial-location research studies of the Appalachian region are presented in this document. These studies relate to the casting, plastic, metal, and food industries. Each study devotes sections to (1) a profile of the industry, (2) the industry's prospects for growth, (3) technology and trends, (4) primary factors influencing selection of locations, and (5) selecting public-investment policies and activities which will enhance the competitive position of Appalachia. It is noted that, although some industry relies heavily on in-plant training through the apprenticeship programs, the area of vocational training is felt to be one of the most effective public investments for industry. Suggested course offerings for vocational education are given for some of the industries. Each study is appended with pertinent information. (Related documents are RC 004 206 and RC 004 211.) (AN)

APPALACHIAN RESEARCH REPORT

RESEARCH REPORT NO. 7

INDUSTRIAL LOCATION RESEARCH STUDIES:

Reports 17-25



Prepared For The Appalachian Regional Commission
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The INDUSTRIAL LOCATION RESEARCH STUDIES, prepared by The Fantus Company, Inc., have been compiled into the following APPALACHIAN RESEARCH REPORT volumes:

APPALACHIAN RESEARCH REPORT NO. 4

INDUSTRIAL LOCATION RESEARCH STUDIES: SUMMARY AND RECOMMENDATIONS

APPALACHIAN RESEARCH REPORT NO. 5

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REPORT NO. 1—THE PAPER AND ALLIED PRODUCTS INDUSTRY

REPORT NO. 2—THE TEXTILE MILL PRODUCTS INDUSTRY

REPORT NO. 3—THE APPAREL INDUSTRY

REPORT NO. 4—THE PRINTING AND ALLIED INDUSTRIES

REPORT NO. 5—THE ELECTRICAL COMPONENT PARTS INDUSTRY

REPORT NO. 6—THE TEXTILE MACHINERY/PUMPS & VALVES INDUSTRY

REPORT NO. 7—THE OFFICE MACHINERY INDUSTRY

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REPORT NO. 9—THE CHLOR-ALKALI INDUSTRY

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REPORT NO. 12—THE INSTRUMENTS AND CONTROLS INDUSTRY

REPORT NO. 13—THE NONCELLULOSIC SYNTHETIC FIBER INDUSTRY

REPORT NO. 14—THE METAL STAMPINGS INDUSTRY

REPORT NO. 15—THE AIRCRAFT AND AEROSPACE PARTS INDUSTRY

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REPORT NO. 17—THE NONFERROUS CASTINGS INDUSTRY

REPORT NO. 18—THE MALLEABLE AND DUCTILE IRON CASTINGS AND STEEL FORGINGS INDUSTRY

REPORT NO. 19—THE FOAMED PLASTIC PRODUCTS INDUSTRY

REPORT NO. 20—THE ROLLING, DRAWING, AND EXTRUDING OF NONFERROUS METALS INDUSTRY

REPORT NO. 21—MEAT AND POULTRY PROCESSING, DRIED AND FROZEN PRODUCE INDUSTRY

REPORT NO. 22—THE PLASTIC AND POWDER METAL PRODUCTS INDUSTRY

REPORT NO. 23—THE REFRACTORY METALS INDUSTRY

REPORT NO. 24—THE PRIMARY STEEL AND STEEL MILL PRODUCTS INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically Standard Industrial Classification industry codes 3361, Aluminum Castings; 3362, Brass, Bronze, and Copper Castings; and 3369, Zinc and Other Nonferrous Castings, Not Elsewhere Classified.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

The nonferrous castings industry consists of aluminum, brass and zinc operations that buy raw stock from primary smelters and cast metal shapes in dies or molds. The aluminum castings industry is about double the size of either the brass or zinc industries in terms of the number of employees, value added, value of shipments or the number of U.S. establishments.

By far the largest market for nonferrous castings is within the automotive parts industry, followed in size by the appliance and plumbing fittings markets. Oriented to the center of these markets, the nonferrous industry has located intensively in the East North Central states, with Pennsylvania high in the representation from the Middle Atlantic states.

Growth in this industry with $1.4 billion annual sales has been dependent largely on consumer spending for automobiles and appliances that in the aggregate has produced a 7 percent annual growth pattern. This growth, if constant, would have the effect of nearly doubling production in 10 years' time.

Die casting by machinery is by far the most important sector in the nonferrous castings industry. Casting operations have a high proportion of trainable skills that can provide job opportunities for male labor without much previous experience or technical training. Materials handling accounts for a high proportion of the work involved.

Transportation is a critical element of location. Since nearly half of the casting operations are job shops casting to customer specifications, there is a need for consistent delivery and direct liaison with the customer. Superior highway transportation to automotive and appliance manufacturers of the East North Central and Middle Atlantic states is essential to an Appalachian plant location.

Public investment at the state and federal level to build highways from central Appalachia will enhance the location attractiveness for the region.

Vocational training is the second most important area where public investment through federal aid and grants can condition the essential skill requirements for the nonferrous castings industry.

I. PROFILE OF THE INDUSTRY

Size

There are nearly 1,900 establishments in the U.S. that shipped $1.4 billion worth of nonferrous castings in 1964. In the same year, wages and salaries to the industry's 70,000 employees amounted to $439 million. Shipments of nonferrous castings in 1964 totaled 3,123 million pounds compared to 2,926 million pounds in 1963 and 2,816 million pounds in 1962.

As can be readily seen in Table 1, the nonferrous castings industry represents only 3.4 percent of the value of shipments in the primary metals industry. Capital expenditures have been relatively light in the industry, with the exception of plant and equipment expenditures for expanding the aluminum castings sector of the nonferrous group. More than half of the capital expenditure for the group was spent by the aluminum castings industry, the leading sector in many respects.

Table 1.

Rankings of the durable goods industries 1/

(Numbers in millions)

Industry rank	Employment		Value of shipments	
	TOTAL	9.199	TOTAL	$232,170
1	Transportation Equipment	1.624	Transportation Equipment	57,846
2	Machinery	1.537	Primary Metals 2/	40,036
3	Electrical Machinery	1.483	Machinery	34,219
4	Primary Metals 2/	1.179	Electrical Machinery	31,054
5	Fabricated Metals	1.116	Fabricated Metals	24,877
6	Stone, Clay, & Glass	.581	Stone, Clay, & Glass	12,973
7	Lumber & Wood	.562	Lumber & Wood	9,885
8	Furniture	.386	Instruments	6,616
9	Instruments	.309	Furniture	6,302
10	Ordnance	.234	Ordnance	4,421
	NONFERROUS CASTINGS	.070	NONFERROUS CASTINGS	1,354

Industry rank	Capital expenditures		Value added by manufacture	
	TOTAL	$7,130	TOTAL	$115,744
1	Primary Metals 2/	1,887	Transportation Equipment	23,961
2	Transportation Equipment	1,297	Machinery	19,762
3	Machinery	946	Electrical Machinery	18,039
4	Electrical Machinery	889	Primary Metals 2/	16,732
5	Fabricated Metals	728	Fabricated Metals	12,636
6	Stone, Clay, & Glass	626	Stone, Clay, & Glass	7,520
7	Lumber & Wood	369	Lumber & Wood	4,361
8	Instruments	165	Instruments	4,333
9	Ordnance	117	Furniture	3,225
10	Furniture	106	Ordnance	2,871
	NONFERROUS CASTINGS	45	NONFERROUS CASTINGS	725

1/ Source: 1964 Annual Survey of Manufactures
2/ Figures for "Nonferrous Castings" included in "Primary Metals".

The nonferrous castings industry can be broken into three sub-industries: (1) aluminum castings (SIC 3361); (2) brass, bronze and copper castings (SIC 3362); and (3) zinc and other nonferrous castings, not elsewhere classified (SIC 3369). Size relationships between these 3 industries are shown in Table 2. Data includes captive establishments to the extent that they file separate census forms.

Table 2.

Comparison of industries within the nonferrous castings group as of 1964 1/

	Aluminum castings	Copper-base alloy castings	Zinc & other nonferrous castings
Total Employees (000's)	37	16	18
Value Added ($000,000's)	382	158	185
Value of Shipments ($000,000's)	709	317	327
Number of U.S. Establishments 2/			
Total	954	549	391
Employment over 100	79	40	8
Shipments in Million Pounds 3/	1,254	891	978 4/

1/ Source: 1964 Annual Survey of Manufactures
2/ Source: 1963 Census of Manufactures
3/ Source: Current Industrial Reports, February 15, 1966, Bureau of Census
4/ Includes 32 million pounds of magnesium castings and 30 million pounds of lead die castings.

Products and Markets

Nearly one half of the products manufactured by the nonferrous castings industry are produced in captive plants. That is, the casting is but one of several processes in the assembly of a finished product, such as a sewing machine where the attachment of other parts and paint cover the basic housing--a zinc die casting. This study does not cover the location characteristics for captive plants in that the peculiar circumstances of the individual company will dictate the location of such facilities.

Automobile grilles, headlight trim, door handles, mirrors, transmission housings and engine blocks are but a few of the products made from die castings for the automotive industry alone. Housings for small appliances, power tools, typewriters, locks, gears, flanges and toys are among the innumerable products that are basically a casting that has been plated, anodized or painted.

The automotive industry is by far the most important market for aluminum and zinc castings. Valves, pipe fittings, pumps, compressors, instruments and controls are major markets for copper-base alloy castings. It is significant that these latter named industries are among those included in this Appalachia Region study. Though a minor market, magnesium castings are important to the aircraft industry.

A ranking of markets for zinc, aluminum, and copper-base alloy castings is shown by Tables 3, 4, and 5 which follow.

Table 3.

Industry consumption of aluminum castings 1/

(Purchases and interplant transfers)

Rank & Industry		Pounds 2/ (millions)
1.	Motor vehicles & parts	146.993
2.	Internal combustion engines	37.052
3.	Household appliances	28.335
4.	Aircraft & parts	26.394
5.	Metal doors, sash & trim	20.280
6.	Measuring instruments & temperature controls	15.672
7.	Electric lighting & wiring equipment	14.234
8.	Motors & generators	11.225
9.	Refrigeration equipment	7.750
10.	Farm machinery & equipment	6.705

1/ Source: Marketing Guide to the Metal Castings Industry, 1962 edition

2/ Above industries represented 314,640,000 pounds or 71 percent of all aluminum castings produced for sale during the year.

Table 4.

Industry consumption of copper-base alloy castings 1/

(Purchases and interplant transfers)

Rank & industry	Pounds 2/ (millions)
1. Valves & pipe fittings	56.334
2. Plumbing fittings, brass goods	19.906
3. Pumps & compressors	19.550
4. Measuring instruments & temperature controls	14.946
5. Hardware	9.246
6. Switchgear & switchboards	8.250
7. Steam engines & turbines	7.397
8. Ship and boat building & repair	6.661
9. Power transmission equipment	5.538
10. Electric lighting & wiring equipment	4.743
11. Construction & mining machinery	4.386
12. Motor vehicles & parts	4.037

1/ Source: Marketing Guide to the Metal Castings Industry, 1962 edition

2/ Above industries represented 160,994,000 pounds or 45 percent of all copper-base alloy castings produced for sale during year.

Table 5.

Industry consumption of zinc castings 1/

(Purchases and interplant transfers)

Rank & industry	Percent of total 2/
1. Automotive (motor vehicles)	47.1
2. Home appliances	21.0
3. Industrial & commercial machinery & tools	9.6
4. Plumbing & heating & builders hardware	7.4
5. Office equipment & business machines	4.1
6. Photographic, optical, recording devices, etc.	2.6
7. Electronic devices & communications equipment	2.1
8. Timing & time operated devices, clocks	1.8
All other industries	4.3

1/ Source: Marketing Guide to the Metal Castings Industry, 1962 edition

2/ These figures cover approximately 70 percent to 75 percent of total zinc castings production.

Distribution to these markets is direct from manufacturer to consumer. There is no significant middle distribution such as wholesaling or jobbing.

Plant Ownership and Size Structure

The industry has a reputation for including a large number of small firms. Several large, publicly owned firms are leaders in the nonferrous castings industry, but because their products are so diversified outside of the castings line, it is difficult to measure their concentration. Some of the more important metalworking industries, such as the automotive and appliance industry, make their own castings as part of a vertical integration of many processes.

Geographic Prevalence

The East North Central states account for 689 nonferrous castings establishments, while the Middle Atlantic Census District has 401 establishments of the 1,894 within the U.S. Table 6 provides details of regional distribution in the U.S.

A comparison of the number of die casting machines in production ranks the metropolitan areas of Chicago and Los Angeles at the top. (See Table 7.)

Table 6.

Regional distribution of establishments 1/

	SIC 3361	SIC 3362	SIC 3369	SIC Total
NEW ENGLAND				
Total	76	59	34	169
Employing over 50	7	5	2	14
MIDDLE ATLANTIC				
Total	153	150	98	401
Employing over 50	21	21	20	62
SOUTH ATLANTIC				
Total	49	17	14	80
Employing over 50	3	-	2	5
EAST NORTH CENTRAL				
Total	354	191	144	689
Employing over 50	67	25	43	135
EAST SOUTH CENTRAL				
Total	21	5	7	33
Employing over 50	3	1	-	4
WEST NORTH CENTRAL				
Total	68	29	21	118
Employing over 50	14	5	6	25
WEST SOUTH CENTRAL				
Total	54	22	13	89
Employing over 50	7	3	2	12
MOUNTAIN				
Total	15	7	4	26
Employing over 50	-	1	-	1
PACIFIC				
Total	164	69	56	289
Employing over 50	20	4	13	37
TOTAL U.S.	954	549	391	1,894
Employing over 50	142	65	88	295

1/ Source: 1963 Census of Manufactures

Table 7.

Metropolitan areas with concentrations of aluminum and zinc die casting machines 1/

Rank	Metropolitan area	No. of die casting machines
1	Chicago	692
2	Los Angeles	594
3	New York City	416
4	Newark	379
5	Detroit	341
6	Cleveland	301

1/ Source: Marketing Guide to the Metal Castings Industry, Foundry 1962, The Penton Publishing Co., Cleveland

Establishments producing copper alloy castings and aluminum castings are concentrated in Los Angeles, New York City and Chicago, as shown in Table 8.

Table 8.

Metropolitan areas ranked by number of establishments producing copper-base alloy castings 1/

(Aluminum castings establishments are shown unranked for comparison)

Rank	Metropolitan area	Number of establishments	
		Copper-base	Aluminum
1	Los Angeles	138	261
2	New York City	103	117
3	Chicago	98	183
4	Newark	87	113
5	Cleveland	84	138
6	Detroit	67	80
7	Pittsburgh	65	60
8	Philadelphia	61	69

1/ Source: Marketing Guide to the Metal Castings Industry, Foundry 1962, The Penton Publishing Co., Cleveland

Other than these concentrations of nonferrous castings operations, there is a nationwide diffusion of small establishments producing nonferrous castings. Aluminum castings are made in 39 states, and 19 states have 10 or more establishments. Copper-base alloy castings are made in 37 states, and 13 states have 10 or more establishments. At least 33 states produce zinc and other nonferrous metal castings.

Table 9 gives no indication of widespread Appalachian specialization for the industry, although Pennsylvania has an above average concentration of all the nonferrous castings industries.

Table 9.

Establishments within the Appalachian Region 1/

State	SIC 3361	SIC 3369	SIC 3362	Total
New York	1	2	3	6
Pennsylvania	23	5	29	57
Maryland	-	-	-	-
Virginia	-	-	-	-
West Virginia	-	2	5	7
Ohio	3	-	-	3
North Carolina	-	-	1	1
South Carolina	3	-	1	4
Georgia	5	-	-	5
Kentucky	-	-	-	-
Tennessee	7	1	1	9
Alabama	3	1	3	7
TOTAL	45	11	43	99

1/ Source: 1963 Census of Manufactures

Economic Impact

Payment of wages and salaries to employees provides the greatest impact on an area. Production workers in the nonferrous castings industry received average weekly wages of $112 in 1965, about average for the durable goods industry as a whole. The 70,000 employees in the industry were paid salaries and wages of $439 million in 1964, or $6,270 per employee.

For every $1,000 of gross output at least $718 is spent on goods and services. Table 10 shows that the primary nonferrous metal industries (i.e. copper, aluminum and zinc mills) receive the greatest share of this dispursement. The use of Table 10 has its limitations in view of the fact that it covers the entire non-ferrous metals industry. As a matter of note, the figures pertaining to direct purchases from nonferrous metal ore mining should be entirely discounted in reference to the castings sector of the nonferrous metals industry. Few, if any, castings plants would draw raw ore direct from the mine.

Purchases from the wholesale, retail, transportation and utility industries would consequently stand out as significant expenditures by the manufacturer. These expenditures create an economic value for the area in which a plant is located. The establishment of a single plant would not generally create sufficient demand to stimulate location of satellite industries. Clusters of nonferrous castings plants, such as in Cleveland, is an example of a market large enough to attract satellite industries. However, these clusters are not created as much by firms relocating in the areas as they are by spin-offs from other Cleveland castings companies. A spin-off takes place when two or three men within a company pool their financial resources and technical knowledge to go into business for themselves. This spin-off creates clusters of similar companies.

Table 10.

Direct requirements per $1,000 gross output for primary nonferrous metals manufacturing 1/

(Producer's prices, 1958 dollars)

Purchases from other industries	
Primary nonferrous metals manufacturers	$ 303.57
Gross imports of goods & services	85.41
Nonferrous metal ore mining	79.06
Wholesale & retail	33.87
Transportation & warehousing	21.53
Electric, gas, water & sanitary services	21.48
Primary iron & steel manufacturers	11.83
Plastics & synthetic materials	11.21
Engines & turbines	10.64
Other industries	139.36
Total purchases	$ 717.96
Value added	282.04
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Sales

Copper-base alloys derive their demand from valves, pipe fittings and other durable goods industries. In the past few years, the annual rate for the valve and pipe fittings industry has been 7 percent. There is some innovation and substitution of materials that might adjust this 7 percent annual growth trend downward. Substitution of plastic and aluminum in the plumbing fittings industry may cause some deterrent to growth. Moreover, a short supply of copper has caused rapid price increases that are accelerating the substitution trend.

Die casting represents the fastest growing sector of this industry, with all indications pointing to a continuation of this growth. Sales of $1.354 billion in 1964 are predicted to reach $1.527 billion in 1966 for an increase of 12.8 percent. Derived demand from the automotive and home appliance industries is such a large factor in forecasting future sales that the American Die Castings Institute predicates much of its long-range projections on auto sales.

Auto and home appliance sales are both dependent on the consumer's disposable income. Assuming that real per capita income and population will continue to increase at the 1965-1966 pace, auto production should reach 11 million annually by 1970, up from 9.3 million 1/ in 1965. Using these factors as a basis for derived demand, the American Die Castings Institute predicts 1970 production of 1.700 million pounds of aluminum castings, up from 1.254 million pounds in 1964. Production of 1.350 million pounds of zinc castings are forecast for 1970, up from 916 million pounds in 1964. 2/ The 891 million pounds of copper-base alloy castings produced in 1964 should rise to 940 million pounds by 1970.

Profits

In 1964, Dun and Bradstreet's survey of 47 firms in the nonferrous castings and foundry industry estimated the median for net profits as a percent of net working capital at 18.14. Table 11 is a measurement of other profit ratios for the industry.

1/ Source: Automobile Manufacturers Association
2/ Source: American Die Castings Institute, unpublished figures

Table 11.

Profit ratios in the metal industries, 1964 1/

	SIC 336 Nonferrous foundries (47)	SIC 332 Ferrous foundries (57)	SIC 331 Integrated operators (58)
Net profits, percent			
On sales	5.78	5.54	6.35
	3.70	4.25	5.07
	1.77	2.53	2.59
On tangible net worth	17.79	16.58	11.81
	9.98	11.20	9.34
	5.65	6.48	6.39
On net working capital	31.68	33.57	23.32
	18.14	23.50	16.85
	10.39	13.89	10.80

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc.

According to the August 1966 Monthly Economic Letter published by the First National City Bank of New York, the nonferrous industries showed 1966 net income up 30 percent when compared to the first 6 months of 1965. Meanwhile, the iron and steel industry's net profits were down 11 percent from 1965 during the same period.

Long production runs from contracts with the automotive and appliance industries tend to support higher profit ratios in these relatively heavy capital-use industries. Volume in these capital-intensive industries allow for spreading out the overhead costs. Short runs produce an adverse effect on the profit picture when jobs are quoted on a standard cost basis without a volume factor. As a result, many companies will establish a minimum order requirement which assures covering the overhead and returning a reasonable profit.

Employment

In general, gains within the industry in production and sales have outstepped increases in employment. Much of this productivity gain may well be attributed to increased utilization of die casting--a process characterized by low manpower, high volume capabilities.

Table 12 demonstrates employment growth as reflected in data published by the Bureau of Labor Statistics. Significantly, employment for both of the industry groups demonstrates a substantial increase. However, this must be tempered somewhat by the fact that the base year, 1958, represented the all-time employment low for the period between 1950 and the present.

Table 12.

Employment change in the nonferrous castings industry 1958-1965 1/

SIC	All employees 1965 (000)	Percent change 1958-1965	Women employees 1965 (000)	Percent change 1958-1965	Production workers 1965 (000)	Percent change 1958-1965
3361	37.0	32	3.2	14	31.5	37
3362, 3369	40.[illegible]	29	5.2	24	34.0	32

1/ Source: Employment and Earnings - Establishment Data, Bureau of Labor Statistics.

For the industry as a whole, it can be said that automation and plants with larger capacity are providing substantial contributions to productivity. A trend to higher capital and lower manpower utilization is evidenced and has a tendency to reduce the skill requirements for a larger portion of the work force. At the same time, skill requirements for the highly technical setup of machinery are increased. The trend is expected to continue as long as the capital investment in machinery is readily justified by savings in labor costs.

The future employment prospects in the nonferrous castings industry look bright for the highly technical skills, relatively poor for the semiskilled and fair for the unskilled.

Investment and Locational Activity

As measured by the Census of Manufactures, capital investment for new plant and equipment has been the heaviest in the aluminum castings industry where an average of $18 million has been spent annually since 1958. The copper alloy and zinc castings industries each only invested $5 million annually during the same period.

Market and transportation considerations have been the major location determinants. Much of the aluminum castings industry expansion took place in the Los Angeles area during the 1950 to 1963 period. The huge aircraft industry surrounding Los Angeles attracted the plants because transportation across the country from traditional metal castings centers was not economically feasible.

In the past four years, the following are some of the major Appalachia locations that have attracted new plants or expansions in the nonferrous castings field: Leeds and Sheffield, Alabama; Dunkirk, New York; Chillicothe, Ohio; Grove City, Leetsdale, Lehighton, and Zelienople Pennsylvania; and Greenville, South Carolina.

While production increased in all sectors of the industry between 1958 and 1963, the number of plants actually decreased in the aluminum and copper alloy castings field. As Table 13 clearly shows, zinc and the other nonferrous alloy castings plants increased in number within the U.S., and also Appalachia.

Table 13.

Locational activity for the nonferrous castings industries 1/ (Net Change)

Industries	Establishments 1958	Establishments 1963	Net increase (decrease)	Percent change
Aluminum				
Total U. S.	955	954	(1)	(0.1)
Appalachian	50	45	(5)	(10.0)
Copper-base alloys				
Total U. S.	665	549	(116)	(17.4)
Appalachian	44	43	(1)	(2.2)
Zinc and all other nonferrous alloys				
Total U.S.	345	391	46	13.3
Appalachian	6	11	5	83.3
TOTAL U. S.	1,965	1,894	(71)	(3.3)
APPALACHIAN	100	99	(1)	(1.0)

1/ Source: 1963 Census of Manufactures

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

In the metal casting arena, three basic classifications are generally recognized. These are: (1) sand casting; (2) permanent mold casting; and (3) die casting. The latter, die casting, is the most extensively used method for nonferrous metals. It has been defined as the production of accurately dimensioned parts by forcing molten metal, under pressure, into metal dies or molds. Significantly, it does not involve casting into metal molds by gravity or centrifugal forces. These are classified as permanent mold castings.

Sand casting is used for producing large parts, particularly of copper-base alloys, where precision surface and dimension tolerances are not necessary. The process entails simply pouring molten metal into sand molds that have been embossed or shaped by a wooden model of the actual part. Production is slower than any other method, but the capacity to handle the high heat requirements of copper-base alloys serves an important function. Today, sand casting is a relatively minor part of the aluminum castings industry and is insignificant in zinc casting.

Permanent mold casting closely parallels die casting. However, it is generally slower and less flexible in terms of the capability of handling thinner cross sections and intricate designs.

Die casting also relies on a "permanent" mold; however, metal is injected under pressure. As the fastest of all casting processes, it finds extensive application where rapidity and economy in production are essential. It is able to compete effectively with such other forming processes as metal stamping, die forging, plastic molding, powder metallurgy, and screw machine production where large quantities of identical parts are required.

Most die casting today is completely automatic in operation. Molten metal flows from a reservoir into a cylinder or injection chamber. Air or hydraulic pressure then forces the metal into a "permanent" die. The metal solidifies rapidly. When solid, the dies separate, and the part is ejected from the machine. On modern machinery, excess metal is trimmed from the part automatically during the injection cycle.

Advantages of die casting are many. Among the more important, are the following:

(1) Suitable for rapid and economical mass production in quantities usually ranging from 1,000 upward to any quantity required.

(2) Minimum, nominal costs for die upkeep.

(3) Remarkably close dimensional limits requiring little, if any, machining.

(4) Extremely smooth surfaces, free from irregularities, providing excellent appearance and minimizing the cost of applied finishes where such finishes are desired.

(5) Allows much thinner sections than other casting procedures with holes so accurately cored that little or no machining is required.

(6) Possesses mechanical properties superior to those of the same alloys using sand molds.

(7) Allows casting of an infinite variety of shapes including quite intricate or complex designs. Parts can be cast readily with inserts of other metals and/or provided with integral fastening elements to facilitate rapid assembly.

A few plants plate, or otherwise coat, the product to customer specifications. As mentioned earlier, nearly one half of the nonferrous castings operations are captive plants producing parts for further assembly of finished products classified in other industries such as appliances or automotive.

The unique capabilities of die casting have fostered a tremendous growth in the utilization of this procedure. As a significant mass production tool, it is becoming increasingly important to industry. As a result, it is this sector of the nonferrous castings industry which demonstrates the greatest potential for establishing new Appalachian locations. Accordingly, subsequent sections of this report are devoted entirely to this method.

Raw Materials and Materials Handling

Brass, bronze, copper, aluminum, and zinc are all furnished to the die caster on a freight prepaid basis. Much of these shipments move by rail in carload lots of 60 tons. However, smaller operations seeking to minimize inventory capital requirements, will order in 30,000 truckload lots.

The small die casting operation will usually purchase raw materials which are suitably alloyed for direct use in the casting machine. Larger operations will purchase high purity metal and combine scrap or alloying materials for the desired feed.

For the past two years, molten aluminum has been transported by insulated tank truck from Ravenswood, West Virginia to a point in Indiana 300 miles distant. Currently, transportation of molten metal is the exception; however, it is becoming increasingly important in the establishment of large-scale aluminum casting operations.

Following the casting process, which was described in the first section, small parts are packaged like eggs in a crate, large parts are put into tote bins or onto wooden pallets, and generally shipped by truck to the assembly plant. Assembly may be within the same establishment or a customer located some distance away. While the industry is basically market oriented, many producers are forced to ship to outlying assembly plants in order to gain a large automotive or appliance contract. Thus, a producer in the Detroit area might also ship to Atlanta auto assembly points.

Outbound transportation is one of the most critical aspects of plant location for the castings industry. Lead times are generally short, and a constant supply is demanded by the customer to insure continuity in his production line. Motor common carriers handle 75 percent of the interplant traffic in the industry. Most shipments are less-than-truckload from small points.

Several large casting companies have their own fleet of trailer trucks which deliver directly to the customer in partial trailer load lots. In the following typical operation, two typewriter customers are located in one city. A customer making sewing machines is just 50 miles beyond. A trailer load is made up of the three casting orders and delivered on one truck, which then returns to the home plant, often by way of a raw material supplier for a load of billet to help spread out the overhead costs.

Manpower Utilization

Innovation and faster cycles have increased the productivity of die casting plants. In modern establishments, a handful of highly skilled set-up men prepare the equipment for operation. Mechanical and electrical maintenance skills round out the high skill requirements.

After setup, a single, relatively low-skilled operator can handle one or more machines depending on the size and complexity of the equipment. In essence, his job is to maintain molten metal feed levels and to shut down the equipment in the event of malfunction.

Finishing operations are usually quite simple with comparable skill requirements. Some castings must be trimmed and deburred. Most plants perform some drilling and tapping operations, and a few do minor machining.

The simple nature of the finishing operations as well as packing requirements for the mass produced parts allow up to 30% of the work force to be comprised of females.

Large scale die casting plants will exhibit the additional requirement for a highly skilled tool and die operation. Smaller firms will tend to job this work to local services and/or solicit contracts where the customer furnishes the die.

Virtually all skills in the die casting plant will be derived through in-plant training. For most jobs, proficiency will be gained in a short period of time. For the skilled positions (tool and die, setup, and maintenance) an extensive apprenticeship program will be required, and initially these skills will have to be imported.

Significantly, a large portion of the die casting industry is highly seasonal. The heavy reliance on automotive and appliance markets makes the industry susceptible to the fluctuating demand and changeover periods of these markets. As a result, manufacturers frequently prefer to draw upon a more rural work force where agriculture can supplement incomes, and the economic impact of reduced requirements is minimized.

Product Innovation and Interproduct Competition

Aluminum, because of its lightweight, dimensional stability, resistance to cold flow, and speed of casting, has been used extensively for parts formerly made of brass or ferrous castings. Aluminum is now readily cast in large sizes, such as automatic transmission housings and in most complex shapes. Other aluminum castings weigh only a fraction of an ounce. Aluminum castings are readily anodized, but difficult to plate. Aluminum die casting has earned a reputation for the mass production of low-cost parts. Its economy surpasses that of the slower sand casting method even on short production runs.

Zinc alloys, the most popular of materials for die casting, feature exceptionally good tensile, impact and elongation' characteristics. Their low melting points impart less wear on the dies and high-speed casting is possible. These alloys allow high dimensional accuracy, thin walls and smooth surfaces, which in turn reduces the cost of finishing by machine and/or coating.

Copper alloys are the strongest and toughest of the three metals mentioned so far. Slower casting speeds, due to high melting points, are among limiting factors for performance.

The ability of die casting to economically handle large volumes of work places it in direct competition with other mass production techniques. Metal stampings provide the most formidable competition, and the two techniques are currently fighting for the large auto grille market. Plated injection molding is also a large competitor, with powder metallurgy and ferrous metal castings following close behind. Factors favoring nonferrous die casting frequently include: reduced finishing requirements; closer tolerances; capabilities for larger and more intricate parts; strength properties; die replacement costs; and sometimes raw material costs. Moreover, a broader range of physical properties is available from brass, zinc, aluminum and magnesium alloy castings than available from powdered metals, plastics and ferrous metal stampings or castings.

In order to keep ahead of competitive materials, much has been accomplished by the nonferrous castings industry. Improved plating methods have been developed to diminish corrosion on the 70 pounds of zinc die castings on the average automobile.

Quality improvement in high density aluminum castings has been developed by a major automobile producer. Called "Acurad", the process uses a 2-plunger system plus a wide die opening, a low injection rate, and controlled cooling of the die to reduce trapped air. The result is more uniformly dense and stronger parts.

Transportation of molten aluminum from the primary producer to the casting plant has now been extended to 300 miles where, heretofore, 10 miles was considered the limit. This will eliminate costly reheating of metal to the melting point and reduces capital outlay for the casting company's furnace requirements.

Single cavity die casting machines for small parts have been developed that automatically clean the sprue and gates from a cast part as the machine opens the two halves of the die. Another die casting machine forms items with moving parts, such as toy scissors, which are finished and ready to be coated when they eject from the machine. This process, called "Intercast", has wide application in small parts manufacture where several machine and assembly operations are virtually eliminated.

The physical properties of the nonferrous castings metals will hold their own among competitive materials for many years to come.

Distribution

Job casting shops contract directly with manufacturers that assemble the castings into finished products. As with all industrial goods, there is only a limited number of distribution channels. Jobbers, wholesalers, and middlemen in general, are not common.

Once a long production run is established to the satisfaction of the customer, customer-supplier conferences diminish in importance. Annual model changes in the automotive and, more recently, the domestic appliance field, perhaps demand slight modifications, but usually the parts specifications become standard and subject to only minor variations.

Physical distribution is generally a direct daily shipment to the customer so that a consistent "pipeline supply" is maintained. Some shippers have come to recognize that parts moving to a customer 700 miles away will take three or four days for delivery. By accumulating Wednesday, Thursday and Friday shipments, they may save on transportation costs by shipping in one large lot on Friday and still produce a Monday delivery to the customer. Large shipments tend to have lower ratings, move faster, and are subject to less damage from handling in transit. Large shipments are handled less and loaded direct.

About three-quarters of the nonferrous alloy castings move by motor common carrier. The railroads handle about 16 percent of the traffic made up largely of carload lots to high-volume customers. Private trucks account for about 6 percent of the transportation in this industry according to the 1963 Census of Transportation. At least one major zinc die casting company operates a fleet of trucks from their New York State plant delivering partial and full loads as far as 500 miles to customers.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

The locational requirements for the nonferrous die casting industry are rather flexible in certain respects and rigid in other respects. Market considerations, transportation, tooling services for dies and molds, and labor requirements stand out as primary locational factors.

Community environment, taxation and financing tend to be relatively minor considerations for most manufacturing firms in this industry. Although having met the primary locational factors, a community that has the "extra" in secondary considerations might prove to win the plant location.

Market Considerations

The spectrum of end uses for die castings is very broad. The major industrial users, as outlined in Section I, are in the automotive, appliance, plumbing fixture and business machines industries. The continued decentralization trend of these customers creates market opportunities for the nonferrous die casters that can locate in close proximity. Between 1958 and 1963 there was a 23 percent increase in plants manufacturing motor vehicle parts within Appalachia. During the same period, the U.S. gained only 16 percent in the number of establishments manufacturing automotive parts. There are 140 of these plants within Appalachia, many that require nonferrous castings.

Good motor carrier transportation is extremely important since many raw castings are shipped in bulk with limited lead time allowed for filling orders. Finishes to die cast parts may consist of anodizing or chrome, nickel or cadmium plates, and are generally applied by the customer. Therefore, bulk shipments in tote bins or burlap bags will not damage the finish on castings in transit.

Access to the automotive parts plants, not the auto assembly plants, is the chief factor in distribution. Castings are assembled into a finished part, and shipment is then made to the automobile plant. A recent auto parts plant was announced for West Virginia that will be of the type consuming a broad line of die castings. Original equipment manufacturers usually purchase all their small parts outside the company. These contracts provide a long production run for a small casting operation which thrives on the volume.

Transportation

Transportation services, particularly motor carrier, must be available on a daily pickup and delivery basis. At least one or two long-haul carriers providing direct service to the plant site would be desirable, but not mandatory. Often, a local agent can perform the pickup and delivery services for several long-haul carriers, thus giving a broad selection of service and the flexibility to choose the best advantages of each.

A rail siding is desirable for a small operation, and mandatory for a large plant anticipating raw material shipments in 60-ton lots.

Air service is not a strong location factor. General aviation within an hour's drive is sufficient for branch plant operations that need transportation to other plants and the home office. Scheduled airline service is helpful, but not essential. Sales and engineering people in this industry generally establish standard specifications that require very little liaison for modification or change during long production runs.

Services

Tool and die services are essential for small casting plants that do not have a sufficient number of contracts to keep an in-plant tool and die shop busy. Sometimes the die is owned by the customer who contracts the work with a small casting shop on a bid basis of so many parts to be supplied in a given period. On this basis, a small casting operation would not require tool and dies services nearby. As a general rule, however, nearby tooling should be available. While this would tend to limit the number of currently suitable Appalachian locations, further industrial development in the Region will attract new facilities offering these services. In the meantime, new casting plants, without captive tool and die capabilities, will gravitate generally to within one day delivery of existing services.

The services of a mill supply house providing same-day delivery would benefit a die casting shop in particular. As pointed out by the input-output data of Table 10, a good share of the local expenditures go to wholesale and retail establishments.

Labor Supply

Automatic machinery, particularly in die casting operations, has made it possible to increase productivity with lower labor skills. As stressed in Section III under "Manpower Utilization," plants require a few men with high technical competence to set up and start the production run, but once an operator takes charge, the machine might run 8 to 24 hours a day without shutdown. The volume of parts produced might keep two or three relatively unskilled workers, that might be women, trimming and cleaning the excess sprue from the castings. Heavier deburring of sharp edges may be required in brass castings, for example, where male labor would be needed.

Training of five to six weeks would be necessary to acclimate a mechanically inclined die casting machine operator. Previous vocational training would help in filling this operation. The cleaning of the casting is an operation that could be learned in a day of in-plant training.

Most materials handling operations would require practically no skill training, but a familiarity with the shop storage areas and the overall production flow is required. Lift truck and other materials handling machinery require about a week's training for a well coordinated individual.

Packing and shipping operations can easily be divided into small jobs, each requiring only a limited area of responsibility and no special skills that would take more than a week of in-plant training.

Technical competence is essential for the tool, die, maintenance, and casting machinery setup men. These skills usually involve an extensive apprenticeship. Help for these jobs may require importing skilled labor at premium pay, or moving them from an established plant. Vocational training programs would assist the long-run requirements for these skills in the nonferrous castings industry.

Wage differentials for Appalachia cover a spectrum that has only one basic pattern--urban and industrialized areas tend to have higher wage rates. Within the locational constraints of marketing, transportation, and services, new locations will be established in those areas offering the most favorable wage advantage. Thus, the more rural outlying areas proximate to industrialized centers may well receive first consideration.

Many die casting plants have substantial seasonal fluctuations in employment. For example, die casting suppliers to the automotive industry lay off workers in April and May in anticipation of the shutdowns for model changeover in July. This increases the attractiveness of a rural work force that is available for callback to meet peak demands. Such a requirement can be satisfied at many locations within Appalachia.

Other Factors

Community environment and size, utilities, access to raw materials, site requirements, financing, state and local taxes and influence of labor laws do not have primary importance in the location decision of the nonferrous castings industry.

There is no pattern to community environment or size that can be distinguished. Police and fire protection, education facilities, community size, power, water, and waste disposal are of varying qualities and size in recent locational experience.

Major raw materials for all die casting operations are on a delivered price basis and are not a location factor. There are no special site requirements.

Nonferrous casting operations would require a minimum of 20 acres to allow for future expansion and flexibility in plant layout. Easy access to utilities and rail transportation enhance the desirability of the site.

Financing of the plant, state and local taxes, and the influence of labor laws are secondary considerations that management will consider only after the primary factors have narrowed the area of choice. Revenue bond financing will be most desirable if coverage includes machinery and equipment.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

Public policies that contribute to improved highway transportation and the upgrading of mechanical skills within Appalachia will assist in satisfying two of the primary location factors. The choice of location for a nonferrous castings plant will first consider the available markets. Another prime consideration for a small operation is the access to tooling services. Both of these latter factors provide little room for effective public action.

This section of the report looks at those policies and activities which will promote the expansion of the nonferrous castings industry in Appalachia.

Access to Markets

Much of this industry's location activity within Appalachia in the past four years has followed market demand. Section II illustrates this point under the heading "Investment and Locational Activity".

Highways to the markets of the die castings industry would lead to the automotive parts suppliers that cluster around the East North Central states of Ohio, Indiana, Illinois and Michigan. There is a secondary automotive parts market in the Middle Atlantic states of New Jersey, New York, and Pennsylvania. Access to the appliance market from central Appalachia emphasizes the need for highways from eastern Kentucky west to the Louisville area and northwest toward Chicago. A good share of the small appliance manufacturers are located in the eastern seaboard belt parallel to Appalachia. East-west corridor highways from central Appalachia would open the way to this market.

As pointed out in Section III under "Raw Materials", there is a need for rail transportation to supply large castings plants, but for the most part the small operations will be receiving raw materials and shipping raw castings by motor carrier. Water and air transportation are relatively unimportant to this industry's location.

Mechanical Skills

Vocational training schools will be certain to contribute to the labor supply needs of the nonferrous castings industry by training tool and die makers, machine operators, and materials handling operators as illustrated in Section IV under the subject of "Labor Supply". Vocational training need not be specific to the machinery operated within the die casting industry. It is sufficient to acclimate trainees to machinery in general. In-plant training by the industry can more easily inculcate the specific methods of casting machinery operation following the vocational training.

Other Considerations

In the final stages of the location decision--when the choice is narrowed to a small number of communities essentially equal in their ability to satisfy the primary factors of location--the site-seeking executive will turn to a number of secondary factors to arrive at the final selection. In some cases, it may involve nothing more than personal preference. More frequently, however, the final selection might be based on lower financing or tax rates, community attractiveness, training assistance offered, proximity to air service, or simply, the responsiveness of a specific community.

In terms of public action, providing financial assistance (e.g. revenue bond financing and the like) might be most effective. In any event, the community which can demonstrate progress in making the area a better place to live--and, the desire for industry as a welcomed neighbor--will definitely enhance their prospects for this industry.

Appendix A

SELECTED INFORMATION SOURCES

Published Information

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(2) Marketing Guide to the Metal Castings Industry, 1962, The Penton Publishing Co., Cleveland, Ohio.

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(7) Employment and Earnings Statistics for the United States, 1909-65, U. S. Department of Labor, Bulletin No. 1312-3, Washington, D. C.

(8) Goldman, Morris R.; Marimont, Martin L.; Vaccara, Beatrice N., The Interindustry Structure of the United States, November 1964, Survey of Current Business, U. S. Department of Commerce, Washington, D. C.

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(13) Corporation Income Tax Returns, July 1962-June 1963, Internal Revenue Service, U. S. Treasury Department.

(14) Standard Listed Stock Reports, 1966, Standard & Poor's Corporation, New York.

(15) Secondary Nonferrous Industry in California, 1962, Bureau of Mines, U. S. Department of the Interior.

(16) Automobile Facts and Figures, 1963 and 1966, Automobile Manufacturers Association.

(17) The Powder Metallurgy Design Guidebook, Powder Metallurgy Parts Manufacturers Association.

Unpublished Information and Personal Contacts

(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Manufacturers of nonferrous castings inside and outside Appalachia.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

(7) American Zinc Institute, 292 Madison Avenue, New York City

(8) American Die Castings Institute, 366 Madison Avenue, New York City.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 18--THE MALLEABLE AND DUCTILE IRON CASTINGS AND STEEL FORGINGS INDUSTRY

TABLE OF CONTENTS

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically Standard Industrial Classification industry codes 3321, Gray Iron Foundries; 3322 Malleable Iron Foundries; and 3391, Iron and Steel Forgings.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

The $4 billion ferrous casting and forging group of industries plays a major role in the primary metals industry of this country. Shapes produced by malleable and ductile iron casting, as well as by steel forging, are focused upon in this report because of their dynamic growth potential within the ferrous casting and forging group. Machinery for the industrial strength of the country is cut from these basic shapes that have been cast or forged.

For the layman it is easy to associate a forging with a blacksmith hammering a shape from white hot metal. On the other hand, casting is pouring of molten metal into hollow molds shaped in the form of the desired part. Malleable castings withstand sharp impact. Ductile iron castings have the physical property of greater elongation, are more fluid in pouring, and thus are easily molded into more intricate shapes than other ferrous castings. Steel forgings are made primarily from carbon steel for strength properties, or alloy steel for corrosion resistance.

Major trends in the industry point to a doubling of ductile iron casting production between 1966 and 1971. Physical properties common to steel castings, and yet less costly, stimulate this growth of ductile iron.

The most profitably operated casting and forging plants today are medium sized (employing 250-500), modern, efficient facilities located in strategic market positions. Those plants which are not, are moving, modernizing, merging or simply going out of business.

Key plant location factors include: access to markets within a 300-mile radius, excellent rail and motor carrier service, availability of relatively unskilled labor, and low-cost power. Appalachia has several vantage points that will attract future expansions of this industry.

Public investment policies and activities that will enhance the competitive position of Appalachia for this industry group should have the following priorities:

(1) Construct highway corridors from central Appalachia to industrial markets of the East North Central States, in particular.

(2) Construct east-west lateral highways from Interstate Highways 75, 77, 79 and 81 that will generate reciprocal trade within Appalachia.

(3) Encourage Interstate Commerce Commission policies encouraging mergers that will extend through rates and routes in the operating authority of long-haul rail and motor carriers.

(4) Plan future job opportunities in casting and forging for displaced workers of other industries through regional councils made up of union leaders, industrial management, and state and local industrial development officials.

(5) Seek the enactment of Federal tax credits to companies with formal in-plant training programs.

(6) Encourage projects that will produce power rates competitive with those of the TVA.

I. PROFILE OF THE INDUSTRY

Size

Industry spokesmen forecast 1966 sales of $1.7 billion for malleable and ductile iron castings and steel forgings. Substitution of malleable and ductile castings for steel and gray iron castings, in particular, has demonstrated dynamic growth patterns since 1964.

Table 1 places the entire ferrous casting and forging industry in perspective with the other durable goods industries as they stood in 1964. Included are statistics for the gray iron and steel casting industry which is now converting much of its plant capacity to ductile iron.

Sales of ferrous castings and forgings represent about 10 percent of that for the entire primary metals industry. The value added by manufacture also represents 10 percent of the value added by the transportation equipment industry, its largest market.

The 248,000 employees in the ferrous foundries and forging plants earned wages and salaries amounting to $1,675 million in 1964. Of this number, 126,000 were employed in gray iron casting, 24,000 in malleable iron casting, 39,000 in forging plants, and the remaining 62,000 in steel foundries.

This report will emphasize the ductile casting foundry operations, statistics for which are often combined with those of the gray iron casting industry. Wherever available, the data for ductile casting foundries have been separated. The 450,000 short tons of ductile castings shipped in 1965 represent only one-half of the 1,137,000 short tons of malleable casting shipments and about one-quarter of the steel forging weight of 1,820,000 short tons.

The relative size of each of the three subindustries is shown in Table 2.

Table 1.

Rankings of the durable goods industries 1/

(Numbers in millions)

Industry rank	Employment		Value of shipments	
	TOTAL	9.199	TOTAL	$232,170
1	Transportation equipment	1.624	Transportation equipment	57,846
2	Machinery	1.537	Primary metals 2/	40,036
3	Electrical machinery	1.483	Machinery	34,219
4	Primary metals 2/	1.179	Electrical machinery	31,054
5	Fabricated metals	1.116	Fabricated metals	24,877
6	Stone, clay & glass	.581	Stone, clay & glass	12,973
7	Lumber & wood	.562	Lumber & wood	9,885
8	Furniture	.386	Instruments	6,616
9	Instruments	.309	Furniture	6,302
10	FERROUS CASTINGS & FORGINGS	.248	Ordnance	4,421
11	Ordnance	.234	FERROUS CASTINGS & FORGINGS	3,993

Industry rank	Capital expenditures		Value added by manufacture	
	TOTAL	$7,130	TOTAL	$115,744
1	Primary metals 2/	1,887	Transportation equipment	23,961
2	Transportation equipment	1,297	Machinery	19,762
3	Machinery	946	Electrical machinery	18,039
4	Electrical machinery	889	Primary metals 2/	16,732
5	Fabricated metals	728	Fabricated metals	12,636
6	Stone, clay & glass	626	Stone, clay & glass	7,520
7	Lumber & wood	369	Lumber & wood	4,361
8	Instruments	165	Instruments	4,333
9	FERROUS CASTINGS & FORGINGS	126	Furniture	3,225
10	Ordnance	117	Ordnance	2,871
11	Furniture	106	FERROUS CASTINGS & FORGINGS	2,313

1/ Source: 1964 Annual Survey of Manufactures
2/ Figures for "Ferrous castings & forgings" included in "Primary metals"

Table 2.

Industry shipments by production segment 1/

(Percentages based on dollar value)

Classification	Dollar value of shipments ($000's)	Shipments percent of total
Iron & steel forgings	$ 941,159	63.2 %
Malleable iron foundries	366,675	24.8
Ductile iron foundries	178,000 2/	12.0
	$ 1,485,834	100.0 %

1/ Source: 1964 Annual Survey of Manufactures

2/ Source: Fantus estimate

Products and Markets

Ductile iron castings have many of the physical properties found in malleable iron in that they resist sharp impact, can be elongated and readily machined. In fact, the machining of ductile iron might be compared to cutting butter at room temperature, where ordinary gray iron castings would be brittle as refrigerated butter.

Because of these physical properties, ductile iron castings are rapidly capturing the smaller parts market now held by steel castings. Ductile castings cost 10 to 15 cents per pound less than steel castings, which has the effect of accelerating the market penetration. The basic reason for the lower cost is simply that iron is cheaper to produce than steel.

Products range from less than 1 ounce to 5 tons, but generally, steel castings take over the larger sized chunks of molded products used chiefly in the railroad and heavy machinery industries. At least 51 percent of the malleable and ductile casting production finds its way into the automotive industry. The end-use market for malleable iron castings is ranked in Table 3 and that for ductile castings is ranked in Table 4. About three-fifths of all ductile and malleable iron castings are produced for sale and the rest for internal use by captive plants.

Table 3.

Malleable castings market by industry rank 1/

Rank	Industry	Percent of total market
1	Motor vehicles and parts	51
2	Agricultural machinery and equipment	11
3	Plumbing valves and fittings	10
4	Valves and fittings, except plumbing	9
5	Construction and mining machinery	4
6	General industrial machinery	3
7	Railroad equipment	2
8	Electrical machinery and supplies	2
	All other industries	8

1/ Source: Marketing Guide to the Metal Casting Industry

Table 4.

Ductile castings market by industry rank 1/

Rank	Industry	Percent of total market
1	Motor vehicles and parts	51
2	Agricultural machinery and equipment	9
3	Boiler shop products	7
4	Internal combustion engines	4
5	Metalworking machinery	3
6	Pumps and compressors	3
7	Paper industries machinery	3
8	Rolls for rolling mills	3
9	Construction machinery	2
10	Motors and generators	2
	All other industries	13

1/ Source: Fantus Area Research

Steel forgings are used in the fabrication of a wide variety of products. In terms of tonnage and value, however, orders for a large part of the steel forgings manufactured are tied directly to the transportation equipment industry. The production of motor vehicles, railroad locomotives and railroad cars influence the prosperity of the steel forgings industry more than any other single factor.

Gears, pinions, axles, cams, railroad car wheels, and automobile steering knuckles are just a few of the items hammered out from steel forgings.

Pearlitic malleable iron castings have physical properties similar to ductile iron, and their competition often depends on the price and delivery time. Pearlitic castings may carry a lower price and a longer delivery time. A pearlitic malleable casting tends to be stronger but does not have the 10 percent elongation factor of a ferritic ductile casting.

In Table 4, there is a comparison of 1965 tonnage figures for the entire ferrous casting and forging industry which provides size relationships within the industry for various types of physical properties fused from iron.

Table 5.

Size relationships of the ferrous casting and forging industries for 1965 1/

Industry	Thousands of short tons shipped
Castings	
Gray iron, other than ductile 2/	15,263
Ductile iron	450
Standard malleable iron	828
Pearlitic malleable iron	309
Steel 2/	1,961
Forgings	
Carbon steel	1,200
Alloy steel	620

1/ Source: Current Industrial Reports, U.S. Department of Commerce, and Gray and Ductile Iron Founders Society

2/ Gray iron (other than ductile) and steel castings are not included in this industry recommendation but are included here for comparison purposes

Plant Ownership and Size Structure

The 8 major steel companies in the U.S. have a very sizable share of the market. According to 1964 statistics from the U.S. Department of Commerce, 98 percent of the open die or smith forgings are produced in steel mills; also, 51 percent of the malleable iron castings and 36 percent of the ductile castings produced in the U.S. come from plants of the 8 major steel companies. On the other hand, there are 62 U.S. companies in 81 locations primarily engaged in malleable iron foundry work, and 230 iron and steel forging companies in 273 plants. Plants specializing in ductile casting number about 50, with nearly 225 plants licensed to produce the relatively new material.

In the past, steel forging production was centered in the larger plants owned by one of the eight major steel companies in the U.S. This is changing. There is now a trend for smaller, yet medium-sized, forging plants capable of short runs and specialties that provide buyers short lead times and product features that the high-overhead manufacturers cannot meet. In marketing terms, the medium-sized forging plants are carving themselves a healthy market by quick delivery and product differentiation.

Some large companies produce malleable iron, steel castings, and open die forgings in the same plant. Other companies manufacture cast iron pipe as a major product and fill in their capacity with job lots as a subcontractor for parts.

Outside the major producers, the greatest number of malleable iron foundries are in the 100-249 employment bracket. This employment figure is an indication of the economy of large-scale operations. Heavy capital requirements for furnaces and related casting machinery preclude small companies from operating in this field. The iron and steel forging industry has the normal spread of plant size common to most industries, that is, a great number of small plants and fewer large plants when size is measured by employment. The trend for large-scale plants in the forging industry is indicated by the net loss of 28 small establishments between 1958 and 1963 (see Table 11).

The parameters of cost, production time and product differentiation are pushing the entire industry into medium-sized firms capable of flexibility.

Geographic Prevalence

Of the 1,492 establishments in the industry, 573 are located in the East North Central States and 278 are in the Middle Atlantic States. Table 6 provides an analysis of regional distribution.

At least 225 manufacturers of gray iron castings are licensed to produce ductile iron castings. Census statistics do not breakdown figures for the ductile casting subindustry, but prevalence of existing or potential capacity can be deduced from statistics provided for the gray iron casting industry. Gray iron casting manufacturers are changing to ductile iron casting as capital permits.

The heaviest shipments from gray iron foundries flow from the states of Michigan (425 million in 1963), Ohio ($327 million), and Pennsylvania ($127 million). In 1963, Michigan led in the shipment of malleable iron castings ($97 million) and was second in the shipment of iron and steel forgings ($146 million).

Table 7 displays the Pennsylvania and Alabama concentration of the gray iron foundry industry. Other industry statistics show that these plants are centered in Birmingham and Pittsburgh.

Statistics from the 1963 Census of Transportation and plant location experience clearly demonstrate that the casting and forging market lies close to the point of manufacture. At least 80 percent of the forging market and 60 percent of the casting market are within 300 miles of the producers.

A southern Connecticut plant producing ductile iron castings opened a branch plant less than 100 miles away simply to deliver products for a special market. Delivery time and transportation costs make this industry group highly market-oriented.

Appalachian specialization is not evident, although 13 percent of the U.S. establishments in this industry are located within Appalachia. On the average, Appalachia shares 8 percent of all the U.S. industrial establishments employing over 50 persons.

Table 6.

Regional distribution of establishments 1/

	SIC 3321	SIC 3322	SIC 3391	Total
New England				
Total	90	6	18	114
Employing over 100	13	4	6	23
Middle Atlantic				
Total	199	21	58	278
Employing over 100	44	15	16	75
South Atlantic				
Total	93	4	5	102
Employing over 100	18	1	-	19
East North Central				
Total	402	40	131	573
Employing over 100	117	33	56	206
East South Central				
Total	78	-	4	82
Employing over 100	24	-	1	25
West North Central				
Total	101	4	9	114
Employing over 100	21	3	-	24
West South Central				
Total	59	2	20	81
Employing over 100	9	1	2	12
Mountain				
Total	17	2	1	20
Employing over 100	4	-	-	4
Pacific				
Total	99	2	27	128
Employing over 100	19	1	1	21
Total U.S.	1,138	81	273	1,492
Total employing over 100	269	58	82	409

1/ Source: 1963 Census of Manufactures

Table 7.

Establishments within the Appalachian region 1/

State	SIC 3321 Total	SIC 3321 Employ over 100	SIC 3322 Total	SIC 3322 Employ over 100	SIC 3391 Total	SIC 3391 Employ over 100	Total Appalachia	Total Employ over 100
New York	7	1	1	1	2	2	10	4
Pennsylvania	68	15	6	4	17	6	91	25
Maryland	1	-	-	-	-	-	1	-
Virginia	2	-	-	-	-	-	2	-
West Virginia	10	3	1	1	1	-	12	4
Ohio	16	5	2	2	2	-	20	7
North Carolina	1	-	-	-	2	-	3	-
South Carolina	2	2	-	-	-	-	2	2
Georgia	4	-	-	-	-	-	4	-
Kentucky	1	-	-	-	-	-	1	-
Tennessee	15	5	-	-	-	-	15	5
Alabama	34	15	-	-	-	-	34	15
Total	161	46	10	8	24	8	195	62

1/ Source: 1963 Census of Manufactures

Economic Impact

This high-wage industry will impart a heavier impact on the local economy than most other industries that might be selected for industrial development. The industry is highly labor-oriented, ranking higher, for example, than either the textile or tool machinery industry. The average production worker earns $131 per week, $16 per week above the average for the durable goods industries as a group.

A casting or forging plant employing 160 production workers and 40 nonproduction workers would generate an annual payroll of at least $1,362,000. Initial expenditures of this income within the community would have a ripple, or multiplier effect throughout the region surrounding a plant location or expansion.

As demonstrated in Table 8, the primary iron and steel mills will receive 22.7 percent of the industry's direct expenditures. Primary iron mills reduce the iron ore to ingots for processing by the ferrous casting and forging industry.

Table 8.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from other establishments	Primary iron & steel manufacturing
Iron & ferroalloy ores mining	$ 54.05
Coal mining	26.15
Maintenance & repair construction	6.59
Chemicals & selected chemical products	9.54
Petroleum refining & related industries	7.59
Stone & clay products	15.40
Primary iron & steel manufacturing	227.10
Primary nonferrous metals manufacturing	16.46
Stampings, screw machine products & bolts	6.48
Other fabricated metal products	17.31
Metalworking machinery & equipment	6.63
Machine shop products	7.44
Transportation & warehousing	52.64
Electric, gas, water & sanitary services	24.02
Wholesale & retail trade	35.96
Finance & insurance	7.54
Business services	8.71
Gross imports of goods & services	11.83
Other industries	63.44
Total purchases	604.88
Value added	395.12
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

The coal mining and transportation industries have substantial income from the casting and forging industry in payment for heat, power, and the inbound transportation of raw materials. Transportation for finished products is FOB the nearest producing plant to the customer. Local electric and gas utilities as well as wholesalers absorb a good share of the dollars generated by a casting or forging plant. Local tool shops and mill supply houses benefit from a high-friction industry such as casting and forging, which wears out bearings, dies, and other machine parts at an extremely high rate.

One of the more important long-range economic benefits derived from a casting or forging operation is the attraction for industrial machinery shops. Recognizing a readily available local supply, a perimeter of other industries should develop. In particular, the textile machinery, pump, compressor, valve, automotive parts, aircraft, aerospace and paper machinery industries should find attractive benefits by following a basic supplier of castings and forgings. It is significant that most of the above industries are among those supporting the overall Appalachian Location Research Studies Program.

2

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Sales

A long-range perspective of sales displays highly cyclical patterns. The ferrous casting and forging industries have experienced lively growth in the past 5 years. In 1966, the cycle will be on the crest side of oscillation. Production of malleable iron castings will increase 40 percent during 1966. This will mean 1.4 million tons shipped for $560 million in revenue, up from $400 million in 1965, and $367 million in 1964.

Short-range sprints are typical of the industry, however. Shipments of malleable iron castings are anticipated to grow about 5 percent annually over the next 5 years. Capacity by 1970 should reach 1.7 million tons.

The steel forging industry has displayed a 12 percent compound annual rate of growth, with emphasis on closed die forgings.

Production of ductile iron castings has greater potential for growth than any other sector of the ferrous casting or forging industry. Basically a new casting material, ductile iron combines the low-cost process advantages of cast iron with properties resembling those of steel. Much of the future sales in ductile iron castings will be at the expense of the steel casting industry. Costs make the difference.

Comparison of costs readily shows the potential for future market penetration by malleable and ductile castings.

Relative costs per pound of finished castings in high volume production would be in this order:

Type of casting	Cents per pound
Gray iron	20
Malleable iron	25
Ductile iron	30
Steel	40

In the highly industrialized state of Connecticut, 2 ductile iron casting operations in 1964 grew to 6 by September of 1966. Factories now in gray iron castings are rapidly converting equipment and building new plants to meet the dynamic growth in demand for ductile castings.

Growth follows the demands of industry for improved physical properties in terms of tensile strength (ability to resist breaking under stress), yield (ability to spring back to its original shape after stress), and elongation (ability to be drawn out like a rubber band before breaking).

Malleable iron castings, which are highly resistant to sharp impact, are pushing beyond 1.4 million tons of shipments in 1966, with a 7 percent annual rate of growth.

Ductile iron castings sales are growing faster than either ferrous forgings or malleable castings. In 1961, only 205,000 tons were produced. At least 445,000 tons were shipped in 1964, and by 1971, nearly a million tons of ductile iron castings will be produced annually. In perspective, growth trends look like the following for ductile iron castings:

Year	Thousand tons produced
1961	205
1963	300
1964	445
1966	468
1971	965

Projected growth within Appalachia for the ductile iron casting industry is shown in Table 9. Although the states of Ohio, New York, and Pennsylvania display the greatest potential for growth, future industrial locations within Appalachia can change the market picture rapidly. In particular, textile machinery, pumps, valves, and boilershop products have shown distinct signs for marketing potential within the South Atlantic States.

Table 9.

Ductile iron market potential in the Appalachian States projected to 1971 1/

(in hundred net tons)

Industry	Hundred net tons	Production of state in first position	Production of state in second position
Motor vehicles and parts	582	Ohio 409	N.Y. 154
Pumps and compressors	72	N.Y. 30	Ohio 29
Agricultural machinery and equipment	52	Ohio 23	Ky. 18
Boilershop products	50	N.Y. 18	Ohio 12
Motors and generators	48	Ohio 22	N.Y. 19
Metalworking machinery	46	Pa. 19	Ohio 13
Construction machinery	39	Ohio 24	Pa. 10
Internal combustion engines	29	Ohio 16	Pa. 10
Paper industries machinery	29	N.Y. 13	Pa. & Ohio 6
All other industries	1,230		
1971 Market potential			
Total Appalachian States	2,177		
Total U.S.	9,650		

1/ Source: A Fantus Projection

Profits

Profit margins of 7.2 percent in 1965 have been called "optimum" by industry spokesmen. In most capital intensive industries, such as ferrous casting and forging, there is an optimum profit attained at about 90 percent of plant capacity. The slack of 10 percent allows for shutdowns due to machinery maintenance.

The relatively poor year of 1958 touted a 4.4 percent return on sales, and 1964 showed a 4.25 percent return, according to Dun & Bradstreet profit ratios in Table 10.

Table 10.

Profit ratios in the iron and steel foundry industry, 1964 1/

	SIC 332 Iron and steel foundries (57)
Net profits, percent	
On sales	5.54 4.25 2.53
On tangible net worth	16.58 11.20 6.48
On net working capital	33.57 23.50 13.89

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc.

Employment

Employment in some sectors of the industry has seen an absolute increase, while in other sectors decreases attributed to automation have cut the industry's total employment figure.

Employment will increase as present plant capacities are absorbed by the 3 to 4 percent annual growth in the industry. Also, employment will grow as new demand creates a requirement for new plant and equipment at new locations.

Between 1958 and 1963, the gray iron and the steel casting industries increased employment substantially, according to Labor Department statistics represented in Table 11.

Table 11.

Employment change in the iron and steel casting and forging industry, 1958-1965 1/

SIC	All Employees 1965 (000)	Percent Change 1958-1965	Women Employees 1965 (000)	Percent Change 1958-1965	Production Workers 1965 (000)	Percent Change 1958-1965
3321	133.8	18.4	4.6	(5.1)	115.1	18.1
3322	26.1	8.1	1.2	(29.4)	22.2	7.9
3323	64.9	18.0	3.0	(3.0)	51.6	14.7
3391	42.3	(8.6)	2.3	(14.8)	34.7	(6.9)

1/ Source: Employment and Earnings - Establishment Data, Bureau of Labor Statistics.

Investment and Locational Activity

Expansions of existing facilities have increased the industry's capacity more than new plant locations. As an example, very recently there has been a trend to integrate ductile foundries with gray iron foundries.

Future locational activity will be affected by growth, changes in raw materials characteristics, and advances in technology. According to one industry estimate, about one-third of the nation's 2,644 ferrous foundries (including gray iron castings) will build plant additions or entirely new facilities in 1966.

During 1963, capital expenditures for the 3 industries were as follows:

	$ Million
Gray iron foundries	$64.8
Malleable iron foundries	16.3
Iron and steel forgings	17.5
	$98.6

Annual capital investment between 1958 and 1963 fluctuated close to these figures, except in the malleable iron industry where $9 million troughs were hit. Again, it must be emphasized that census figures used here in no way reflect the absolute figures. Much of the ferrous casting industry's productive capacity is an integral part of large complexes of blast furnaces and steel mills, and therefore measured in the aggregate.

The dearth of production capacity in Appalachia parallels a similar void in parts of the South, indicating opportunities for new regional location activity commensurate with the machinery industries.

Plant location files show a tendency for the industry to locate in communities bordering mature industrial centers where populations range upwards from 20,000 people. Since 1962, the greatest number of Appalachian expansions were in the states of New York and Pennsylvania.

Net decreases in the number of plants both within Appalachia and for the entire United States (as shown in Table 12) reflect mergers, consolidations, and the closing of submarginal firms. It is significant that the 1958 to 1963 period saw net increases in the number of steel forging plants within Appalachia whereas the United States, as a whole, suffered a net loss of 9.3 percent.

Table 12.

Locational activity for selected casting and forging industries 1/

Industries	Establishments 1958	Establishments 1963	Net increase (decrease)	Percent change
SIC 3321				
Total U.S.	1,310	1,138	(172)	(13.1)
Appalachian	180	161	(19)	(10.6)
SIC 3322				
Total U.S.	82	81	(1)	(1.2)
Appalachian	10	10	-	-
SIC 3391				
Total U.S.	301	273	(28)	(9.3)
Appalachian	21	24	3	14.3
TOTAL U.S.	1,693	1,492	(201)	(11.9)
APPALACHIAN	211	195	(16)	(7.6)

1/ Source: 1963 Census of Manufactures

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Casting and forging are two entirely different types of metal forming techniques. Casting involves the pouring of molten metal into a mold the shape of the desired part. Forging is the hammering of preheated metal into shape much like the blacksmith shaped metal for centuries. Today, however, forging dies replace the hammer and the anvil, and sheer weight and gravity replace the arm muscles.

Casting requires temperatures above 3,000 degrees to melt pig iron, iron scrap, catalysts of limestone, and other materials. Furnaces have been predominantly of the cupola type, but new conversions of gray iron foundries to ductile iron have installed direct arc refining furnaces, some with rated capacities of 75 tons per day and temperatures of 6,300 degrees.

From the large ladles, which receive the metal at the furnaces, the metal is poured, or "teemed", into green sand molds. In the molds, the molten metal is allowed to solidify in whole or in part. Subsequently the casting is then mechanically or manually shaken and shipped from the mold.

Excess flash, gates and sprues are often chipped and ground off with mechanical hammers and abrasive wheels. Cast parts are then racked or individually placed in gas or oil-fired annealing ovens at 1,600 degrees and held for approximately one hour per inch of thickness.

Ductile iron casting at this heat treating stage takes on the physical properties of a spheroid-shaped, graphite, crystalline structure rather than the flake structure of gray cast iron. For ductile cast iron, the crystalline structural change is an immediate chemical process, whereas malleable cast iron may take two weeks of heating to effect a change by a physical process.

The end result is that both ductile and malleable cast iron have much the same properties. Because of technical know-how, high-heat requirements, and advantages of short lead times, ductile iron is higher priced than is malleable iron.

To forge steel parts, the ingot must be reduced to a bar or billet. The following operations are generally performed in the steel mill before being transported to the forge plant. First, the ingot goes through a soaking pit, or electric furnace, where the ingots are "soaked" in heat up to 2,200 degrees. The ingot is then removed and rolled back and forth like baker's dough by huge mills into slabs and billets. Bars are further rolled from billet in a similar process. It is at this bar or billet stage that the non-integrated forge plant starts to work the metal.

Rolled and cut to various dimensions, the iron or steel bar is reheated to about 1,600 degrees in a furnace, usually gas-fired, conveyed through a high-pressure water descaler, and then manually carried by tongs, white hot, to the die part of a drop hammer for forging. Like a blacksmith's hammer, it may be necessary for the drop hammer to smack down on the hot billet several times before the shape conforms to the die. Annealing processes, similar to that of castings, then temper the steel to its desired properties by various amounts of heat, quenching, and cooling.

Raw Materials and Materials Handling

Low-cost rail transportation provides the most suitable means for carrying billets, bars, scrap iron, limestone and foundry sand into a casting or forging plant. At least 90 percent of the shipments over 90,000 pounds move by rail. Water transportation would be more economical, but site costs are prohibitive to the industry.

Movement of the raw stock within the casting plant is primarily carried out by overhead traveling cranes equipped with giant jaws or "U"-shaped cradles. In casting, molten metal is poured from overhead ladles into molds lined up on the foundry floor. Small precision parts, such as in investment casting, might require only a manual ladle frequently carried on a steel pivot pole between two men.

Manpower Utilization

As illustrated in the above paragraphs, a high proportion of physical manpower is an essential requirement for a ferrous casting plant. Strength and dexterity for the repetitive operations are major prerequisites for labor. At least 70 percent of the operations in a ferrous casting plant could be carried out by labor available in almost any area of Appalachia. High skills are not needed in abundance.

Rural labor, not accustomed to machinery, must first be acclimated to the noise factor in a plant by working in the materials handling phases of manufacture. Once acclimated, and a propensity for dexterity is demonstrated, training in machinery operations might be feasible for the green laborer.

Productivity is often keyed to a machine. A conveyor that feeds parts into position ready for manual pickup, a drop hammer or upset timed to strike every few seconds, or a furnace that hits the critical temperature for pouring molten metal, all place the laborer in a responsible position. With a manpower breakdown, the production line must stop if backup is not available. Casting and forging operations are typical examples where a lead man steps in for backup. Experience, in all phases of the process makes the lead man's skill a key to the basic operations.

A working foreman is also common in the ferrous casting plant. Responsible for temperature control, continuity of handling goods in process, sampling the metal for quality control, and overall supervision on the line is a brief job description difficult to fill from any labor supply.

Typically, a casting plant employing 100 workers would have the following division of labor:

Degree of skill	Operations	Number of employees
High	Molding	20
High	Pouring	15
Low	Shaking out molders	4
Low	Cutting flashes	6
Medium	Annealing	10
Medium	Grinding	20
Low	Materials handling	25

Product Innovation and Interproduct Competition

Ductile iron castings will gradually replace many forms of steel castings where the tensile and yield properties of ductile are within the limits of engineering design. A comparison of standard physical properties for the three types of castings give some idea of their similarity. Therefore, where possible, the lower cost material is used in casting the part. A comparison of relative costs and physical properties follow:

Properties 1/:	Tensile	Yield	Percent elongation	Cost in cents per pound
Ferretic ductile	60	45	10	30
Pearlitic malleable	80	60	3	25
Steel casting	100	80	2	40

1/ Tensile measures degree of stress before breaking.
Yield measures degree of stress before not returning to shape.
Elongation measures degree of stretch before breaking.

Other casting innovations include:

- carbon dioxide hardened sand-cores that save hours in preparing molds;
- shell molding that reduces finishing costs;
- and centrifugal molding that eliminates bubbles and allows thin walls.

Recent innovations in forging operations include automation through an electronically-controlled machine called "Chambersburg Impacting". Production is increased from 2 to 4 times that of conventional forge presses. Heavier equipment leads to higher productivity. With a 4,000-ton press, 2,600 forgings can be produced by three men in an 8-hour shift.

There is a definite need for more capital expenditures to increase productivity with heavy presses and materials handling equipment. New casting and forging plants locating within Appalachia could help fill this void.

Distribution

Sales are generated by company representatives, jobbers, and manufacturer's representatives. Direct contract with the auto industry, for example, is a typical sales procedure in the casting and forging job shops.

Distribution is primarily direct hand-to-mouth supply from a casting or forging plant to the manufacturer. In some instances, the prime contractor will route the casting or forging to another subcontractor for further machining or coating. In all cases, the inventory of goods in process is typically rushed to keep the production line supplied.

Due to the nature of this hand-to-mouth ordering, a greater share of the shipments of finished castings and forgings move by motor common carrier. Still, 41 percent of the forging shipments move by rail due to their weight and volume.

Statistics from the 1963 Census of Transportation reveal that 22 percent of the gray iron castings move by private truck.

Transportation costs establish a plant location parameter in relation to the market. The forging and casting industry must locate close to the market so that freight charges do not wipe out profits. Census of Transportation statistics reveal that 60 percent of the iron casting shipments move less than 300 miles, and 30 percent move less than 100 miles. Steel forgings are moved even shorter distances to market. More than 80 percent of the forging market is within 300 miles of the forge mill.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

Market orientation, transportation, availability of labor, and energy requirements are the critical variables leading to expansion of new ferrous casting or forging plants.

Proximity to markets is of prime importance in the weighing of opportunity costs that shape the new plant location decision. From all key market indicators available, ductile iron casting operations will have the greatest need for new plant expansions over the next 10 years. Pearlitic malleable and steel forging plant locations and expansions will have somewhat lower frequency.

Weighing the important factors that shape a location decision for this industry group is the primary concern of this section of the report.

Market Orientation

Sections I and II established market potentials for ductile and malleable castings as well as forgings. As demonstrated in Section III under "Distribution," the industry tends to locate within 300 miles of its market. Studies of market potential reveal that 51 percent of the demand for malleable castings and ductile castings is derived from the transportation equipment industry, the largest industry in the country.

Northern Appalachia would have a tendency to attract more of the casting and forging plants manufacturing for the present automotive parts market. The whole of Appalachia would have market location advantages for casting and forging supplies to the textile machinery industry, for example. As a matter of fact, the entire spectrum of markets, other than automotive (listed in Section I, Table 3) would fit Appalachian plant locations.

Some of the more important market potentials in the Appalachian States include: the textile machinery industry centered in North and South Carolina; the pump industry in Alabama, North Carolina, and Pennsylvania; the agricultural implement industry with major plants spread through all of the Appalachian States; the construction machinery industry with large plants in Alabama, Georgia, New York, Ohio, and Pennsylvania; and the railroad equipment industry scattered throughout Alabama, Ohio, New York, Pennsylvania, Tennessee, and West Virginia.

Delivery time and transportation costs from Appalachian locations would be well within the limits that the industry can bear.

Transportation

Excellent rail and motor carrier transportation service is essential to the casting and forging industry. Rail sidings adjacent to plant sites, and within commercial switching limits, are essential for supplying raw materials. Highway transportation plays a major role in supplying the casting and forging market.

As stressed under the heading of "Distribution" in Section III, the high cost of parts inventories in machinery plants encourages hand-to-mouth buying of castings and forgings. In the case of high-value, low-inventory stocks, highway transportation fits the service requirements. Frequent small shipments by truck can be readily expedited, traced, and delivered.

Large castings, having long production runs, ordered in volume, and less urgently required to stock inventories, tend to move to customers by rail. Transportation costs limit the distance castings and forgings can be shipped. The markets listed under "Market Orientation" are readily within the freight cost limitations of the industry.

Private truck operators can figure that driving time to a customer approximates delivery time. The private truck can drive directly from a casting or forging plant to the customer's plant. On the other hand, motor common carriers, and rail lines in particular, must route shipments circuitously. Most motor common carriers restrict their traffic to two-line hauls, but as many as 4 railroads might handle a portion of the routing for a shipment from Cooperstown, New York to Birmingham, Alabama.

Local cartage agents for motor carriers, railroads, and the carloading companies cover the rural or sparse industrial areas. Service to these rural areas is often not profitable for the long-haul carrier. In other cases, the topography and operating authority limit the service. Typical examples of isolated service, hampered by topography, can be found in southeastern Kentucky, central Pennsylvania, and scutheastern West Virginia.

Availability of Labor

There are pockets of surplus labor fitting the needs of the casting and forging industry throughout the Appalachian Region. Under the heading of "Manpower Utilization", the point was made that a great many of the repetitive and materials handling operations require relatively lower grades of labor skills. Casting and forging operations can be carried out with up to 65 percent of the work force in relatively unskilled jobs. Dexterity, strength, and good judgment overshadow the technical labor requirements in the industry.

In-plant training is informal in most operations, with the untrained employees starting as materials handlers or assistants to machine operators and working up in skills as they become more able and familiar with the work. The high cost of machinery precludes shop experience training of casting and forging men in vocational schools. Classroom lectures and plant visits would be interesting, but of no real value when compared to actual factory experience.

Because of the relatively high wages in this industry, high attrition from other industry may occur in the locale where a casting or forging plant opens. On the other hand, many of the location factors point to industrial locations already populated with high-wage industries. The work force for a new plant in this case would likely be drawn from the unemployed. In areas of intense unionization, modernization or automation might have resulted in the younger, more able-bodied being "bumped" into the unemployment status. These men would be ideal labor for the casting and forging industry.

Although work-force requirements are termed "relatively unskilled", workers are able to attract a relatively high wage due to such poor working conditions as high noise level, poor atmosphere, heat, and a large requirement for physical exertion. Unionization also plays a key role in establishing wage levels.

The Appalachian areas where workers have been displaced by automation, innovation, or depletion of resources could readily supply the labor force for this industry. Steel mill workers displaced by automated mills and coal miners out of work would ideally suit the jobs opened by casting and forging plants locating in their community.

The industry tends to be highly unionized with no major local wage differentials for equal job classifications.

Energy Requirements

There are ample resources in Appalachia for gas, electric and coal furnaces used to heat or melt the metals processed by this industry. Plant sites should be adjacent to the pipeline of supply for at least one of these sources of heat.

Steel forging or casting consumes 124,000 Btu's per dollar value added, or about 1,000 Btu's per employee. An electric arc furnace with a 1 ton per hour melting rate discharges 10,000 amps through its 3 electrodes. Connection to electric power service of 28,000 volts stepped down to 280 volts at the furnace is a typical installation for a small ductile iron casting plant. Consumption would be in the range of 500 to 800 kwh's per ton of steel melted.

Future casting installations will generally prefer the electric arc furnace for two reasons: (1) it is a faster means of melting iron, and (2) electricity is clean. Many state and local governments now have air pollution control laws that inhibit the use of coke-fired cupola furnaces.

Heat-treating furnaces are generally oil-or gas-fired, and they use the most economical fuel available at the location. Energy requirements here are not in the magnitude that they would be a major location determinant.

Community Location Factors

Communities attracting casting or forging operations usually are those which have experienced growth and perhaps maturity from other industrialization. For this reason, statistics reflect urban plant locations where the population is 25,000 or more. The actual plant site is usually on the fringe of a major industrial center in order to obtain the necessary land and yet be within the proximity of supporting supplies and services.

Community zoning should provide for heavy industrial areas located on sites screened by nature from residential areas. With electric arc furnaces, air pollution will be only nominal in casting operations. Noise and relatively light gas effluent would restrict forging plant sites to areas away from residential zones and on the leeward side of prevailing winds.

Schools, junior colleges, and local amenities such as recreation facilities will be more important in future locations. The laborer seeks to provide the kind of community life for his children that he could not enjoy. However, the immediate locations for casting and forging plants will be in communities where some of these amenities are subject to great improvement. Industry will accept these potential tax burdens only if there is some indication that the burden of cost will be shared by State and Federal agencies. Police and fire protection would be mandatory for a plant location in this industry. Insurance costs would otherwise be prohibitive.

Site Requirements

Sites with a minimum of 30 acres would be necessary for a forging or casting plant. Riverside sites, although not essential, would assist in disposing of the quenching water effluent. Pollution, if any, would be limited to a minor thermal effect, easily corrected prior to leaving the plant. Deepwater sites for transportation would generally create a cost factor too high for the industry.

Adjacent utilities of gas, electricity, water, sewerage, and a rail siding would attract new plants to a particular site. There are presently many sites available that fit only the minimum needs of a casting or forging plant. Only the choice sites, fully serviced, would gain the attention of management.

Site acreage must allow for future growth because initial capital costs for plant and equipment are high, and they cannot be readily moved. In addition to the actual plant, parking for 100 to 400 workers must be provided.

Other Location Factors

Financing

Revenue bond financing for the smaller companies (within the forging and casting industry) would provide an effective location inducement. Although there are many facets to the controversy over revenue bond financing, states offering them continue to accelerate their industrial development programs with new plants.

Taxes

Heavy capital investments in casting and forging plants imply that state and local tax policy regarding equipment would weigh heavily in a location decision. Goods in process and finished inventories are usually of low value and not accumulated in inventory stocks at the producing plant. They are therefore not a major tax consideration.

Municipalities with stable tax policies provide management with predictable costs from which they can determine prices. Undeveloped communities may be overlooked by firms who are wary of tax burdens which may be imposed to pay for expanded services.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

As pointed out in Section IV, and supported by qualitative and quantitative analyses in the preceding sections, the forging and casting industry is highly market-oriented. While public investment and policies could do little to change the existing market, they could shape the future for transportation, labor supply, and energy requirements.

Community responsiveness to the needs of the casting and forging industry will center on tax policy, zoning, and local amenities not always found in heavy industrial centers.

With emphasis on these location factors, this section of the report summarizes the impact that public investment policy and activity will have on location activity of the ferrous casting and forging industry.

Access to Markets

The market potential for Appalachian plant locations in the casting and forging industry were outlined in Sections I and II. In addition, Section IV of this report identified market orientation as one of the most important location factors for this industry.

It is important to notice that the ferrous casting and forging industry is a supplier to many of the other industries chosen for the Appalachian Regional Commission studies. Textile machinery, pumps, valves, fittings, automotive parts, mobile homes, office machinery, and materials handling equipment all create a demand that would add to reciprocal generation in the Appalachian economy.

Transportation to present and potential markets will require access highways and railroad services not now unified or coordinated to effect the best delivery. As Section III pointed out, distribution is limited generally to markets within 300 miles of a producing plant. This distance precludes rail transportation, except for large castings or volume orders which are not usually released as one shipment. Hand-to-mouth releases of job lots are peculiar to the industry.

The fringe of communities already industrialized will attract the forging and casting industry. Highways between the existing industrial communities of Appalachia would generate intra-regional potential. In addition, corridors from northern Appalachia to the manufacturing centers for automotive parts in Ohio and Michigan will enhance location activity. For the most part, the proposed Federal Highway Program will cover this need. However, an additional corridor from the Fairmont area of West Virginia following Route 250 northwest and continuing beyond Wheeling, West Virginia would cover much of the area. East-west corridors from eastern Tennessee industrial centers to the area of Greenville, South Carolina and Winston-Salem, North Carolina would open market channels not readily established because of topography.

Waterway and scheduled air transportation will not play an important role in attracting this industry to Appalachia. Although transportation for raw materials supply would be cheaper by water, the deepwater sites are too costly for the industry. Customer liaison requiring scheduled aviation is not a dominant factor for the casting and forging industry.

Labor Supply

To meet the labor requirements for the industry, employers, unions, and local industrial development departments must cooperate in an effort to plan the source of supply.

Since the ferrous casting and forging industry is highly labor-oriented, the ample supply of relatively unskilled workers is necessary. Section IV suggested that in areas of underemployment or where workers have been displaced by automation and innovation, there is an appealing opportunity for the location of this industry.

Responsiveness and cooperation of unions, industry, and communities could guide the unemployed to new job opportunities created by the location or expansion of casting and forging operations. For example, if a steel mill plans to install a continuous casting operation that will displace 100 to 200 workers, there should be an advance alert made to the union, to the local development department, and to the local unemployment office. Potential surplus labor pools known to be forming over a 6- to 18-month period would provide leverage for development departments seeking industry and diminish the demands of unions to forestall further automation.

Where the casting and forging industry tends to be of the same fraternal union as the basic steel industry, there could be a simple substitution of employers among displaced workers. Displaced workers could move from the steel mill to the forging or casting shops with very little training or acclimation.

As pointed out in Section IV, vocational training for the casting and forging industry is not generally feasible because of the high capital costs for equipment. Informal in-plant training is practiced by the industry.

However, the casting and forging industry must perpetuate the skills of critical jobs in casting and forging that tend to be lost by attrition.

Federal tax allowances for apprentice training by industry will encourage more formalized in-plant programs. Major companies have dropped apprenticeship programs because they lost to other companies the very men they trained. Tax allowances for investments in skilled labor are important to the long-run health of Appalachian industry.

Energy Requirements

Areas with low-cost power would attract those casting and forging operations that use electric furnaces for melting. Heat treating is essential to this industry and although many firms use gas fuel, low-cost electricity might be more economical in certain areas.

Power projects that will produce rates comparable to those of the TVA would also enhance location attractiveness.

Community Policies

Community responsiveness to the needs of the casting and forging industry should focus on property tax policy. High capital investments in machinery and equipment force this industry to locate where machinery and equipment is either not taxable or the community displays a history of equitable and stable taxation. Industry that can depend on stable costs may be attracted to a community even if it taxes property that other communities do not tax.

To attract the casting and forging industry, local zoning should allow for natural barriers to screen residential areas. Areas with low cloud ceilings have been known to reflect forging hammer noise up to one mile.

There is a tendency for this industry to locate in communities already highly industrialized. These communities could benefit from long-range programs to improve secondary education curricula directed more toward junior college enrollment.

Financing of Industry

The major producers in this industry are not usually sensitive to financial assistance programs. However, many of the 400-odd smaller companies in the industry may require some type of industrial financing help in order to justify the establishment of new facilities.

State and local governments with enabling legislation that supports revenue bond issues (that pay for a new industry's plant and equipment) will find many financially stable casting and forging companies ready to expand in Appalachia.

Appendix A

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Published Information

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(3) Fantus economic geography files for states and communities.

(4) Manufacturers of castings and forgings inside and outside Appalachia.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 19--THE FOAMED PLASTIC PRODUCTS INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian states must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically that part of Standard Industrial Classification industry codes 3079 and 3993 pertaining to Foamed Plastic Products.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

The foamed plastic products industry employs about 12,000 people. Although small by major industry standards, its growth potential makes it an ideal target for Appalachian industrial development efforts.

Ubiquitous in its locations, part of the industry bears a kinship with producers of corrugated boxes. Other segments of the industry resemble chemical compounders. The expanders of polystyrene beads, producing consumer goods such as ice buckets, surfboards, and floatation equipment display similarities with the garment industry.

Current markets continue to expand, while production capacity sometimes follows, but more often predicts the trend. A major breakthrough into the building insulation market provides the greatest potential for a new leap forward.

Profits play the only somber note in the industry. Nevertheless, selected companies appear to be breaking through a barrier with new products, lower cost production methods, and cheaper raw material prices. Yet, price competition remains intense, and all producers stand ready to exploit any new markets developed by the leaders.

The industry continues to radiate optimism. It has bounced back from adversity, it has developed new markets and reformed old ones, and it has successfully challenged entrenched products.

I. PROFILE OF THE INDUSTRY

Size

Among nondurable goods industries, foamed plastics, a segment of the rubber and plastics industry, employed 11,900 workers nationally in 1964. Capital charges, labor inputs, and profits contributed $105 million to value added. Although classified with nondurable goods manufacturers, the material finds its principal uses among durable goods producers such as furniture, transportation equipment, and appliances.

Table 1.

Ten ranking nondurable goods industries compared to foamed plastic products, 1964 1/

(Numbers in millions, unless otherwise noted)

Industry rank	Employment		Value added by manufacture		Capital expenditures	
1	Food	1.6	Food	$23,054	Chemicals	$1,876
2	Apparel	1.3	Chemicals	19,133	Food	1,419
3	Printing	0.9	Printing	11,065	Paper	886
4	Textiles	0.9	Apparel	8,150	Textiles	492
5	Chemicals	0.7	Paper	7,805	Printing	463
6	Paper	0.6	Textiles	6,736	Petroleum/ coal	412
7	RUBBER/ PLASTICS	0.4	RUBBER/ PLASTICS	4,984	RUBBER/ PLASTICS	400
8	Leather	0.3	Petroleum/ coal	3,774	Apparel	124
9	Petroleum/ coal	0.1	Leather	2,270	Tobacco	59
10	Tobacco	0.08	Tobacco	1,772	Leather	38
	FOAMED PLASTICS (thousands)	11.9	FOAMED PLASTICS	105	FOAMED PLASTICS	8

1/ Source: 1964 Annual Survey of Manufactures, U.S. Department of Commerce, and Interpolation of 1963 Census of Manufactures, U.S. Department of Commerce.

Products and Markets

As defined by the SIC classification system, foamed plastic products (SIC 30792) include the following subclassifications and product lines:

SIC 30792-00: Foamed plastic products, not specified by kind.

SIC 30792-11: Mattress cores (includes uncovered mattress cores only).

SIC 30792-21: Formed and slab stock for pillows, seating cushioning, etc. (includes foamed seats, backs, armrests, crash pads, foamed sheet, stock, etc.).

SIC 30792-31: Insulation (includes thermal and acoustical for refrigeration, automotive, electrical, building construction, weather stripping, pipe insulation).

SIC 30792-41: Carpet and rug cushions.

SIC 30792-98: Other foamed plastic products (includes buoys, floats, sponges, holiday decorations, etc., including products foamed from resins and those fabricated from purchased foam stock).

SIC 30794-53: Packaging and shipping containers, plastic disposable cups and tumblers, including foamed.

SIC 30794-67: Foamed protective shipping pads and shaped packaging (including foam containers for typewriters, instruments, etc., box inserts, liners, etc. Includes pads and packaging fabricated from purchased foam.).

SIC 30798-73: Picnic jugs, cooler chests, and ice buckets, including foamed.

SIC 3993: Advertising novelties.

Based on the 1963 Census of Manufactures, the largest value of shipments was made up of formed and slab stock for pillows and cushioning, followed by other foamed plastic products (see Table 2). Insulation uses, which could be a big gainer in the future, rested in third place. One major market and product not specifically listed above consists of lightweight insulated clothing made from foam-backed fabric. Other foam products not accounted for are found in classifications distinct from SIC 30792.

Table 2.

Industry shipments by product class 1/

SIC	Product class	Value ($ million)	Percent of total
30792-00	Foamed plastic products, N.S.K. 2/.	10.3	3.9
30792-11	Mattress cores (uncovered only) ...	8.4	3.2
30792-21	Formed and slab stock for pillows and cushioning	127.1	48.7
30792-31	Insulation	48.8	18.7
30792-98	Other foamed plastic products	51.6	19.8
	Miscellaneous (insufficient description)	15.0	5.7
30792	TOTAL FOAMED PLASTIC PRODUCTS	261.2	100.0%

1/ Source: 1963 Census of Manufactures, U.S. Department of Commerce, Bureau of the Census.

2/ Note: N.S.K. (Not specified by kind).

Some difficulties rear up when trying to gauge the industry. They relate to methods of making or using foamed plastics. For example, rigid foam is generally formed directly from raw materials into final products by the end-user. In 1965, less than 15 percent was shipped as factory-produced slab stock.

Plant Size and Geographic Distribution

Many foaming operations, like much of the plastic parts production, do not require elaborate facilities. Production is simple. Polystyrene foamed goods such as jewelry boxes, instrument packages, and small containers are often made on automatic machines which pour plastic beads into a mold where they are then heated, expanded, and fused. The molded form is then ejected by mechanical or hydraulic means. Beads again automatically fill the mold, and a second unit is foam molded. The sequences repeat. Production continues automatically. Firms employing fewer than 20 workers are not unusual. Many operate in small garage-type factories.

Polyurethane foaming operations, however, require carefully controlled chemical mixing and generally call for more complex manufacturing procedures. Although some plants work less than 25 people, others range up to 350. Since an actual chemical formulation is made during the manufacturing process, a list of polyurethane manufacturers in the United States is obtainable (see Table 3).

Table 3.

Polyurethane foam procedures in the Continental United States 1/

State	No. of plants	State	No. of plants
Alabama	1	Missouri	4
Arizona	1	Nebraska	1
California	14	New Hampshire	1
Colorado	1	New Jersey	13
Connecticut	3	New York	13
Florida	1	North Carolina	6
Georgia	3	Ohio	10
Illinois	9	Pennsylvania	9
Indiana	6	South Carolina	3
Iowa	1	Tennessee	2
Maryland	2	Texas	6
Massachusetts	7	Virginia	2
Michigan	8	Washington	2
Minnesota	2	Wisconsin	2
		TOTAL	133

1/ Source: Stanford Research Institute, Menlo Park, California, and Fantus' records.

Appalachian Specialization

Of the plants listed above, 12 are operated in the Appalachian Region (Table 4). The largest of these, located in Pennsylvania, employs over 350. Another relatively large producer fabricates foamed products in Tennessee. It should be noted that 1 plant is located at Dalton, Georgia in the midst of the carpet industry. Carpet backing provides 1 of the growing uses for polyurethane foam.

Table 4.

Polyurethane foam producers in the Appalachian Region 1/

Location	
State	City
Alabama	Birmingham
Georgia	Dalton
Maryland	Cumberland
North Carolina	Mount Airy
Pennsylvania	Hazelton Pittsburgh Sharon Waynesboro
South Carolina	Blackburg Spartansburg
Tennessee	Chattanooga Morristown

1/ Source: Stanford Research Institute, Menlo Park, California, and Fantus' records.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Sales

Polyurethane foams dominate the overall market. But there is vigorous growth ahead for polystyrene, the vinyls, polyethylene, ABS resins, and urea formaldehyde. In fact, 1 of the dynamic forces of growth is new knowledge of how to make foams with almost any thermoplastic or thermosetting resins.

From less than 10 million pounds in 1958, sales of urethane foam shot up to 290 million pounds in 1964. Production in 1965 ran over 325 million pounds with some estimates ranging upward to 388 million pounds.

Shipments in 1963 reached $261 million, close to a 36 percent increase over 1962. By way of comparison, sales in 1962 surpassed the 1961 volume of $192 million by a 29 percent margin. A breakthrough to the $500 million mark is expected by 1970.

New uses for foam are constantly demanding increased production. The major customers for foam products in 1963 were as follows:

	Percent of total	
	Weight basis	Value basis
Furniture and bedding Formed and slab stock for pillows, seating, cushioning, etc.; mattress cores.	42	44
Automotive Seat cushion topper pads and seat backs, door pulls and arm rests, instrument panel trim and crash pads, weatherseals, vibration mounts, etc.	18	23
Thermal and acoustical insulation Appliances, commercial refrigeration freight cars, roof insulation, backerboard aluminum siding, prefabricated building panels, interlining, laminated fabrics, etc.	31	20
Miscellaneous Packaging, displays, toys, rug underlays, athletic clothing, footwear, boats, sponges, exports, etc.	9	13
TOTAL	100	100

A contributing factor to greater market breakthroughs has been the reduction in raw material costs, expecially the isocyanates, and improved control over foam densities. This combination has enabled plastic foam producers to displace higher cost-per-volume rubber latex foam in the upholstered furniture industry and higher cost-per-insulation-effectiveness fibrous products in the appliance business.

Rigid Foam

Among urethane foams, the rigid product, growing at 48 percent a year since 1960 when 10 million pounds were sold, captures 25 percent of the United States market. About 80 million pounds were used in the United States in 1965. This year, foam makers expect sales of 105 million pounds.

Construction provides the biggest potential market. Depending upon how successfully this market for building insulation is penetrated, estimates for the consumption of rigid foam range between 160 million pounds to 300 million pounds for 1970. Building codes present 1 stumbling block, although questions about the product's flammability have been answered by making it self extinguishing. Builders themselves, displaying a natural reaction against change, tend to remain with older products. Furthermore, until recently, rigid foam's cost was not competitive. Now, however, urethane slab stock sells for about 12 cents per board foot. A projected comparison of the end-use demand for rigid foam is shown in Table 5 below.

Table 5.

Comparison of the construction market for rigid urethane foam with other end uses 1/

End use	1963	1964	1965	1966	1970
Transportation	10	18	25	28	35
Appliances	9	15	23	30	45
Construction	5	6	8	15	55
Industrial insulation	4	6	8	10	15
Flotation	2	4	6	8	15
Packing	1	2	3	4	10
Other	4	4	7	10	20
TOTAL	35	55	80	105	195

1/ Source: Stanford Research Institute and Chemical and Engineering Estimates.

Rigid polyurethane foam possesses high insulating value and is twice as effective in preventing heat transmission as fibrous glass or polystyrene foam. Thus, in uses where wall thickness is important (refrigerators, freezers, refrigerator trucks and railroad cars), it has cornered a large share of the market.

Currently, the major markets for rigid foam are appliances and transportation. Refrigerated trucks and rail cars consumed 25 million pounds of rigid foam in 1965. However, this market is about 80 percent saturated with little room for additional growth.

Use in refrigerators and freezers has further room for expansion. Until recently, high prices and cost of application prevented universal adoption. But now, prices have dropped, and improved systems have helped foam move strongly into the appliance insulation field.

As a result, urethane foam is replacing bulkier glass fiber insulating materials in refrigerators and allowing designers to come up with the new thin-wall styling now in vogue.

However, economies preceded fashion. Two or three years ago urethane foam was selling for about 60 cents a pound; today it is available for about half this price. Some producers are using foam insulation widely; others are now expanding their use of the material so that cabinets from 16 cubic feet and up are all foamed, using an average of 12 to 13 pounds per shell. Generally speaking, the tendency is to use foam in larger, more deluxe models.

Commercial and home freezers and refrigerators took 23 million pounds of rigid foam in 1965. This market still provides growth potential since it is only about 40 percent saturated. As shown in Table 5, the estimated appliance market for 1970 amounts to 45 million pounds. One major appliance manufacturer predicts the possibility of even greater use if prices of resins and diisocyanates can be further reduced. Under the stimulus of lower prices, a demand of 46 to 52 million pounds is projected by the appliance industry.

Sizable markets are also being uncovered among producers of mobile homes and campers. Here, the space-saving qualities of urethane foam insulation give the home manufacturer a solid selling feature.

A Unique Potential for Rigid Foam

The near tragedy of the Gemini 8 mission, together with the enlargement and growing complexity of manned space vehicles, has given priority to the development of a feasible emergency escape system for rescuing astronauts. Working for the government, 1 company has tested and determined as practical the MOOSE (Manned Orbital Operations Safety Equipment), an individually erectable ballistic escape capsule.

The astronaut, leaving his disabled vehicle, dons and inflates a set of clear plastic coveralls equipped with oxygen supply, retro-rockets, and parachute. The coveralls go over the normally worn pressure suit. As he jumps clear of the vehicle, the astronaut releases foamed polyurethane from a tank mounted on his shoulder. The plastic material fills the void between the coveralls and the flyer's pressure suit. Protected from reentry friction heat by a thermal shield coating on the coveralls, the astronaut, encapsulated in foam, fires a hand rocket to propel him to a parachute landing in the ocean.

Among the initially tested foaming materials was a mixture of castor oil and a polyester prepolymer which produced a semi-rigid foam. However, this material proved unsatisfactory. A substitute pour of a formulation which produced a rigid polyurethane foam turned out successful.

The foam weight amounts to 73.4 pounds per man at a density of 2.5 pounds per cubic foot. The total weight of the MOOSE system concept, including rocket fuel, is 322 pounds. In addition to advantages of simplicity of operation and small storage requirements, the urethane foam does double duty as a life raft in ocean landings.

When space travel becomes as common as present day airplane flights, a whole new field of protective packaging of humans may evolve.

Expanded rigid polystyrene provides a further use of foam in the packaging industry with the development of a shipping tray for strawberry growers. Individual plastic pint baskets of strawberries are placed in the shipping tray for protection during transport to markets.

From California alone, an estimated 10 million trays of strawberries will be air freighted to market in 1966. Each foamed tray will save 13 ounces in shipping weight and yet remain strong enough to be stacked high on pallets--even when wet. Although these trays cost more at present than the more commonly used packaging material, their lighter weight resulting in lower freight charges offsets this additional cost.

Sizable growing areas for perishable fruits and vegetables exist in Appalachian areas. The Sand Mountain area of northeast Alabama, extending into Tennessee, provides 1 major market for packaging of garden crops. Fresh market strawberry crops in eastern Kentucky and Tennessee provide another. Additional fresh market strawberry crops in commercial quantities are harvested in New York, Pennsylvania, North Carolina, and Virginia (see Table 6). Encouragement to develop these areas, especially eastern Tennessee and Kentucky, would enlarge the market for plastic foam packaging.

Other crops (see Table 6) would also lend themselves to protective foam packaging. Sizable production of these staples takes place within or close to Appalachian areas.

Further experimentation with foam shipping packages could lead to greater use, lower prices, and increased production of plastic foam in the Appalachian Region.

Table 6.

Production commercial quantities of perishable agricultural products by states oriented to the Appalachian Region 1/

State	Apples (1,000 bushels)	Cherries (tons)	Fresh Grapes (tons)	Peaches (1,000 bushels)
Alabama	-	-	-	300
Georgia	400	-	-	5,400
Kentucky	500	-	-	350
Maryland	1,480	-	-	480
New York	25,500	40,200	3,240	520
North Carolina	2,600	-	-	1,500
Pennsylvania	10,000	18,900	1,800	2,800
South Carolina	-	-	-	7,800
Tennessee	-	-	-	220
Virginia	9,800	-	-	1,000
West Virginia	5,300	-	-	750

State	Fresh Market Strawberries (1,000 pounds)	Eggs (millions)	Fresh Market Tomatoes (1,000 cwt)	Cantalopes (1,000 cwt)
Alabama	1,725	2,098	240	72
Georgia	-	3,227	135	360
Kentucky	3,520	815	56	-
Maryland	2,520	263	-	-
New York	10,730	1,872	418	117
North Carolina	5,500	2,264	406	138
Pennsylvania	5,500	3,073	336	-
South Carolina	-	1,002	592	132
Tennessee	9,500	851	280	-
Virginia	4,840	1,155	432	-
West Virginia	-	298	250	140

1/ Source: Agricultural Statistics 1965, U. S. Department of Agriculture.

Flexible Foam

Of the total foam output in 1965, flexible foams accounted for about 75 percent of the production. It swelled from 75 million pounds in 1960 to an estimated 220 million pounds in 1965. Some accounts place production in the 245- to 270-million-pound range. During the 1961 to 1965 period, flexible foam showed a growth rate of 17 percent, and producers expect to see an average upward trend of 10 percent a year until 1970.

At present, the major portion of shipments go to furniture makers who in 1965 took 50 percent of the output. Textile laminations and automobiles also provide major markets for flexible foam. In general, producers foam polyester urethane for textile and apparel applications and polyether urethane for furniture cushioning.

Urethane foam's route into the upholstered furniture market ran into some rough roads before reaching today's successful levels. In fact, at 1 point, the furniture market was almost lost because of product imperfections. Improved foaming methods and better control over densities which eliminated problems of set, bottoming, and lack of resiliency won back the furniture market. Performance improved to such an extent that 1 major furniture producer actively promotes the product in its luxury furniture line.

Use of foam in textiles shot up dramatically because technical innovations made it possible to bond fabrics to both sides of the foam interlining. Sales of foam-lined clothing brought about increases in purchases of plastic foam bonded material from 40 million yards in 1963 to 300 million yards in 1965.

Markets among carpet makers are equally extensive. Value shipped by Alabama, Georgia and South Carolina producers approached 700 million dollars in 1963, and provides a potential for 206 million yards of foamed backing.

Automobiles, which presently use approximately 23 percent of the dollar value of foamed plastics, will increase their demand significantly. The recent Senate automobile safety hearings will lead to greater stress on safety factors in cars. Thicker headlining, more absorbent crash pads, optional headrests, protective door padding, and heavier visors will make their appearance on new models. The acceleration of the trend has already appeared. One manufacturer boosted its use of foam 44 percent in 1966 models over cars produced in 1964. A maker of plastic foam predicts a jump in automobile padding from 5 pounds to 20 pounds per car.

Improved technology will cause a further increase in automotive use of foam. Heat-sealing of polyether and vinyl foams to vinyl sheeting at high production speeds eliminates higher cost stitching operations for padded parts. More padding at less cost pleases expense-conscious automobile men.

Profits

The industry's success in building up volume suffers under a cloud thrown up by restricted profit margins. Spurred by chemical producers, the foam producers overbuilt capacity, depressing prices. To add to the problem, raw material makers edged toward producing foam. However, the threat of action by the Justice Department called a halt to this forward integration movement.

Price competition remains intense although expanded consumption allowed pressures to recede. One producer, heavy in foamed systems as well as material production, recorded a net income of $3.6 million on $65.7 million sales in 1965, up substantially from its 1963 profits of $1.5 million on sales of $55.9 million.

One other manufacturer, a leader in flexible polyester urethane foam, showed rising earnings for 1963, 1964, and 1965. Still, profit margins approximate only 3.3 percent of sales. Other major producers of foam concentrate their chief activity in tires, rubber products, and paper, thus preventing any responsible assessment of foam's contribution to the profit picture.

Employment

Employment in the industry, although small compared to broader industry classes, has shown outstanding growth. Based upon the industry's outlook, prospects for further expansion in the work force appear bullish. New plants now coming on stream should lift work force estimates above the present 12,000. Particular impetus to the industry will come with the acceptance by regulatory authorities and mass builders of foam's economic insulating value in the home building industry.

Female workers generally work at clerical and packaging operations and account for but a small portion of the productive effort. Newer, more sophisticated techniques are demanding higher skills in the male work force. However, since so much of the work is in the development stage, pools of men with necessary skills do not exist in abundance anywhere. Because of this, underindustrialized areas have equal opportunities to compete and develop worker skills with the older manufacturing centers.

Investment and Location Activity

Up to 1963, foam producers have invested $115 million in expectation of large developing markets. The total investment was divided into $15 million for development and $95 million for plant, equipment, and working capital. Added to this, the investments of raw material producers, basic chemical companies, added another $250 million ($220 million in plant and equipment).

Although sales continue to forge ahead, the industry is not without its problems. Based on 1963 figures, foam producers turned over their capital less than twice a year. Considering the industry's gross profit margins, indications are that many producers were in a break-even state. New products and expanded uses since 1963 have begun to reverse the weak financial picture.

A major flexible polyurethane plant is slated for construction in Bremen, Indiana. Expected to come on stream in the winter of 1967, the new unit will replace a production unit formerly operating in Chicago. New raw materials plants in Circleville, Ohio for urethane resins and expanded operations at Kobuta, Pennsylvania for polystyrene reflect current industry estimates.

Another company located in Hazelton, Pennsylvania has a 60,000-square-foot expansion of its 300,000-square-foot facility underway. Its output of flexible polyether urethane foam will be directed toward the furniture industry, while flexible polyester urethane foam finds use as clothing interlining.

In Sharon, Pennsylvania a new facility for "foamed-in-place" insulation of railroad tank cars is now operative. The new building, 320 feet long, 50 feet wide, with a 30-foot ceiling height, has a capability of handling 250 railroad cars per month.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Basically, 3 methods are used to make foam materials. One method is similar to baking a cake, a second holds a relationship with whipping cream, while a third procedure resembles the action experienced when the valve on an aerosol can of shaving cream is pressed. In the first method, gas to raise the cake was evolved by the ingredients of the recipe; in the second, gas (air) was beaten into the cream; and in the third, foam resulted because the vaporization of a volatile constituent expanded the material when exposed to the lower (outside the can) atmospheric pressure.

Many foamed plastic sheets are made by the extrusion process, a procedure demonstrating kinship with the aerosol can method described above. Squeezing toothpaste from a tube provides a simiplified everyday example of forming by this means. The plastics generally used are the polyolefins and polystyrenes. These resins are heated and softened so that they will react with chemical additives to form gases in the melt. To control cell formation, nucleants are also added.

The driving screw in the extruder provides the mixing necessary to insure uniform foaming and conveys the material under pressure to the extrusion die. After leaving the extruder and passing through the die, the material experiences a drop in pressure to atmospheric, thus allowing the gas it contains to evolve and form cells which are joined together in a cellular structure.

At present, most manufacturers inject the gas-producing blowing agent directly through the barrel of the extruder into the melt.

Circular extrusion dies have replaced flat ones because of problems stemming from the 3-dimensional expansion of the material when it emerges from the extrusion die. Although the final product resembles a long tube, slitting the tube results in a flat sheet.

Foamed plastic packages are often made by molding. Molds for packaging cover many sizes, with a concentration in the 12" x 15" to 36" x 48" ranges. Machines fill the mold with polystyrene beads, fuse and expand the beads by the application of steam pressure, and eject the finished product.

The use of modern equipment is converting a semiautomatic process to an automatic one. Manufacturers claim roughly a 60 percent labor savings through such automatic operation.

Urethane foams are made by reacting polyols with isocyanates. Typical materials used are detailed in 2 representative "one-shot" formulations below:

Raw Material	Number of Parts: Flexible Foam	Number of Parts: Rigid Foam
Resin	100.00	100.00
Isocyanate	45.00	74.00
Blowing agent	7.00	34.80
Surfactant	1.50	1.80
Catalyst A	.10	-
Catalyst B	.35	.87
Catalyst C	-	.87
Water	3.70	-

The chemicals required include a catalyst, isocyanate, resin, and generally a surfactant to facilitate homogenization. These are often silicones which give the water and resin miscibility. Catalysts provide reactivity and process control in order to achieve fine uniform cell structure throughout the product. Such consistent physical properties allow the manufacturer to exercise complete command of density, load bearing, compression, and resiliency.

Until recently, cellular plastics applications in appliances were foamed in place. However, the introduction of a modified toluene diisocyanate permitted elimination of the prepolymer step to make a one-shot rigid foam.

This major technological development brought about further study of application methods and systems. As a result, slab pouring similar to that used in the flexible foam industry was adopted to make molded and contoured shapes and slabs for appliance insulation. To control the increasing rate of thermal conductivity (lowered insulating value) resulting from advancing age in slabs or shapes with cut exposed sides, various types of protective skins are being applied to the edges of rigid foam panels.

Flexible foam makers have learned how to better monitor the manufacturing process. One company using an electronically controlled batching system exercises greater accuracy in weighing the chemical ingredients. In some ways, production is similar to baking. The "dough" mixture, made up of a polyol, an isocyanate, and a catalyst which chemically react, rises like a cake, then goes to the slicing machines.

An innovation called the frothing method is replacing some "cake baking" operations. Instead of pouring the liquid formulation into a mold and then waiting for it to rise, a froth or pre-expanded bulk of foam is placed in the mold or form. Advantages gained include lower densities and a lesser buildup in pressure, once a problem with poured-in-place refrigerator insulation.

A production method called foaming-in-place obviates shipping large volumes of low-density product. Either sprayed or poured, the urethane sticks to most surfaces, permanently eliminating the need for adhesives. In a typical construction application, the foam is sprayed onto exposed cinder block walls and then plastered. By cutting out the need for furring strips and rock lath, total costs of insulation are reduced about one-third.

Using a process for which it has obtained an exclusive license, one company now makes a dielectrically heat-sealable foam which can be heat-sealed to vinyl sheets at high production speeds. A blend of polyether and vinyl foams, the product appeals to the automobile industry because it does away with the stitching formerly needed to make upholstered bucket seats, padded armrests, etc.

Raw Materials

Basic raw materials are produced in the Appalachian Region and nearby points. One company with an annual capacity of 120 million pounds a year makes the polyether resin at Institute, West Virginia. Plants turning out polyester resins are located in Alabama, Pennsylvania, New York, West Virginia, and South Carolina.

Isocyanate capacity at Moundsville, West Virginia; New Martinsville, West Virginia; and Institute, West Virginia total 150 million pounds per year. Additional capacity at Elkton, Maryland would provide quicker shipments to Appalachian points in Pennsylvania, New York, and Maryland.

Distribution

Producers ship all over the United States and Canada. Some also ship extensively to Europe. Both truck and rail transportation are used for continental deliveries, with rail generally favored for distances over 300 miles. Producers own or lease their own trucks and trailers. Truckloads of the low-density product will often weigh only about 1 ton. One company has developed a highly compressible foam permitting it to make heavier truckload shipments.

Terms and freight allowances depend on distance to customer, regularity of customer purchases, and size of orders. Carload orders will generally be sent freight prepaid. Customers buying intermittently will usually have to pay the freight on orders less than $300.

IV. PRIMARY FACTORS INFLUENCING THE SELECTION OF LOCATION

Introduction

Marketing considerations dictate the plant locations for polyurethane foam products producers. Molders of foamed styrene goods are rather ubiquitous and are not necessarily oriented towards their markets. For example, a successful producer of foamed insulated buckets and freezer chests ships nationwide from a Mississippi location. However, producers of packaging will favor urban sites oriented towards their market. Many similarities in locational attributes are noted between foamed plastic producers and manufacturers of corrugated boxes. They are markets oriented and penalized heavily by transportation costs when shipping beyond area markets.

Economic Considerations

Transportation Costs

Because plastic foam products are light but bulky, long-distance shipping carries penalties. Orders for finished products are taken on a volume basis (board feet) or are unit priced. For example, prices range from 7-1/2 cents to 40 cents per board foot, with much of the product selling at 15 cents. Prices vary with densities and specific customer design requirements.

A high cube trailer of 2,800 cubic feet can handle roughly 5,000 pounds of flexible foam having a density of 1.8 pounds per cubic foot. A truckload shipment could carry a maximum of approximately 33,600 board feet. At 15 cents per board foot, the value would amount to $5,040 and represent a net profit to a manufacturer of about $200. Shipping costs for 300 miles would amount to $180--almost the equivalent of the net profit on the load. For shipments much above 300 miles, transportation charges bear close to a 1-to-1 ratio with profits and soon begin to dig into profit margins significantly.

On shipments over longer distances, rail is utilized because costs will generally be lower than private carriers. Even so, a carload of 66,000 board feet shipped 1,000 miles could cost $360 for transportation and end up with a high, almost 1-to-1 ratio to profits.

With transportation costs supporting such a high ratio in relation to profits, it can be seen that producers of plastic foam have a rather restricted economical shipping radius. Not that manufacturers cannot ship beyond these distances, this they presently do. But with growing competition and mounting pressures on profits, the economics of absorbing shipping charges will force a realignment in operating locations. This should become increasingly evident within the future.

Plants originally established to serve local metropolitan markets will have to follow the pattern established by the corrugated boxmakers if they expect to successfully penetrate new sales territories. For the producers of packages, service considerations will doubly add to the pressures.

Appalachian locations pointed towards the carpet-producing areas in Georgia, Alabama, and South Carolina, or the upholstered furniture market centering on High Point, North Carolina, or the fruit and vegetable production throughout the Appalachian Region would enable foam producers to compete successfully against competition shipping in from Midwest or Northeast locations. Operators in northern Appalachian areas can focus on automobile assembly plants in Delaware, New Jersey, and New York. Assembly plants in Atlanta, Georgia provide additional markets for producers locating in southern Appalachian regions. The expanding use of foam as a garment interlining will create markets throughout the region. More detailed information to aid in assessing area markets for foam producers is given in Section II of this report.

Inbound transportation costs will play an insignificant role in plant locations. Generally, delivered pricing on resins, isocyanates, and other chemical additives will prevail.

Labor

Labor demand will not be unique. Since a core of experienced workers possessing skills in foam production is not available anywhere, no area will be placed at a particular advantage or disadvantage. In-plant training will satisfy the majority of requirements.

Labor costs will be a variable factor in locations. Yet, only under inordinately unusual conditions would differentials be large enough to sway locational decisions soundly based upon market penetration factors. However, firms presently located in high wage areas and now bucking high shipping costs may be able to achieve significant labor savings which will provide supplementary advantages to a new plant location.

Sites

No unusual or unique site criteria exist. A well-drained, serviced site with good highway access and rail siding will constitute the principal requirements. A tract of 15 to 20 acres will generally meet all expansion requirements.

Receipt of principal raw materials in carload lots will necessitate a rail siding. Even though the output of a proposed plant will be chiefly directed towards markets close enough for economic service by private motor carrier, on large shipments to customers within a 300-mile radius, rail deliveries on materials of lower density are often competitive with leased truck operations.

Because of the tight profit picture in the industry, which is expected to continue as development costs soar, producers will be conscious of price differentials among competitive sites.

Neither the water demand nor effluent disposal will create an unusual problem for site seekers. Communities of 2,000 with adequate water and sanitary sewer systems should experience no difficulty providing the necessary services to the plant site. Industrial tracts in urban centers and major metropolitan areas would normally be expected to have all utilities in and operating.

Utilities

Differences in utility costs are a minor consideration. The annual bill for water, power, and fuel for process use usually varies little between areas. However, substantially lower power costs in TVA territory can return significant savings to foamed plastic product makers turning out extrusions or molded packages.

Financing

Because of low profit returns, state financing and equipment bonding plans have much appeal to foam producers. Private placement of debt is often difficult, and point premiums are generally required. Even where private money is available, capital needs can only partially be met. Mortgages will not generally cover more than 60 percent of a building's cost, thus placing an added burden on the foam producer.

Other Considerations

Community amenities, ancillary industries, selection of vendors, lead time in placing orders, and make-or-buy decisions will play, at best, only a minor role in site seeking. Quite frequently, these factors will be "of interest" but not "determinants."

Summary

It should be remembered that as the industry develops, technological changes may force a reassessment in its locational factors. At the present state of the art, market and transportation considerations weigh heaviest. However, some changes, even now, may be in the offing.

One type of flexible foam can be compressed for shipment. When unstrapped at the receiving point, it snaps back to its original form, losing little of its resiliency. Obviously, this development will permit the shipment of greater weights of this kind of foamed product for longer distances at a lower cost per unit. Because this characteristic has been developed in only 1 particular kind of foam, it will not force any major reorientation in location thinking in the near term for the overall industry.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Opportunities for public investment to encourage producers of foamed plastics to locate in Appalachia are rather limited. Improved east-west highways can bring the large upholstered furniture market of the Carolina Piedmont within the orbit of potential foam-producing locations in central Appalachia. A 300-mile circumference centering on High Point, North Carolina will give dimension to a territory offering site potentials for manufacturers serving that market.

Federal efforts to stimulate agricultural production of perishable fresh market commodities listed in Table 6, combined with local promotional efforts directed towards foam packaging producers, would provide reasonable inducement for foam package makers to locate at strategic agricultural marketing centers.

Prospects for growth of this industry in Appalachia relate primarily to the overall industrial development of the Region. Accordingly, its sensitivity to public investment policies and activities essentially remains indirect. Nonetheless, the industry demonstrates a substantial potential for Appalachia and was included in the study program for this reason.

Appendix A

SELECTED INFORMATION SOURCES

Published Information

(1) Annual Survey of Manufactures, 1964, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

(2) 1958 and 1963 Censuses of Manufactures, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

(3) Annual reports for individual companies.

(4) Directory of Chemical Producers, Stanford Research Institute, Menlo Park, California.

(5) Moody's Industrial Manual, 1966, Moody's Investors Service, Inc., New York.

(6) Handbook of Agricultural Charts, 1965, U.S. Department of Agriculture.

(7) Plastics World, September 1966, Cahners Publishing Company, Inc., Boston, Massachusetts.

(8) Chemical and Engineering, September 1966.

(9) Standard Listed Stock Reports, 1966, Standard & Poor's Corporation, New York.

(10) Chemical Week, May 1966, McGraw-Hill, Inc., New York, New York.

(11) Hercules Chemist, April 1966.

(12) Industrial Heating, June 1966.

(13) Modern Plastics, October 1957, Breskin Publications, Inc., New York, New York.

Unpublished Information and Personal Contacts

(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(5) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 20—THE ROLLING, DRAWING, AND EXTRUDING OF NONFERROUS METALS INDUSTRY

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian states must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically Standard Industrial Classification industry codes 3351, Copper Rolling and Drawing; 3352, Aluminum Rolling and Drawing; 3356, Rolling and Drawing, Not Elsewhere Classified; and, 3357, Nonferrous Wire Drawing, etc.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

In 1964, the rolling, drawing, and extruding of nonferrous metals provided employment for over 131,000 production workers, and total employment ran in excess of 167,000. Product shipments for that year were $7.254 billion with value added by manufacture of $2.229 billion.

Serving as raw materials for a wide range of metal fabricating and construction industries, leading nonferrous metals are all experiencing a general tightening of supply in varying degrees, and future prospects for increased locational activity appear bright. Aluminum leads the field with an estimated $2 billion in new facilities by 1970.

In general, these industries are dominated by large integrated producers of primary metal. Significantly, the Appalachian Region claims 10.44 percent of establishments employing over 100 in the production of nonferrous mill products, while only 6.7 percent of the plants account for all employment sizes.

The consensus of industry opinion places growth at an average annual rate of 7 percent or over for aluminum, copper, and titanium mill products. This, plus an apparent upturn in the industry profitability, speaks well for an increase in locational activity.

Total transportation costs and the cost of utilities, principally power and natural gas, lead the list of primary locational determinants. Transportation demands first consideration and has forced industry into a relatively high degree of market orientation. The industry exhibits a heavy reliance on both trucking and rail.

Other primary factors influencing the selection of new locations include the availability of adequate water supplies, an available labor force which will allow for long-term operating satisfaction with the area, 125- to 175-acre sites with minimum development costs, an equitable tax climate, and a relatively attractive community environment.

Public policies, actions, and investments which would be most effective for these industries will emphasize, in order of priority:

(1) development of competitive power rate structures;
(2) provision for natural gas service;
(3) improved transportation facilities; and
(4) vocational training programs in tune with the industry's needs.

I. PROFILE OF THE INDUSTRY

Size

The rolling, drawing, and extruding of nonferrous metals in 1964 accounted for 14.23 percent of all employment in primary metals manufacturing, 13.3 percent of value added by manufacture, and 10.3 percent of the new capital expenditures generated by the overall industry (SIC 33). A comparison of these data with the 10 durable goods industries is reflected in Table 1.

Table 1.

Rankings of the durable goods industries, 1964 1/

(Numbers in millions)

Industry rank	Employment		Value added by manufacture		Capital expenditures	
1	Transportation equipment	1.62	Transportation equipment	$23,971	PRIMARY METALS	$1,887
2	Machinery	1.54	Machinery	19,762	Transportation equipment	1,297
3	Electrical machinery	1.48	Electrical machinery	18,039	Machinery	946
4	PRIMARY METALS	1.18	PRIMARY METALS	16,732	Electrical machinery	889
5	Fabricated metals	1.12	Fabricated metals	12,636	Fabricated metals	728
6	Stone/clay/glass	.58	Stone/clay/glass	7,520	Stone/clay/glass	626
7	Lumber/wood	.56	Lumber/wood	4,361	Lumber/wood	369
8	Furniture	.39	Instruments	4,333	Instruments	165
9	Instruments	.31	Furniture	3,225	Ordnance	117
10	Ordnance	.23	Ordnance	2,871	Furniture	106
	ROLLING, DRAWING, & EXTRUDING NONFERROUS METALS	.17	ROLLING, DRAWING, & EXTRUDING NONFERROUS METALS	2,229	ROLLING, DRAWING, & EXTRUDING NONFERROUS METALS	194

1/ Source: 1964 Annual Survey of Manufactures, U.S. Department of Commerce, and Fantus Area Research estimates

In 1964, over 131,000 production workers produced rolled, drawn or extruded nonferrous product shipments of $7,254 billion.

Products and Markets

Table 2 indicates the relative significance of the 4 industry classifications discussed in this report.

Table 2.

Industry shipments by production segment 1/

(Percentages based on dollar value)

Classification	Shipments percent of total
Nonferrous wire drawing, etc.	32.0
Aluminum rolling & drawing	31.7
Copper rolling & drawing	26.8
Rolling & drawing, N.E.C.	9.5
	100.0

1/ Source: 1964 Annual Survey of Manufactures

In essence, the products of these industries serve as raw materials for metalworking, fabrication and assembly operations, or the construction industry. The sole exception is found in electrical transmission and communication wire and cable, which may be considered as end products. Table 3 presents a breakdown of industry shipments by major product classes.

Table 3.

Value of selected product shipments, 1964 1/

Product class	Value of shipments ($ million)
Rolled, drawn, and extruded copper & copper-base alloy products	$ 1,679.2
Aluminum plate & sheet (incl. foil stock)	888.6
Nonferrous rolling & drawing, N.E.C.	649.9
Communication wire & cable	608.5
Other insulated wire & cable	526.7
Extruded aluminum rod, bar & other shapes	402.6
Magnet wire	306.9
Copper & alloy wire for electrical transmission	281.7
Power wire & cable	272.3
Rolled aluminum rod, bar, and structural shape	161.5
Aluminum tube	148.3
Plain aluminum foil	132.4
Appliance wire and cord	110.3
Copper & copper-base alloy wire for other than electrical transmission	80.8
Aluminum and alloy wire, except that made in rolling mills	79.6
Aluminum extrusion billet made in aluminum rolling mills	59.3
Aluminum & aluminum-base alloy wire made in aluminum rolling mills	58.2
Aluminum ingot made in aluminum rolling mills	54.7
Other nonferrous metal wire	27.7
Nonferrous metal cloth	23.8
	$ 6,553.0

1/ Source: 1964 Annual Survey of Manufactures

The above table indicates, in part, the broad range of products manufactured by these industries. Rods, bar stock, wire, cable, tubing, and structural shapes are produced in a multitude of sizes and lengths in almost all of the various nonferrous materials. Extrusions can be made available in countless shapes and sizes, limited only by the size of equipment and the technical aspects of die design.

Markets for these products follow, generally, the degree and level of industrial and construction activity. Measurements contained in the 1963 Census of Transportation indicate a geographical breakdown of nonferrous metal markets for that year, as follows:

Census district	Percent of U.S. total
New England	6.6 %
Middle Atlantic	20.1
East North Central	31.5
West North Central	7.3
South Atlantic	9.8
East South Central	4.2
West South Central	9.5
Mountain	3.3
Pacific	7.7
	100.0 %

Analysis of the interindustry (input-output) tables yields the relative significance of end user industrial markets. As might be expected, industry output is spread among many fields. However, new construction ranks well ahead of other industries. Heating, plumbing, and structural metal products claim second place, and fabricated metal products, aircraft and aircraft parts, and electric industrial equipment and apparatus are grouped not too far behind.

Plant Ownership and Size Structure

The tabulation presented in Table 4 documents the overall size structure of the industries covered by this report, as measured by the latest census statistics.

Table 4.

Manufacturing plants by employment size, 1963 1/

SIC 3/	Number of companies	Total mfg. plants	Percent employing: 1-19	20-49	50-99	100-249	250-499	500-999	1,000 or more
3351	81	112	17.9	13.4	11.6	16.1	18.7	9.8	12.5
3352	166	212	27.8	19.8	15.1	17.5	8.0	4.2	7.6
3356	N.A. 2/	125	46.4	15.2	12.8	13.6	4.8	4.8	2.4
3357	210	299	24.1	19.1	9.7	22.1	15.0	7.7	2.3

1/ Source: 1963 Census of Manufactures

2/ N.A. - Not available

3/ SIC 3351 - Copper Rolling and Drawing
SIC 3352 - Aluminum Rolling and Drawing
SIC 3356 - Rolling and Drawing, not elsewhere classified
SIC 3357 - Nonferrous Wire Drawing, etc.

In general, these industries are dominated by the large, integrated primary metal producers. As an example, the leading producer of primary aluminum (accounting for over 35 percent of domestic capacity) gains over 80 percent of its sales revenues from fabricated products. A similar situation is found in that industry's second largest firm. Together, these firms operate 25 separate facilities with over 30 million square feet involved in rolling, drawing and/or extruding of aluminum.

The leading U.S. fabricator of nonferrous metals ranks as the second largest copper producer and also holds an important position in the production of lead, aluminum, zinc, uranium, and other nonferrous metals. This company currently operates a total of 20 plants.

The largest U.S. manufacturer of electrical conductor wire and cable operates no less than 25 facilities in 16 states. Sales revenue in 1964 equaled 11 percent of the industry's (SIC 3357) value of shipments.

Titanium fabricators in the U.S. number about 30; however, the leading firm in that industry accounts for about half of the annual mill shipments.

Geographic Prevalence

State representation in the rolling, drawing, and extruding of nonferrous metals is indicated in the following:

	Number of states: with industry representation	with more than 10 establishments
Copper	18	4
Aluminum	32	8
Other nonferrous metal	25	3
Nonferrous wire drawing and insulating	31	10

When combined, the Middle Atlantic, South Atlantic, and East South Central districts claim 45.6 percent of the plants employing over 100 in the rolling, drawing, and extruding of aluminum. Comparable figures for copper, other nonferrous metals, and nonferrous wire drawing and insulating are 32.8 percent, 40.2 percent, and 36.9 percent, respectively. Table 5 presents the actual distribution of establishments among the census districts.

Appalachian Specialization

As demonstrated in Table 6, the Appalachian Region maintains a relatively respectable population of these industries in relation to its own area and population. Significantly, the Region claims 10.44 percent of establishments employing over 100, while only 6.7 percent of the plant count for all employment sizes.

Table 5.

Regional distribution of establishments 1/

	SIC 3351	SIC 3352	SIC 3356	SIC 3357	Total
New England					
Total	33	11	21	78	143
Employing over 100	22	1	5	38	66
Middle Atlantic					
Total	39	40	41	87	207
Employing over 100	19	15	11	46	91
South Atlantic					
Total	2	26	10	13	51
Employing over 100	1	12	2	6	21
East North Central					
Total	27	71	33	65	196
Employing over 100	17	27	12	33	89
East South Central					
Total	2	15	2	3	22
Employing over 100	1	9	-	-	10
West North Central					
Total	2	7	-	9	18
Employing over 100	-	2	-	4	6
West South Central					
Total	-	7	6	6	19
Employing over 100	-	5	-	3	8
Mountain					
Total	1	4	3	-	8
Employing over 100	1	1	1	-	3
Pacific					
Total	6	31	9	38	84
Employing over 100	3	7	1	11	22
United States total	112	212	125	299	748
Employment over 100	64	79	32	141	316

1/ Source: 1963 Census of Manufactures

New York	-	-	-	-	-	-	-	-	-	-
Pennsylvania	8	5	6	5	6	3	8	6	28	19
Maryland	-	-	-	-	-	-	-	-	-	-
Virginia	-	-	1	-	-	-	-	-	1	-
West Virginia	1	-	2	2	1	1	1	-	5	3
Ohio	-	-	1	1	1	1	1	1	3	3
North Carolina	-	-	1	1	-	-	-	-	1	1
South Carolina	-	-	-	-	-	-	-	-	-	-
Georgia	-	-	3	2	-	-	-	-	3	2
Kentucky	-	-	-	-	-	-	-	-	-	-
Tennessee	1	-	2	2	-	-	-	-	3	2
Alabama	1	1	3	2	1	-	1	-	6	3
Total	11	6	19	15	9	5	11	7	50	33
Percent of U.S. establishments	9.8	9.4	9.0	19.0	7.2	15.6	3.7	5.0	6.7	10.44

1/ Source: 1963 Census of Manufactures

Economic Impact

New nonferrous rolling, drawing, and extruding facilities will employ typically between 100 and 350 hourly workers. Assuming a plant of 150 employees, with a pay scale comparable to the national average, the new locale would benefit from an annual payroll of $951,600. Using an economic velocity multiplier of 3, this impact reaches over $2.8 million. Department of Commerce figures further demonstrate that these 150 new jobs will mean 111 additional persons in services, trades or professions, 6 more retail outlets, and $540,000 in new retail sales.

A further indication of the industry's impact can be derived from analysis of the interindustry (input-output) tables. Purchases from direct suppliers are related to $1,000 of primary nonferrous metals industry gross output in Table 7.

Table 7.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from other establishments	Primary nonferrous metals manufacturing
Nonferrous metal ores mining	$ 79.06
Chemicals & selected chemical products	9.69
Plastics & synthetic materials	11.21
Primary iron & steel manufacturing	11.83
Primary nonferrous metals manufacturing	303.57
Stampings, screw machine products & bolts	9.29
Other fabricated metal products	10.64
Metalworking machinery & equipment	7.14
Electric lighting & wiring equipment	5.51
Transportation & warehousing	21.53
Electric, gas, water & sanitary services	21.48
Wholesale & retail trade	33.87
Finance and insurance	7.09
Business services	7.74
Gross imports of goods and services	85.41
Other industries	92.90
Total purchases	717.96
Value added	282.04
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

As can be determined from the foregoing table, these industries rely heavily on purchases from other establishments. Of particular significance, a plant producing $4 million in gross output would expend $307,520 (1958 dollars) in transportation, warehousing, electric, gas, water and sanitary services, and wholesale and retail trade.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Consumption

Aluminum dominates the expansion picture in the rolling, drawing, and extruding of nonferrous metals. However, substantial increased activity in titanium is now being planned, and current indications speak well for copper mill products, assuming the world supply-demand balance and the present pricing upheaval can be brought back into line. Moreover, a relatively new market is rapidly opening in the area of clad metals which holds out the promise of new applications for many of the nonferrous materials.

Currently, the production of primary aluminum is exceeding 100 percent of rated capacity. Plans now call for the addition of 1.1 million tons per year of new primary capacity by 1970. This new production must be rolled, drawn, extruded, or otherwise converted to usable raw materials for industry. In addition, the Federal Government's insistence on holding the line on primary metal prices has forced the industry to seek added profits in the area of fabricated mill products. Virtually all major producers have current programs and plans under way to expand their position in aluminum mill capacity.

Titanium mill product shipments totaled 9,400 tons in 1965 and are expected to reach 12,500 tons in 1966. While increased military requirements accounted for close to 2,500 tons of the anticipated 1966 growth, other developments speak well for the metal's future. Currently, about 40 percent of the shipments to aircraft companies are being used in commercial planes. Each new airplane developed requires a larger amount of titanium. The developmental C5A super cargo carrier will need 15,000 to 35,000 pounds for the airframe and 5,000 for each engine. The new supersonic transport will require 160,000 to 300,000 pounds per plane, with between 400 and 800 craft anticipated.

Titanium mill products are also finding increased application in chemical, hydrospace, desalination, and industrial markets which, in combination with the above, have led the industry's two top producers to recently announce over $120 million in expansion programs. It is felt that demand could easily top 35 million pounds per year by 1970, if a significant price reduction can be effected.

Copper production in the U.S. ran to 1.25 and a record 1.55 million tons in 1964 and 1965 respectively. Nonetheless, neither year was able to satisfy the domestic consumption of 1.82 and 1.98 million tons. Moreover, these consumption figures cannot be considered as indicative of demand since the material is in short supply and producers are selling everything they can make. The U.S. industry, while now claiming the world's largest capacity, has programs under way to add 464,000 tons of new (annual) capacity by 1970.

Altogether, the industry's outlook must be considered as bright. In each major area, production is running close to or over 100 percent capacity and all are serving growing markets. Indications of the optimism prevailing among leading industry experts are found in their expressions of anticipated annual growth in near term (up to 1970) consumption. Specifically, these are typified by the following:

	Average annual growth rate
Aluminum mill products	8.0
Aluminum extruded products	7.3
Titanium mill products	7.0
Aluminum wire and cable	7.0

Profits

The profit picture and history of nonferrous mill product producers varies with the specific primary metal involved. Both titanium and aluminum have recently grown out of a period of substantial overcapacity. The supply-demand imbalance of copper has forced mill producers into a varied profit pattern. Most fabricators are on allocation, and the extent of dependence on outside sources, at prices over double the domestic rate, plays a large role in determining overall profitability. Table 8 indicates the more recent profit experiences of leading firms in the industry.

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Table 8.

Profit ratios in the production of nonferrous mill products 1/

Company	Net income on net sales 1965	1964	1963
Aluminum			
A	6.5	5.9	5.3
B	7.1	5.9	4.9
Copper and other nonferrous metals			
A	8.0	6.4	6.4
B	14.5	14.2	11.9
C	4.0	3.5	3.0
D	3.1	2.9	2.0
Wire and cable			
A	7.0	5.8	5.2

1/ Source: Company financial statements.

Current trends indicate that aluminum profits are on the upswing. Recently, the industry eliminated the traditional but unpublished discounted pricing practice on fabricated mill products, and the profit outlook for 1966 is reported good. Profits from the production of copper mill products have similarly been moving upwards, and the industry should benefit further from 1966 price increases of 4 to 15 cents a pound.

Producers of titanium mill products suffered a bad year in 1965 with the majority operating in the red or under marginal conditions. Here again, prospects are bright for 1966, and the industry leaders all predict a profitable year.

Employment

As a group, the industries covered by this report (SIC 335) experienced a net increase in employment during the 1958 to 1965 period (see Table 9). All of these industries participated in a general employment decline between 1959 and 1961; however, the rolling and drawing of copper (SIC 3351) failed to regain the employment high of 49,000 reached in 1959.

Table 9.

Employment change in the
nonferrous mill products industry, 1958-1965 1/

	SIC 335	SIC 3351	SIC 3352	SIC 3357
All employees, 1965 (000's)	191.2	44.0	63.0	65.2
Percent change, 1958-1965	11.9%	(4.3%)	19.1%	16.8%
Women as a percent of all employees, 1965	13.1%	7.7%	7.8%	22.2%
Women employees, 1965 (000's)	25.1	3.4	4.9	14.5
Percent change, 1959-1965	3.3%	(12.8%)	(5.8%)	9.8%
Production workers, 1965 (000)	146.5	33.6	48.7	50.8
Percent change, 1958-1965	12.4%	(5.6%)	20.8%	18.1%

1/ Source: Employment and Earnings - Establishment Data, Bureau of Labor Statistics

Currently, the prospects for growth in all categories appear bright. Anticipated new investment activity designed to fulfill rising demands is expected to bring a general industrywide increase in employment.

Investment and Locational Activity

Historically, the investment pattern for both aluminum and titanium reflects the periods of overcapacity generated by rapid wartime expansions. Both industries have now outgrown these problems and are entering a period of new investment activity. Much of the new investment will be directed to the expansion of existing facilities; however, some new plants will appear in each of the industries under discussion. The rolling, drawing, and extruding of copper and titanium will generally emphasize expansions. A somewhat larger percentage of new plants will appear for aluminum mill products, and activity in the drawing and insulating of nonferrous wire will be primarily directed to the establishment of new facilities.

Table 10 reflects statistically the locational activity of these industries during the 1958 to 1963 period. Appalachia's relatively poor performance was substantially improved in the succeeding years.

Table 10.

Locational activity for selected nonferrous mill product industries 1/
(Net Change)

Industries	Establishments 1958	Establishments 1963	Net increase (decrease)	Percent change
SIC 3351				
Total U.S.	105	112	7	6.7%
Appalachian	10	11	1	10.0
SIC 3352				
Total U.S.	185	212	27	14.6
Appalachian	19	19	-	-
SIC 3356				
Total U.S.	143	125	(18)	(12.6)
Appalachian	13	9	(4)	(30.8)
SIC 3357				
Total U.S.	278	299	21	7.6
Appalachian	13	11	(2)	(15.4)
TOTAL U.S.	711	748	37	5.2
APPALACHIAN	55	50	(5)	(9.1)

1/ Source: 1958 and 1963 Census of Manufactures

Since 1963, the Appalachian Region has claimed 8 significant expansions of aluminum facilities and 4 copper mill expansions. No less than 7 new aluminum mills were gained during this same period. Other nonferrous metals accounted for one new plant and 2 expansions, and there were 3 new plants and one expansion of wire drawing and insulating facilities.

Significantly, the titanium industry has just recently announced $120 million in new investment programs. At least $50 million of this is directed toward Appalachia with most of the balance going into the Ohio fringe area. Moreover, the industry has recently attracted a new entry which is planning facilities in Akron, New York, and Parkersburg, West Virginia.

As noted earlier, the aluminum industry is expected to add investments totaling close to $2 billion by 1970. While some of this will go to adding some 1.1 million tons per year of new primary capacity, this increase will obviously require new mill facilities.

A parallel to the aluminum picture appears in the copper industry. Total planned additions to worldwide primary copper capacity now stands at 1.5 million tons per year by 1970. Of this, domestic capacity will increase by over 460,000 tons annually, and, with the recent congressional suspension of the 1.7 cent per pound duty, imports are expected to increase. Accordingly, expanded capacity for copper mill products and wire drawing is also anticipated during this period.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

The rolling, drawing, and extrusion of nonferrous metals generally parallels the processes utilized for ferrous materials. Remelt furnaces, charged usually with raw metal, scrap, and any required alloying material, reduce the metal to a molten state for casting rolling ingots. The shape of these ingots depends on the particular process to be employed. Rolling ingots are then placed in "soaking pit" furnaces to bring them to the proper working temperature.

The production of plate, sheet, or foil is achieved by passing the ingot through a "breakdown" mill converting it into an elongated slab. This is subsequently passed through various rolling mills which progressively reduce the thickness of the material while concurrently increasing it in length. Plate, sheet, and foil differ only in thickness. Plate is .25 inch or more in thickness while foil is less than .006 inch thick.

Bar, rod, and structural shapes are also made by rolling. However, mill rolls, instead of being flat as in sheet production, are grooved in the shape desired. Rolls are designed with progressively smaller openings; working the metal into the final size and shape.

Wire is made by drawing or pulling rod through a series of dies with openings smaller than the rod itself. When it becomes less than three-eighths of an inch in diameter, it is considered wire.

Extrusion processes are applied for an infinite variety of shapes including tube. In this instance, a billet is placed in an enclosed cylinder and a powerful hydraulic ram forces the hot metal through a die. In principle, the process is similar to that of squeezing toothpaste from a tube. Impact extrusion is a different process wherein a small "slug" of aluminum is placed in the bottom of a cup-shaped die. A powerful ram is forced into the die and with a single stroke, forces the metal up around the punch. Products commonly made by this process include toothpaste tubes, cans, flashlight cases, etc.

The processes described above generally apply to all of the more common nonferrous metals. Differing physical properties result in variances in temperatures, metallurgy, and other limitations determining the extent and precise application of specific steps of any one process.

Trends within the industry are placing increased emphasis on automated and integrated equipment control, as well as improvements in equipment and techniques allowing for closer tolerances and improved products (i.e. longer and thinner extrusions, etc.)

Raw Materials

Generally speaking, the industry's raw materials consist solely of primary metals. This is not to say, however, that raw material technology does not have a pronounced effect on the industry. Rather, the development of new alloys will continue to open up new applications and further enhance the growth outlook of these industries.

Widespread utilization of titanium is currently inhibited by a price of close to $6 a pound for mill products. Officials are hoping to reduce this by as much as 20% by 1970. This large cost reduction must come from economies in primary metal refining. An improved electrolytic process is now being installed in Henderson, Nevada which is designed to cut production costs substantially. If this can be done, the lower price of finished product would definitely open new markets for titanium mill products.

Manpower Utilization

Table 11 provides a rough indication of the change in productivity within the 4 selected industries between 1958 and 1964.

Table 11.

Changes in employee productivity, 1958 and 1964 1/

SIC	Industry	% Change All Employees	% Change Production Workers	% Change Value of Shipments 2/
3351	Copper rolling & drawing	- 1.0	+ 1.3	+51.9
3352	Aluminum rolling & drawing	+19.6	+21.3	+38.8
3356	Rolling & drawing N.E.C.	+ 4.3	+ 4.4	+34.0
3357	Nonferrous wire drawing	+ 5.1	+ 7.3	+49.5

1/ Sources: 1963 Census of Manufactures
1964 Annual Survey of Manufactures
2/ Based on 1958 dollars.

Major improvements have been effected in the area of more efficient materials handling including increased utilization of automated techniques. New and/or more efficient processing equipment, centralized control, and continuous casting procedures have also contributed to the rise in productivity.

Interproduct Competition

Interproduct competition among the major nonferrous metals (aluminum, copper, and titanium) exists in most marketing outlets of these materials. As relative newcomers to the primary metals industry, aluminum and titanium have been forced to displace other materials in order to establish a growing demand. Titanium is currently making inroads into aluminum's aviation stronghold, while aluminum is becoming well established in electrical applications formerly dominated by copper. Virtually all outlets involve some competition with other metals (ferrous or nonferrous) with ultimate success usually dependent on some combination of a metal's installed cost, maintenance considerations, and metallurgical properties.

Significantly, most marketing outlets are growing at a rate sufficient to allow for the individual growth of competing nonferrous materials.

Distribution

The majority of nonferrous products are sold on a "delivered" price basis. Other than this, distribution procedures will usually vary by company and product.

Companies will usually maintain sales offices throughout the country to handle direct sales. Standard warehouse items are normally marketed through distributor organizations. Jobbers, dealers, and brokers handle the majority of foil and building products, receiving shipments either from the producing plant or from company-owned regional warehouses.

IV. PRIMARY FACTORS INFLUENCING THE SELECTION OF LOCATIONS

Introduction

Utility costs and transportation considerations are the 2 primary factors influencing the establishment of new nonferrous rolling, drawing, and/or extruding mills. The significance of outbound transportation charges on the locational decision demands first consideration and has created a high degree of market orientation in the locational pattern. Of almost equal importance, however, is the availability and economics of power and natural gas supplies.

Other factors considered as significant by location-seeking executives of the industry require a labor force allowing selective hiring and a community environment providing acceptable living conditions for transferred personnel.

It is the purpose of this section to evaluate the relative importance of primary locational determinants as they operate in the commercial marketplace.

Market Orientation

New establishments involved in the production of nonferrous mill products typically are positioned to serve a predetermined market at minimum transportation cost. Actual marketing patterns and limitations vary extensively by company and product. Moreover, marketing considerations will normally account for the present locations of company and competitor facilities as well as new marketing objectives such as the desire for increased penetration or the introduction of a new product line.

Occasionally, the industry will serve a national market with the output of an individual facility. This is usually limited to a single product and is characterized by special equipment requirements or distribution channels differing from that of other company products. A typical example is found in the Appalachian location of a leading aluminum manufacturer, where aluminum foil is produced for distribution throughout the United States.

More often, manufacturers will prefer a location allowing for disposition of the majority of plant output, within a 500- to 750-mile radius.

Generally speaking, market orientation will prescribe the broad geographical limitations for the locational search. Whether the plant is to be a small, special purpose facility concentrating on a narrow mix or products or a larger, more flexible facility producing the broad range of products will affect the extent of these geographical limitations.

A significant plus for the Appalachian Region is found in the fact that over 50 percent of most aluminum mill product markets is accessible from an Appalachian location., based upon U. S. Department of Commerce data.

Transportation

Transportation considerations of both service and cost remain as the most significant locational determinant in establishing new nonferrous mill facilities. Both rail and trucking services are required, and in locations where the future addition of primary capacity is a factor, waterway transportation should be easily accessible.

As a group, these industries utilize commercial motor carriers for over 50 percent of their total shipments. Rail now claims about 30 percent, and private trucking accounts for just over 15 percent of the outbound traffic.

Outbound transportation charges usually run between 15 and 35 percent of a plant's total annual operating costs. It is not unusual for these charges to substantially exceed the hourly payroll, and geographical variations are usually more pronounced.

An analysis of freight rates will explain, in part, the market orientation of the industry. As an example, a Pacific Northwest producer must pay 2.3 cents per pound to ship aluminum sheet to the Detroit market. However, the rate on aluminum ingot for this same distance amounts to only 1.3 cents per pound. Thus, substantial savings are afforded through shipping ingot to rolling facilities in the marketing area. Table 12 presents rate-distance comparisons for both aluminum ingot and finished mill products.

Table 12.

Comparative freight rates 1/

(Cents per 100 pounds)

Distance (miles)	Aluminum ingot (rail) 2/	Finished nonferrous mill products: Carload shipments 3/	Truckload shipments 4/	LTL 5/
100	20	33.5	51	104
200	28	44.5	64	137
300	38	54.5	76	165
500	55	75.0	96	213
1,000	89	122.0	154	317

1/ Source: Fantus Area Research Traffic Department.

2/ Present level of 100,000-pound commodity rates.

3/ 30,000-pound carloads. Rates used as representative level are mileage commodity rates published in S.F.A. Tariff 859-E and T.L.-C.T.R. Tariffs E/S 696-D and E/S-2008-I.

4/ 30,000-pound truckloads. Rates utilize commodity column T35, Items 13102-E and 30305, S.M.C.R.C. Tariff 511-N, as representative level.

5/ Less-than-truckload assumes 2,000-pound shipments. Tariff S.M.C.L.C. 504-B.

Inbound transportation costs are much less significant and frequently run only 10 to 20 percent of the outbound total. Both copper and aluminum facilities utilize scrap and secondary metal to some extent in their remelt furnaces, with copper and brass producers relying somewhat heavier on this source than aluminum.

The importance of proximity to raw materials is measured by the effect on total inbound freight costs and the role this element plays in determining the overall plant profitability. In general, raw material availability will depend more on the individual company's raw material position than the physical proximity to other (competitive) sources. However, independent producers will consider close-by sources of raw materials as a definite asset, benefiting from lower inventories, better service, and the prospect of increased allocations of those materials in short supply, as primary metal producers strive to economize on their own transportation costs.

New facilities of this industry will require first-class rail service and a well developed highway network. Locations exhibiting proximity to rail centers and direct 4-lane access to the interstate system will be most attractive.

Utilities

Utility considerations rank second only to transportation as a primary locational determinant. The costs of power, natural gas, and water will normally run between 10 and 15 percent of the total operating expenses. However, the stability of supply can have a large impact on plant profitability. Moreover, the relatively large quantities of power and natural gas that are required provide a cost area subject to substantial geographical variation.

Power

Today's modern aluminum facility requires between 350 and 425 kwh per ton of rolled, drawn, or extruded product. Thus, calculations based on 400 kwh per ton indicate a monthly billing demand in the area of 2,450 kw and consumption of 1.67 million kwh for a plant producing 50,000 tons of product annually. These requirements would result in an annual cost of close to $88,500, assuming the plant were located in TVA territory. The cost per kwh calculates to 4.45 mills. Comparative rates in other eastern locations can produce costs in excess of twice the above amounts.

Obviously, power demands will vary, dependent upon the actual processes and equipment employed. Nonetheless, the significance of this cost variable is great, and locales exhibiting a high rate structure should provide offsetting economies in other areas if they are to remain competitive.

Natural Gas

The consumption of natural gas fuel varies substantially, dependent on the actual equipment and processes employed in the plant, the product mix, the metals under consideration, the extent of heat-treating required, and space heating demands of individual locations. Comparative industrywide data is presented in the following table.

Table 13.

Average consumption of natural gas in the rolling, drawing, and extruding of nonferrous metals 1/ 2/

		Comparative data for 50,000 tons/year		
		Total	Annual costs	
Industry	Mcf per ton	requirements (mcf)	$.26/mcf ($000)	$.40/mcf ($000)
Copper rolling and drawing	4.9	245,000	$ 63.7	$ 98.0
Aluminum rolling and drawing	14.0	698,500	181.6	279.4
Rolling and drawing, N.E.C.	17.2	859,800	223.5	343.9
Nonferrous wire drawing, etc.	1.5	77,350	20.1	30.9

1/ Source: Compiled by Fantus Area Research.

2/ Note: Figures may not add due to independent rounding.

The large variance in gas rates throughout the Applachian Region allows for as much as a 100 percent differential between locations. In addition to the cost element, however, location-seeking executives will review closely the history of service interruptions. When breaks in service are minimal, locations can be chosen to benefit from the lower "interruptible" rate schedules while minimizing the risk of plant shutdown.

Water Requirements

The industry's intake of process (cooling) water will average between 1,500 and 3,250 gallons per ton (output). Thus, a typical aluminum rolling mill producing 50,000 tons annually would require approximately 150 million gallons each year or 12.5 million gallons per month. A similar amount would be discharged as waste.

While the above quantities could be serviced through some municipal facilities, plants of this and larger ranges will generally prefer locations with direct access to adequate ground or surface water supplies. Both initial requirements and expansion plans will be considered.

In general, costs associated with water and sewerage are not a significant locational factor and will be secondary to the adequacy of facilities where sites are dependent on municipal service.

Labor

A typical rolling mill with an annual output of 50,000 tons would employ approximately 200 hourly workers. Units established by the larger integrated companies of the industry will usually adopt wage and fringe patterns consistent with companywide or national bargaining practices. As a result, many of the new establishments will assume a position of wage leadership within a community, and geographical wage differentials are eliminated from the locational decision.

In general, labor costs will represent between 11 and 25 percent of the total operating cost. Fringe benefits will add another 3 to 6 percent, allowing, in total, a significant area of potential savings for those companies where this is an objective.

Wage patterns within these industries predominantly follow the nationwide average of $3.09 per hour for copper, and $3.16 for aluminum in 1965. Nonferrous wire drawing and insulating operated at the lower rate of $2.81, reflecting, in part, a slightly less sophisticated skill mix. Major plants located in Appalachia also exhibit the national wage pattern. However, other plants in the Region are benefiting from hourly savings of $.35 or more. Furthermore, savings almost equal in magnitude are gained through adoption of prevailing fringe benefit patterns. Generally speaking, firms engaged in nonferrous wire drawing and insulating will be the most sensitive to payroll cost savings.

In terms of labor objectives, the industry is unanimous in requiring a location exhibiting a labor-management climate conducive to long-term operating satisfaction and a labor force of sufficient quality and quantity to allow for selective hiring procedures. A history of labor strife or "wildcat" walkouts will eliminate a community from consideration. Smaller firms will look for areas allowing nonunion operations.

In manning the new facility, companies will be looking for areas where the available work force is characterized by semiskilled trainable males with manufacturing experience. High school graduates in the 18-to-35 age group will be preferred, and experience in the primary metal industry would be most desirable.

Skill requirements emphasize the more sophisticated mechanical and electrical maintenance categories as well as highly complex rolling mill operations. However, the majority of requirements involve simpler machine operations (such as corrugating, shearing, slitting, embossing, coiling, and tube and wire mills) and the lower-skilled helper or materials handling categories. Training is handled predominately through in-plant programs, and the more adept workers can develop intermediate skills in 3 to 6 months.

Sites

Site requirements for facilities including rolling and drawing operations would run between 125 to 175 acres for establishments of the size described earlier. A rail siding is mandatory, and highway facilities must allow easy access to the interstate system.

As noted earlier, there is also a requirement for natural gas. Pipeline installation expenses of over $20,000 a mile will give the competitive edge to sites where this service is already available or where such expenses are borne by other parties. Other utility requirements include power, water, and, in some cases, sewerage.

State and Local Taxes

Because of the large investment in plant and equipment, goods-in-process, and raw and finished material inventories, manufacturers will attempt to avoid areas where such items encounter local taxation or where the effects of such taxation can be minimized. This determinant must be considered as secondary in that the total variance between locales normally is not sufficient to offset the economics of other, primary factors of location.

Communities where taxation is restricted to real estate will be preferred, however, and the prudent location-seeker will attempt to analyze the long-term prospects for tax stability.

Community Environment

The importance of community environment diminishes for the smaller, more specialized plants. However, most new facilities will involve a relocation of at least some technical, supervisory, and management personnel, and the prudent location-seeker will review each community to insure living conditions that will satisfy the basic needs of transferees. Where expansion plans are a factor in the decision, the community must exhibit qualities that will not only satisfy but will attract and retain additional personnel. Adequate school and medical facilities are a must. Attractive living areas are almost equally important, and recreational and cultural facilities follow in that order.

Other Locational Determinants

As with all locational decisions, many other factors enter into the picture. Most of these are impossible to measure quantitatively. All of these will vary in importance with the individual company, its specific operating objectives, and the executive charged with responsibility for locating the plant.

Large-scale rolling facilities will frequently assume the position of wage leadership within a community and many times becomes the dominant employment influence. The relatively high wage scale eliminates the area "wage ladder" concept as a locational determinant. Community size requirements display no particular pattern, with recent examples of new locational activity indicating a community population range from 375 to 111,000. Here again, larger facilities can operate successfully in larger communities assuming the labor-management climate is acceptable.

New mills involving the more complex rolling equipment involve the heaviest service industry requirements, and locations allowing relatively easy access to the more developed metropolitan areas will have a distinct advantage. Moreover, the needs for liaison and communication with other company facilities will emphasize reasonable proximity to transportation and communication services normally found in the larger communities. Scheduled air service should be within an hour's drive.

Generally speaking, the following location considerations have minimal influence in the final site decision:

- flexibility in selecting vendors
- lead time in placing orders
- presence of support and auxiliary activities
- availability of police and fire protection services
- labor laws, workmen's compensation insurance, etc.

The importance of short- and long-term financial assistance will vary with the particular company involved. Significantly, the leading aluminum producer refuses to utilize industrial revenue bond financing. However, other leading firms consider this as an important area of "geographically" variable cost and actively solicit local assistance.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

The preceding section of this report demonstrates the requirements for and significance of highway, rail, and air transportation, utility services, and process and cooling water requirements. While some of the areas allow for effective public investment, many other programs provide little or no attraction for this particular industry. Included in the latter category are such as land use planning, land stabilization, conservation and erosion control, forestry development, and management of forestry resources. Of course, flood-free sites are mandatory and public health and sanitation programs will be important to the extent that they improve the overall attractiveness and livability of a competitive community.

This section of the report gives emphasis to those remaining public investment policies and activities which can effectively be applied to foster further development of these industries in Appalachia.

Power

In some cases, new rolling mill sites are being evaluated with the thought of adding additional primary facilities at a later date. In those instances, power becomes the controlling determinant, and public investment policies generally should follow those indicated in the report covering Primary Aluminum.

In most cases, new mill facilities will be smaller units, specializing in a relatively narrow product mix. Power becomes progressively less critical, and facilities will locate on systems where costs run between 4.5 and 10.0 mills per kwh. Obviously, areas with a lower rate will receive first consideration. The responsiveness of local officials in developing rate structures which are competitive with other areas under consideration will play a large role in the final outcome. Public programs on both the federal and state level could be effective in bringing about lower rates. Regulations concerning equipment write-off allowances, inducements for investment in new, modern and more efficient generating capacity, and other more direct actions might well be considered.

Natural Gas

As demonstrated earlier, the industry is a relatively large consumer of natural gas. Sites, if they are to be competitive, must provide for this service at a minimum cost to the manufacturer. With pipeline construction costs now in excess of $20,000 per mile, the absence of existing facilities could easily rule out locations which are otherwise suitable. Effective public programs should then be designed to encourage development of this service into potential site areas.

Public action on the federal, state, and local level can further enhance the Region's overall competitive position if it can provide for direct service to large industrial consumers by the major transmission companies; or, at the least, provide gas service through the local facilities under a comparable rate structure.

Transportation

The importance of transportation costs is highlighted in Section IV. While waterway transportation is only important in those locations where the addition of primary capacity is being considered, the industry cannot exist without first class rail and highway services.

Highway programs already proposed for Appalachia will substantially improve the area's position. Programs designed to further the development of feeder systems will prove an added benefit. Most important, however, is the need to provide specific highway improvements allowing adequate and dependable access to sites which are otherwise suitable.

Vocational Training

As noted earlier in Section III, the industry relies heavily on in-plant training and apprenticeship programs. Nonetheless, the area of vocational training is felt to be one of the most effective public investments for these industries. Generally speaking, a high school diploma is one of the basic hiring standards. Mechanical training and aptitude follows close behind.

Course offerings in the vocational education program should be oriented to development of basic metalworking skills, mechanical and electrical maintenance, and drafting, etc. The development of technicians will emphasize mechanical drawing, mathematics, basic machine design and elemental electricity.

Other basic programs that would also be attractive to the industry include: instrument and electronic repair, pipefitting, welding, materials handling operations, and quality control.

Appendix A

SELECTED INFORMATION SOURCES

Published Information

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(2) The Aluminum Association, New York.

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(4) Interindustry Employment Requirements, July 1965, Monthly Labor Review, Bureau of Labor Statistics, United States Department of Labor.

(5) Concentration in Manufacturing, Industry Summaries, Studies in Business Economics, No. 91, 1966, National Industrial Conference Board, New York.

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(7) Employment and Earnings Statistics for the United States, 1909-65, U.S. Department of Labor, Bulletin No. 1312-3, Washington, D.C.

(8) Goldman, Morris R.; Marimont, Martin L.; Vaccara, Beatrice N., The Interindustry Structure of the United States, November, 1964, Survey of Current Business, U.S. Department of Commerce, Washington, D.C.

(9) Industrial Aid Financing, 1965, Goodbody & Company, New York.

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(15) Industrial and Engineering Chemistry, August 1965, American Chemical Society Publications, Washington, D.C.

(16) Standard Listed Stock Reports, 1966, Standard & Poor's Corporation, New York.

(17) Aluminum: Lightweight Rebounding, 1966, Monthly Review Supplement, Federal Reserve Bank of San Francisco.

Unpublished Information and Personal Contacts

(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Producers of rolled, drawn, or extruded nonferrous products inside and outside Appalachia.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 21--MEAT AND POULTRY PROCESSING, DRIED AND FROZEN PRODUCE INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian States must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically Standard Industrial Classification industry codes 2011, Meat Packing; 2013, Meat Processing; 2015, Poultry and Small Game Dressing and Packing; 2034, Dried Produce; and 2037, Frozen Produce.

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

For the purposes of this study, the meat and poultry processing, dried and frozen produce industry is defined as including: SIC 2011, meat slaughtering plants; SIC 2013, meat processing plants; SIC 2015, poultry dressing plants; SIC 2034, dried produce; and, SIC 2037, frozen produce. While all subsectors of this defined industry demonstrate growth potential for the Appalachian Region, maximum opportunities are presently felt to emphasize poultry dressing, and, secondly, meat processing plants.

In total, the nation's food industry ranks as the largest in the economy. Total employment ran to 1.6 million in 1964. Combined, the value of shipments in that same year for the segments of the industry covered by this report, exceeded $12 billion.

Significantly, the economic impact of local plants of this industry is quite extensive. The agribusiness establishment will attract and foster the growth of the supporting agricultural economy. In addition, there is a large tendency to attract suppliers of both these economic segments (i.e. agribusiness and agriculture).

There is little doubt that consumption of both poultry and beef will grow in the Eastern United States during the coming years. An established trend toward the decentralization of production facilities will most naturally point the site-seeking executive toward the more rural areas east of the Mississippi.

Although the food processing industry will generally follow the sources of raw materials, there appears to be an immediate potential for increased activity of these industries within Appalachia. Their primary factors of location, in addition to raw material requirements, include the availability of labor, proximity to major population centers, adequate transportation facilities and service, the availability of waterway transportation for incoming feed and grain, abundant process water, low-cost power and natural gas, economical waste disposal, and a business climate conducive to achieving an adequate return on investment.

The inclusion of this industry resulted from a high degree of correlation between industry requirements and the Appalachian Regional Commission's objectives. Many common areas exist and are specified at the beginning of Section V. When considered in light of these objectives, an effective program of public activities is apparent and will serve to improve the competitive position of Appalachia for these industries. Specific recommendations cover: (1) highway and waterway development; (2) site/waste disposal requirements; (3) power and water; (4) attracting private investment; (5) vocational education.

I. PROFILE OF THE INDUSTRY

Size

The processing and selling of food is the largest industry in the U.S. economy; absorbing over $71 billion worth of consumer expenditures in 1964. With an employment of 1.6 million people and value added of $23 billion; the size of the food industry parallels that of the transportation equipment industry. Table 1 ranks the food industry at the top of the nondurable goods industries.

Only the chemical and primary metals industries spent more on capital plant and equipment in 1964 than the food industry which concentrated its efforts that year on decentralizing its processing and distribution. Along with decentralization, the industry has experienced a marked trend to processing food into packages ready for cooking. Introduced initially in the processing of fruits and vegetables, the emphasis on meat processing in the future will contribute a larger profit to the meat packers, who have historically been plagued with profit margins of less than 1 percent.

Table 1.

Rankings of the nondurable goods industries, 1964 1/

(numbers in millions)

Industry Rank	Employment		Value added by manufacture		Capital Expenditures	
1	FOOD	1.6	FOOD	$23,054	Chemicals	$1,876
2	Apparel	1.3	Chemicals	19,133	FOOD	1,419
3	Printing	0.9	Printing	11,065	Paper	886
4	Textiles	0.9	Apparel	8,150	Textiles	492
5	Chemicals	0.7	Paper	7,805	Printing	463
6	Paper	0.6	Textiles	6,736	Petroleum/ coal	412
7	Rubber/ plastics	0.4	Rubber/ plastics	4,984	Rubber/ plastics	400
8	Leather	0.3	Petroleum/ coal	3,774	Apparel	124
9	Petroleum/ coal	0.1	Leather	2,270	Tobacco	59
10	Tobacco	0.08	Tobacco	1,772	Leather	38

1/ Source: 1964 Annual Survey of Manufactures, U.S. Department of Commerce.

Products and Markets

Meat processing is any treatment of the carcass other than the slaughtering and dressing of fresh meat. Processed meats command a higher profit margin than dressed fresh meat. This new emphasis on processing is gradually shifting the industry from a commodity base to a manufacturing base.

This report has focused on those primary sectors of the food industry that have the greatest growth potential in Appalachia. These primary sectors include: fresh beef; prepared meats, poultry, dried and frozen food products. The value of shipments for these products exceeded $12 billion in 1964, apportioned as shown by Table 2.

Table 2.

Value of shipments, 1964 1/

SIC	Product	($ Millions)
20111	Fresh beef	$ 6,061
20130	Prepared meats	1,956
20150	Poultry	2,193
20340	Dried and dehydrated food products	337
20370	Frozen fruits and vegetables	1,537
		$ 12,084

1/ Annual Survey of Manufactures, 1964

Corollary industries that will tend to prosper with the growth of these food industries include: beef feedlots, poultry farming, soybean production, fertilizer production, grain distribution, prepared animal feeds (including pet foods), biological feed supplements, processing of poultry by-products, egg production, hatcheries, and all forms of transportation.

Plant Ownership and Size Structure

There is a concentration of ownership among large food processing companies. There is also a mass of small producers penetrating local markets with product specialization and marketing services not available from large firms.

The ten largest meat packing firms, for example, accounted for 40 percent of the U.S. cattle slaughtered in 1960. Between 1950 and 1962, slaughter by the large firms increased moderately while slaughter by the smaller firms increased considerably.

Two of the country's largest meat packers each have net sales in excess of $2 billion from diversified businesses. Although their sales volume is still firmly established in food, with 75 to 80 percent of their income from the sale of meat and food products, non-food operations contribute more than 50 percent to their net profits. Aggregate sales of $10 billion for the nation's top eight food producers, including meat packers, indicate the concentration of ownership at one end of the industry structure.

At the other end of the industry, the prevalence of small firms is demonstrated by the commercial slaughter plants, many owned by families or partnerships. In 1960, there were 2,957 slaughtering plants, each handling more than 300,000 pounds of live animals per year, and 4,750 slaughtering plants, each handling less than 300,000 pounds per year. In a similar manner and on a smaller scale, the poultry packing plants have a broad base of ownership with only a few large companies owning processing plants. There is a trend toward fewer locally owned plants in both beef and poultry processing. Ownership of poultry processing plants by some of the large grain producers is also a trend in the industry. Co-ops are very common in the southeastern states and operate some of the largest processing plants.

Dehydrating and freezing plants tend to be owned by medium to large corporations, capable of financing the necessary plants and equipment.

In order to become more efficient, the massive meat packing plants have become smaller, and the poultry processing plants have grown larger. Within the past five years, the major meat packers moved from the Chicago stockyards to more compact and automated facilities outside the city. At the same time, the poultry packers built larger plants.

As an example, vertical integration in poultry slaughtering plants has increased their profits recently by processing the offal, blood, and feathers into a meal for sale as animal feed and fertilizer supplements. A plant with 400 employees producing 70,000 pounds of dressed broilers per day is not uncommon in modern plants. Large scale operations make the difference in profit. A poultry processing plant, selling this by-product meal at $1.50 per unit of protein, can enjoy a 40 percent return on its fixed capital investment in processing poultry by-products when volume reaches 272,000 pounds of broilers per week. And yet, a 68,000 pound per week operation does not break even until the price of $1.60 per unit of meal protein is reached.

Geographic Prevalence

At present, two-thirds of the nation's beef is raised west of the Mississippi River, while two-thirds of the consumption is in the East. Over 50 percent of fattening and finishing of beef cattle today is carried on in feed lots of the 12 North Central States centered on the Corn Belt of Iowa. However, the tendency to shift with population and preference, which has placed California in third rank for the cattle feeding industry, is a trend well under way in parts of the eastern market.

Pennsylvania, Ohio, Alabama, and Georgia have experienced particular growth in feedlots for quality beef.

Poultry, particularly broiler production, has shown remarkable growth since 1960 in Alabama's northeast plateau. Encouraged by rail rate reductions on grain by as much as 60 percent, the poultry industry, in the southern half of Appalachia, presently has all the prerequisites for long-run growth.

Only spotty prevalence of produce growing can be seen in Appalachia under existing conditions. Topography, soil and alternative use of suitable land inhibit growth of this industry. Potentials for expanding soil agriculture and produce processing are surprisingly large when existing land is improved and put to its most economical use. Produce processing is carried on near the raw materials source.

A summary of states with 10 or more establishments (as shown in Table 3) in this group of food industries shows a high degree of prevalence in meat slaughtering and a lower prevalence in meat, poultry, and produce processing.

Table 3.

Number of states with 10 or more establishments in 1963

Industry	No. of states
Meat slaughtering (all meats)	42
Meat processing (all meats)	30
Poultry dressing	29
Dehydrating of food products	2
Freezing of produce	19

The regional distribution of establishments shown in Table 4 reflects the tendency to process near the source of raw material. For instance, fed beef production is oriented to feed production. Poultry processing is oriented to areas where feed can be more economically transported than matured broilers. Dehydrating and freezing, like the canning industry, locates near truck gardening centers such as New Jersey and California.

Appalachia shares 8 percent of the establishments in the industry as demonstrated by Tables 4 and 5. However, there are only isolated cases of specialization in poultry processing for Appalachian counties which are located in Georgia and Alabama.

In the meat packing industry, over half of the employment is found in 30 major labor market areas. The largest of these industry centers, each with over 5,000 workers, are Omaha, Chicago, St. Louis, Minneapolis, St. Paul, and Kansas City.

Table 4.

Regional distribution of establishments 1/

	Meat Packing SIC 2011	Meat Processing SIC 2013	Dressed Poultry SIC 2015	Dried Produce SIC 2034	Frozen Produce SIC 2037	Total
New England						
Total	66	116	28	1	30	241
Employing over 50	5	23	13	-	9	50
Middle Atlantic						
Total	355	342	102	15	115	929
Employing over 50	53	59	23	1	32	168
South Atlantic						
Total	364	140	180	4	81	769
Employing over 50	70	21	95	2	42	230
East North Central						
Total	652	349	175	7	112	1,295
Employing over 50	103	71	40	2	28	244
East South Central						
Total	249	48	77	1	19	394
Employing over 50	44	4	46	-	10	104
West North Central						
Total	408	78	136	5	41	668
Employing over 50	99	18	72	2	17	208
West South Central						
Total	419	86	116	2	40	663
Employing over 50	59	14	65	-	16	154
Mountain						
Total	214	25	33	8	32	312
Employing over 50	35	4	9	5	11	64
Pacific						
Total	259	146	117	132	177	831
Employing over 50	50	25	38	33	75	221
UNITED STATES						
TOTAL	2,986	1,330	964	175	647	6,102
EMPLOYING OVER 50	518	239	401	45	240	1,443

1/ Source: 1963 Census of Manufactures

Table 5.

Establishments within the Appalachian Region 1/

	N.Y.	Pa.	Md.	Va.	W.Va.	O.	N.C.	S.C.	Ga.	Ky.	Tenn.	Ala.
SIC 2011												
Total plants	19	101	4	6	33	34	5	10	19	12	34	24
Employing over 50	-	10	-	-	3	4	-	2	2	1	4	4
SIC 2013												
Total	3	34	-	1	2	1	3	3	5	1	4	5
Over 50	-	3	-	-	-	-	-	-	1	-	-	2
SIC 2015												
Total	5	22	1	1	6	7	7	3	22	4	4	24
Over 50	-	6	1	1	1	1	5	1	14	3	3	15
SIC 2034												
Total	1	1	-	-	-	-	1	-	-	-	-	-
Over 50	-	-	-	-	-	-	-	-	-	-	-	-
Sic 2037												
Total	8	13	-	-	2	1	1	1	1	-	2	3
Over 50	4	3	-	-	1	1	-	-	-	-	1	2
TOTALS												
Industry	36	170	5	8	43	43	17	17	47	17	44	56
Over 50	4	22	1	1	5	6	5	3	17	4	8	23

1/ Source: 1963 Census of Manufactures.

Economic Impact

Food processing plants specializing in beef, poultry, frozen and dried produce have potent repercussions on the regional economy of a particular location.

This is one of the few industries that could locate in an Appalachian community and immediately create ancillary job opportunities for at least 500 people. For instance, beef processing requires a fed beef supply from nearby feed lots capable of delivery the same day an order is placed. Central poultry plants similarly require a large supply of live broilers from surrounding farms.

In northeastern Alabama, a concentration of broiler processing created the need for 250 to 300 farms raising up to 30,000 birds each on a contract basis. Two grain-mixing elevators valued at over $1 million each supply the contract farmers with feed.

Raising poultry on a contract basis can often be part-time work for a factory production worker and his family. Rural areas that have experienced this supplemental income have generated per capita retail sales comparable to that of highly industrialized cities. The part-time poultry grower can readily dovetail his duties as a farmer with seasonal work often found in cyclical industries such as the manufacture of automobile parts, toys and sporting equipment.

In addition, livestock and poultry production generate satellite industries in the area such as grain feed supplements, growth stimulants, fertilizer mixing and distribution, soybean extractions for feed, egg production from matured broilers, chick hatcheries, and rejuvenation of land rendered uneconomical by strip mining.

A high-labor oriented poultry processing plant can employ 300 women and 100 men in positions that require no special skills. A large, economical plant might locate in almost any Appalachian community that could supply a 2 to 1 selection ratio for labor and 150 rural farmers capable of feeding a total of 2.7 million broilers. (Daily processing of 60,000 birds in a 45-day growing cycle produces 2.7 million broilers. Also, the supply of 60,000 broilers from 3 farmers is processed each day for 45 days, at which time the first supplier's 6-week growth is ready to process, and the cycle is complete.)

Income to the farmer supplying cattle and calves from feedlots can produce a substantial profit (4 percent) under efficient management. While farm profits are highly variable, the high frequency of entry into the cattle feedlot business between 1962 and 1964 gives some indication of the profit potential. See Table 6.

Table 6.

Increases in the number of feedlots within the U.S. by size groups 1962 - 1964 1/

Feedlot Capacity	1962	1964	Absolute Increase	% Increase
1,000 - 1,999	748	808	60	8.0%
2,000 - 3,999	373	421	48	7.8
4,000 - 7,999	63	242	179	284.0
8,000 - 15,999	105	120	15	14.2
16,000 - 31,999	26	34	8	31.0
32,000 and over	5	10	5	100.0
Totals	1,320	1,635	315	23.9%

1/ Source: U.S. Dept. of Agriculture Bulletin SRS-9, 1966

A railroad serving southern Appalachia recently counted 384 new or expanded businesses related to cattle feedlots and the rate reduction on grain from the corn belt. These businesses included the following:

Business	New	Expanded	
Feedmills or elevators	57	85	
Feedlots (Cattle)	82	35	
Feedlots (hogs)	57	60	
Packing Houses	1	7	
Total			384

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Consumption

Consumption of fed beef follows closely the trend of disposable income. In the last 5 years, the U.S. per capita consumption of fed beef increased from 64 pounds to 75 pounds per year at the retail weight (to 100 pounds at the live weight).

Patterns of consumption in the South have a particularly high potential for growth, according to reports of the U.S. Department of Agriculture. In contrast to the rest of the nation, the South (like the East) is a deficit area for fed beef production.

Table 7 shows that 646 million pounds of live cattle had to be shipped into the northeast to supplement the cattle raised for slaughter in that region. The northeast deficit in feedlot production causes an inbound movement of carcasses 3 times (1,821 million pounds) as heavy as that brought in on the hoof.

Trends in commercial cattle slaughter within the Appalachian States from 1962 to 1965 are shown in Table 8. In those 4 years, U.S. slaughter of cattle increased 24.0 percent while in the Appalachian States it increased only 10.6 percent. Slaughter within the Appalachian States represented 15.9 percent of the U.S. total for this period, and has demonstrated particular growth in the states of Virginia, Tennessee, Georgia and Ohio.

Table 7.

Estimated production, slaughter, and consumption of fed beef, with estimated surpluses or deficits by regions, 1960 1/

Regions	Feedlot production (million lbs.)	Fed beef slaughter (million lbs.)	Fed beef consumption (million lbs.)	Surplus of fed cattle production over slaughter	Surplus of fed cattle slaughter over consumption
Northeast 2/	137	783	2,604	(646)	(1,821)
Southeast 3/	287	406	973	(119)	(567)
North Central 4/	3,996	3,831	2,427	165	1,404
West of Mississippi River	3,917	3,317	2,333	600	984
TOTAL	8,337	8,337	8,337		

1/ Source: An Interregional Analysis of the Fed Beef Economy, 1966 U.S. Department of Agriculture

2/ Me., N.H., Vt., Mass., R.I., Conn., N.Y., Pa., N.J., Md., Del.

3/ Va., W. Va., N.C., S.C., Ga., Fla., Miss., Tenn., Ky., Ark., La., Ala.

4/ Ohio, Ind., Ill., Iowa, Minn., Wisc., Mich., Mo.

Table 8.

Trends in commercial cattle slaughter

Region	1962 1/	1963 2/	1964 2/	1965 2/	4-Year Total
	(One thousand head)				
APPALACHIAN STATES					
Alabama	222	220	241	256	939
Georgia	346	326	374	410	1,456
Kentucky	185	176	206	236	803
Maryland and Delaware	132	124	135	128	519
New York	493	444	429	444	1,810
North Carolina	164	163	173	187	687
Ohio	1,165	1,187	1,252	1,270	4,876
Pennsylvania	897	901	941	901	3,640
South Carolina	94	89	101	125	409
Tennessee	433	441	537	589	2,000
Virginia	181	197	207	231	816
West Virginia	70	66	65	69	270
Total Appalachian States	4,381	4,336	4,662	4,846	18,225
Annual Increase		(467)	328	244	
Total United States	26,083	27,232	30,818	32,347	116,480
Annual Increase		1,148	3,586	1,529	
Percent of Growth in Appalachian States		(1.0)	7.5	3.9	10.6
Percent of Growth in United States		4.4	13.2	5.0	24.0
Percent of United States Production In Appalachian States					15.6

1/ Source: An Interregional Analysis of the Fed Beef Economy, 1966, U.S. Department of Agriculture

2/ Source: Livestock and Meat Statistics, Statistical Bulletin No. 333, August 1966, U.S. Department of Agriculture

Broiler consumption has also had an increasing growth pattern due to change in tastes and increases in disposable income. Dining out has become a common occurrence rather than a luxury. According to agriculture economists, annual per capita consumption of broilers has reached 40.8 pounds, up from 38.6 pounds in 1964. Table 9 provides a perspective of per capita consumption of selected agricultural products.

Table 9.

Change in annual per capita consumption of selected foods in the U.S. 1/

Year	Beef lbs. 2/	Poultry lbs. 2/	Eggs lbs. 3/	Frozen fruits lbs. 4/	Dried fruits lbs. 4/	Frozen Veg. lbs. 4/
1956	66.2	30.0	48.0	3.97	3.70	7.24
1957	65.1	31.8	47.3	3.70	3.59	7.45
1958	61.6	34.4	46.3	3.66	3.02	8.04
1959	61.9	35.6	46.1	3.40	3.27	8.85
1960	64.2	34.7	43.7	3.53	3.12	9.72
1961	65.9	38.0	42.6	3.61	3.14	9.91
1962	66.2	37.4	42.3	3.79	3.01	11.53
1963	69.7	38.0	41.2	3.92	2.98	11.87
1964	74.2	38.6	N.A.	N.A.	N.A.	N.A.

1/ Source: U.S. Food Consumption, 1965, U.S. Department of Agriculture
2/ Ready-to-cook weight
3/ 48 pounds equals 369 eggs
4/ Includes only civilian consumption

According to industry experts, the freeze-dried foods industry will grow from 25 million pounds of production in 1964 to 300 million pounds by 1970. This is a conservative estimate allowing only 1.5 pounds per capita consumption.

Convenience foods, particularly boil-in-the-bag vegetables and chicken, are already marketed in the institutional food lines. In this way, individual portions are accurately premeasured, and waste is eliminated. This business is expected to grow tenfold, to a $70 million industry, in the next 5 years.

Dried and frozen foods are gaining wider market acceptance, particularly among young housewives who more readily accept time-saving innovations. The post-war baby boom is showing secondary repercussions on the economy. The demographic patterns reflect new households being created at the fastest rate in history. As a matter of fact, frozen food shipments rose from $1,268,000 in 1958 to $1,735,000 in 1963. Forecasts of $2,863,000 in the value of shipments for 1970 are considered conservative by the industry.

Profits

The greatest opportunity for improving profit margins will come with the further processing of raw materials. The founder of a large meatpacking firm predicts that in 10 years very little meat will be sold retail in anything but packages of individual servings or family cuts.

While profit margins in meat have been running close to 1 percent of sales, many processed meat companies are enjoying profit ratios of 6 and 7 percent of sales. One of the chief reasons attributed to low profits in meat is the inability of the packer to control the supply. The industry's prime difficulty always has been the fluctuating price of livestock, which represents about three-fourths of its costs. The 2 years it requires to raise a 1,100 pound steer makes the market price highly unpredictable and places the packer at a disadvantage. Foreseeing a short supply for current demand, farmers boost their prices. If there is an oversupply or low prices, farmers keep their cattle off the market.

Poultry production, on the other hand, reacts closely to market demand simply because of the short growth cycle. Supply is sensitive to demand. Poultry is sold in the market offering the highest price on a flexible truck delivery basis, much like the produce brokerage business. A short supply in St. Louis will raise prices sufficient to dispatch a load from an Alabama plant on a phone call notice from a central marketing dispatcher. Central marketing may be a co-op venture of several poultry packers, or it might be one of the large, vertically integrated grain or meat-packing companies that perform the marketing service.

Processed beef, poultry and produce can be dried, frozen, and stored for marketing when the price is profitable. Unprocessed food products are placed on the market subject to spoilage and receive the price the market supply and demand determines. The flexibility of processed food marketing allows for improved profits, at least in the short run. Oversupply under any conditions, processed or not, will eventually cost more for storage than profit will return. At this point the stored processed food would be placed on the market where the supply and demand price determinants would take charge. Profits under these long run conditions could be marginal if many producers enter the market at the same time.

Statistics on farm income do not give a complete picture of the economic conditions on the farms. In almost all of Appalachia, a large number of farmers derive substantial income from industrial jobs. Net income figures shown in Table 10 for a few selected states should take this into account.

Table 10.

Total net income per farm in Appalachian States, 1965 1/

U.S.	$4,182
Average of Appalachian States	2,938
Alabama	2,871
Georgia	4,603
Kentucky	2,486
Maryland	2,986
North Carolina	3,075
New York	4,591
Ohio	3,252
Pennsylvania	3,111
South Carolina	3,126
Tennessee	1,817
Virginia	2,595
West Virginia	740

1/ Source: Farm Income, U.S. Department of Agriculture, FIS 203, 1966

The agriculture departments of several Appalachian states have pointed out the 4 percent profit potential available in a well-managed feedlot business. This return offers a high standard of living to a farmer, as his home and taxes are considered business expenses. Recommendations to enter the business have been supported in the Southeast by the substantial reduction of rail rates on grain.

A beef feeding operation requires a great deal of capital. A comparison of capital requirements for alternative farm operations is shown in Table 11.

Table 11.

Investments in selected farm types,
January 1, 1964 1/

Investment	Hog-beef fattening (corn belt) (000's)	Broilers (north Georgia) (000's)	Cotton (south Piedmont) (000's)	Peanut-cotton (south coast) (000's)
Land and buildings	$ 86.1	$12.6	$29.0	$19.3
Machinery and equipment	10.5	4.1	2.2	3.4
Livestock	15.6	N.A.	1.1	1.8
Crops	11.5	0.9	0.5	0.9
TOTAL	$123.7	$17.6	$32.8	$25.4

1/ Source: Farm Costs and Returns, U.S. Department of Agriculture, Bulletin 230, August 1965

Table 12.

Employment change in selected food industries
between 1958 and 1965 1/

	SIC 2011	SIC 2013	SIC 2015	SIC 2037
All employees--1965	189.2	50.1	66.1	47.6
Percent change	(12.0)	13.9	11.0	45.1
Women employees--1965	27.0	15.1	35.2	25.9
Percent change	(16.4)	4.9	0.9	33.5
Production workers--1965	145.6	35.7	60.1	42.0
Percent change	(14.6)	11.1	10.9	44.3

1/ Source: Employment and Earnings, Establishment Data, Bureau of Labor Statistics

Employment

Automation has reduced nationwide employment in the meat-packing industry while at the same time it has increased production. However, the national trend to decentralization will spread job opportunities to areas which are not customarily meatpacking centers.

Employment will grow within the meat processing sector as more companies trim, cut, package and perhaps freeze the raw meat as a convenience food. In effect, plant packaging will replace the present store packaging. Commodity beef, or that which the butcher buys to grade by various cuts, will become less popular and less profitable. Butchers and housewives are willing to pay more for the processed, packaged meat.

Growth in employment for the frozen produce industry increased 45 percent between 1958 and 1965, as shown in Table 12. Increases in female employment nearly maintained this same growth in the frozen food industry.

Today, quick freeze-dried processing is in a growth situation analgous to that of the frozen produce industry 15 years ago. Machinery will perform many of the sorting, grading and materials handling operations of the future. This automation may ameliorate the growth in employment, but the degree of automation is limited by the irregularity of sizes and shapes handled.

Investment and Locational Activity

Growth in the frozen food industry again takes the spotlight. Expenditures for new plant and equipment reflect the attempt to keep up with demand. In the frozen fruit and vegetable field, a trend of future growth is evidenced by capital expenditures of the recent past as follows:

Year	$ million capital expenditures
1959	$23.1
1960	28.7
1961	28.4
1962	40.1
1963	55.6

This represents a 100 percent increase in annual capital expenditure in just 5 years. Appalachia had a 78 percent increase in frozen produce processing plants (SIC 2037) between 1958 and 1963 (see Table 13).

As recently as September 1966, new plant announcements for Virginia and Pennsylvania vouch for the growth of the food industry on the fringe of Appalachia. A $2.6 million broiler packaging plant in Temperanceville, Virginia will employ 500 persons and supply markets in Philadelphia, New York City and New England.

At Thornbury, Pennsylvania, a large food processing plant is being built by a large meatpacker to consolidate 2 Pittsburgh plants.

In the Southeast, the mammoth Cotton Producers Association fosters a co-op venture for 2 important industries. Its biggest business today is the production of broiler chickens. Officials of the organization believe that cooperative beef feeding offers the same potential and have opened an experimental feedlot in Georgia. The initial feedlot handling 3,000 head of cattle is 300 miles from the feed mill owned by the co-op.

Meatpacking establishments are locating closer to livestock supplies. With redevelopment in the city of Chicago, the meatpackers moved out to the rural areas. Hard surfaced roads, refrigerated trucks, and interstate highways to population centers have made it possible to establish packing plants in interior areas away from the traditional terminal markets on rail heads.

Appalachia has not shared in the meatpacking industry's location activity that spread rapidly into the Southeast with the advent of lower rail rates on grain in 1961. There is apparent opportunity for the industry in Appalachia with land and soil improvements.

Meat processing plants, such as sausage and frankfurter producers, are locating closer to the ultimate market where they may use the low grades of local meat for their product. Flavoring, cooking and packaging make the same quality of end product whether or not high-grade meat is used. Retired milk cows provide the greater portion of raw material for the processed meat industry.

Table 13.

Locational activity for selected food processing industries 1/

Industries	Establishments 1958	Establishments 1963	Net increase (decrease)	Percent change
SIC 2011				
Total U.S.	2,800	2,986	186	6.6%
Appalachian	297	301	4	1.3
SIC 2013				
Total U.S.	1,490	1,330	(160)	(10.7)
Appalachian	68	62	(6)	(8.8)
SIC 2015				
Total U.S.	1,233	964	(269)	(21.8)
Appalachian	121	106	(15)	(12.4)
SIC 2034				
Total U.S.	161	175	14	8.9
Appalachian	2	2	-	-
SIC 2037				
Total U.S.	426	647	221	51.9
Appalachian	18	32	14	77.8
TOTAL U.S.	6,110	6,102	(8)	(0.1)
TOTAL APPALACHIAN	506	503	(3)	(0.6)

1/ Source: 1963 Census of Manufactures.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Beef

Red meat is produced in several steps that require definition. Fed beef is cattle which has been brought into a pen area from the pasture for intensive protein feeding and fattening. Fed beef will add 600 pounds in 4 to 6 months "on feed." At about 1,000 pounds, the fed beef is taken to the slaughterhouse by truck. This is usually less than 50 miles distant and therefore injury or weight loss is minimized.

Shocked electrically, humanely slaughtered, the carcass is immediately hoisted on a rail conveyor for further dressing. The 1,000 pounds of beef on the hoof is reduced to 574 pounds of dressed-weight carcass. By-products of the slaughterhouse generally consist of hides, tallows, and miscellaneous offal.

The slaughterhouse confines its production to fresh meats, while the packer produces the full line of processed meats. Packinghouse by-products therefore are more numerous: Edible fats are used in oleo stock and lard; inedible fats go into tallow, grease, and eventually soap; dried blood and bone are processed into fertilizer; horns and hooves are sold for gelatin-based products; offal is sold to specialty houses for delicatessens and restaurants.

The industry has found that raw wastes can be treated effectively and economically in a combination of anaerobic and aerobic ponds. Water requirements are generally higher, the more the meat is processed. A slaughterhouse uses 500 to 2,000 gallons per 1,000 pounds of live weight slaughtered; a packing house, 750 to 3,500 gallons; and a processing plant, 1,000 to 4,000 gallons. Details for processing industrial waste in the meat industry can be found in the U.S. Department of Health, Education, and Welfare Bulletin No. 386, revised in 1965.

In general, massive meatpacking operations of the past (such as in Chicago's stockyard area) have been replaced by more compact plants operating at 90 percent of capacity year-round instead of 60 percent of capacity part-time.

Poultry

Poultry slaughtering of 40,000 to 60,000 birds per day in a plant employing 300 women and 100 men is not uncommon. Broilers 6 to 7 weeks old are brought from surrounding growers in cages. The male labor usually takes on the initial catching and butchering, while finishing is carried on by female labor.

An overhead rail conveyor (power or manual) is used extensively in poultry processing from slaughter to the boxing and icing operations. Automation is not as evident in poultry processing. Rubber-fingered drums pluck the hot wet feathers from a chicken in seconds. A light gas flame then singes off the pinfeathers. But from this point on, dressing of chickens is more a division of labor. Female workers dress and assist in packing chickens in cartons for shipping. Light icing has become a popular means of shipping fresh broilers. A few plants freeze the birds, particularly when markets are oversupplied and prices are down.

Produce

Produce freezing and quick-dry freezing are highly automated operations. Raw material sorting and grading at the initial stage of process consumes the greatest amount of labor, mostly female. Hoppers, conveyors, cooking, steaming, or parboiling are engineered into modern plants. In some plants, 800 female workers are not uncommon in sorting and light materials handling.

The produce freezing plant can only operate during periods of harvest. Spacing of produce harvest periods to make optimum use of the freezer operations has become an industry profit potential. Six to eight months of operation per year would be possible in southern Appalachia.

Raw Materials and Materials Handling

The packing and processing of food is a science of materials handling. From the highly mechanized business of farming crops and feeding livestock to allocating and delivering the finished food products, efficient handling of bulk is the secret to profit.

Ingenious machines have been devised that specialize in handling a specific raw material.

In meatpacking, on-the-rail plants are built to humanely stun the cattle for slaughter, skin off the hide by machine, and completely clean the carcass for blast chill storage without being touched by human hands. This development resulted in maximum utilization of skilled workers previously required to lift and haul carcasses for dressing.

Automated viscera handling has doubled productivity in this operation at some plants. One man on a hydraulic platform can wash 35 carcasses an hour, equaling the output of 2 men previously. Compressed-air hide strippers, operated by 2 men, can peel a carcass in 42 seconds instead of 5 men in 2 minutes. In addition, less skilled help can operate the machinery and produce a superior product.

The beef carcass never leaves the overhead conveyor as it is run into the blast chiller which improves quality and reduces shrinkage.

More and more meat is leaving the modern packing plant as a fabricated product--cut, trimmed, weighed, and packaged. Portion-controlled roasts and steaks, or wrapped wholesale cuts such as chucks, loins, ribs, and rounds, are shipped in packages.

Processed meats, like sausages and frankfurters, command a higher profit margin than dressed fresh meats. Canned, corned, smoked, and precooked portions are usually not integrated with slaughtering operations. Small processing plants locate near the ultimate market. Here they buy carcasses and various meat cuts from local slaughterhouses, grind the meat, flavor it, encase it, and package the product for cool storage. Processed meat is not usually frozen.

A large volume of product can be handled in the small area of a meat processing plant. Buildings 50 by 150 feet have been known to supply half the retail sales of a county with a population of 250,000. Grinders, mixers, cookers, encasing machines, and racks are operated under the supervision of a master blender. Like the chef of a large kitchen, he directs the mixing of ingredients and supervises the overall efficiency.

Large operations in meat processing simply have more production lines and larger storage areas.

Poultry processing has several stages that pass ownership of the hatched chick only once from hatchery to processor.

Although other arrangements are possible, placement of chicks with a great number of growers is a general practice. The processor usually buys the chicks, supplies the grain, and pays the grower through a contract based on time and weight gain.

For example, chick hatcheries as far away as Connecticut may air or express ship day-old chicks to a contract broiler grower in Alabama (although 40 percent of commercial hatchery production is in the South Atlantic States). The contractor places 20,000 to 30,000 chicks on raised wire-mesh enclosures that confine activity and reduce weight loss. Concentrated feeds and antibiotics turn a chick into a 3.5 pound broiler in 8 to 10 weeks. Net returns per broiler are highest when the value of the additional gain just equals the cost of feed used to produce it.

Automatic grain feeders from bulk truckload hoppers reduce manpower requirements. Simple daily checking of the automatic feeders, watering, and exhaust fans make large-scale growing of poultry a one-man or, at most, a family operation. Waste droppings are carried away from beneath raised pens by contractors for use as fertilizer. Delivery of matured birds to the processor is usually in cages. The entire flock is moved out in a single day, generally with labor and truck supplied by the processor, who actually owns the broilers during their growing period.

Mechanization of livestock feed handling in bulk quantities is necessary to overcome substantial increases in labor costs. In the supplying of animal feed from local crops, for example, intensive growth of alfalfa and its conversion into pellet form has a tremendous potential for savings in labor and space costs.

Manpower Utilization

With increased automation, the total employment in the United States for the meatpacking industry turned downward. At the same time, plants were moved closer to the raw material source, made more compact, and employed new supplies of labor. In the transition to new plants, it was only logical that new equipment be introduced. The transition to new locations is still in progress. Many Appalachian locations have profit potential for this industry that will create job opportunities.

Today, fewer skilled workers are required in meatpacking, but they are in very short supply throughout the country. Butchers, meat cutters, boner-dressers, and trimmer-packers are job classifications requiring a trained supply. The efficient cutting of meat is the key to a meatpacker's success. However, plumbers, electricians, and machine operators are skills required for maintenance work.

Female labor will have a larger share of employment in future packing plants where light trimming and packaging will be more predominant. The ratio of female labor varies from plant to plant, depending upon the degree of meat finishing. Industrywide, there is one female worker for 5 males in meatpacking.

Unskilled workers are generally hired by meatpacking establishments and advanced to higher occupational levels through in-plant training. About one-fourth of the plants in the industry have required physical examinations for new employees. While many establishments are willing to hire experienced, older workers, most employers prefer younger workers because of the physical demands of the work. At present, only a very small number of plants have specified educational standards for new production workers.

As mentioned earlier, the poultry processing plant employs 3 women for every man. The lighter work, with lower skill requirements, is attractive to women who may not have entered the labor force before.

Even higher ratios of women are employed in the frozen and quick-freeze-dried produce operations. Being seasonal, the work is subject to layoffs and attracts many who are not dependent on a single source of income. Skill requirements are low, and training periods are short, usually one day.

Product Innovation and Interproduct Competition

In the past 10 years, the per capita consumption of beef has exceeded that of pork. The growth of red meat consumption has been a reflection of a change in tastes and rising levels of disposable income. In like manner, the consumption of poultry, and broilers in particular, has increased. Families can afford to purchase chicken instead of fatback and greens, for example.

Convenience foods that mean more leisure time for the housewife are growing in popularity at the expense of staples and fresh produce. As an example, boil-in-the-bag vegetables and boned chicken will soon be extensively marketed for the consumer. Today, marketing of the product is centered on institutional feeding.

Quick-freeze-dried fruits and vegetables will enter the convenience food market as new freezer plants are built. New types of equipment include freezing in high-vacuum vessels until the product is virtually dehydrated. In preparation by the housewife, the addition of liquid brings out the natural texture, shape, and flavor of berries and fruit sections. Vegetables attain the form of kitchen-prepared foods, such as mashed potatoes.

In addition to the direct consumption by the housewife, a number of commercial food processors are presently testing freeze-dried fruit pellets in such items as cakes, muffins, candy, pancakes, and ice cream. These secondary markets could become a major breakthrough in attracting food processors into Appalachia.

The particular advantage of freeze-drying is that processed products can be stored at room temperature for months, perhaps a year. The shelf life of ordinary frozen foods is not indefinite.

The market area for food products will be greatly expanded when food processing by irradiation comes into greater use. Irradiation of foods has been introduced in the fish packing industry. By passing controlled radiation into the product, 99 percent of the bacteria is killed. Under refrigeration, but not frozen, the product can be shipped safely, with no loss in quality or food value.

A nitrogen atmosphere introduced to a vegetable-laden truck trailer has proved to be a highly reliable means of transporting fresh vegetables to market, even across the country. However, this innovation will not overcome the advantages of frozen produce, which can be stored for long periods of time and placed on the market when and where fresh vegetables are out of season.

Distribution

Red meat is distributed on-the-rail from packing plant to the regional warehouse of the major packer, or direct to a central warehouse of large chain stores. Increasingly, there has been a tendency to ship carcass meat to a regional processor who grades and carves the meat into a selection of high- and low-value cuts. The large meatpackers themselves are often the processors, but sales are also made to independents in volume quantities.

Poultry distribution is on a nationwide basis from many of the large plants. The local market price determines the profitability of shipping distance. Most often packed in ice for chilling, but sometimes shipped frozen, poultry moves from Alabama to Los Angeles, or Maine to Virginia, depending on supply and demand.

All agricultural products in this food industry group can be transported as exempt commodities. A contract carrier can quote any rate or flat charge to transport the goods to market. Contract motor carriers specialize in transporting these exempt commodities, but rail refrigerated cars move consistently heavy volumes on published rates.

The middleman, or food broker, is common in the industry. Allocation of supply in a region where the broker has a specialized knowledge of the market conditions provides the distant supplier with an economical outlet. Diversion of products in-transit can often place them in a market where price advantages will accrue to both the supplier and the broker.

Local distribution direct to the retail outlet is most common in the processed meat industry. Local brands of sausages and frankfurters have been known to capture a share of the local market through product differentiation such as flavor, size, color, or casing.

Decentralization in the livestock slaughter industry has implications for rural communities, for livestock producers, for livestock slaughter, and for livestock service industries.

It is apparent that a successful plant need not integrate all slaughtering and processing functions. Federal inspection and grading have enhanced the probability of success of a small, independent slaughterhouse. Capital requirements for a specialized local slaughterhouse are relatively less than for the older type, full-line plant. As a result of these factors, it may now be easier for a small community to attract or organize a slaughter plant than once was the case.

Co-ops of farmers and feed suppliers have made it possible to marshal large resources for marketing and distribution services that the individual farmer could not afford. Assistance in securing price and market reports, lower aggregate freight charges, and technical counsel have been major factors in co-op growth.

IV. PRIMARY FACTORS INFLUENCING THE SELECTION OF LOCATION

Introduction

Future location activity for the meat, poultry, and produce processing industry will weigh the following prime location factors, listed in order of their general importance: (1) raw material orientation, (2) land to support raw materials, (3) labor, (4) market orientation, (5) climate, (6) transportation, (7) plant sites, (8) power, and (9) available financing. The opportunity costs that quantitatively weigh these location factors have a broad range, even for adjacent Appalachian counties.

This report emphasizes the profitable processing of fed beef, broilers, and selected produce. At the same time, forage crops that support fed beef production are included in the assessment of land, soil, and climate conditions. Major location factors are also covered in this section for many of the industry's ancillary services.

Raw Material Orientation

As mentioned earlier, in Section III, this industry tends to locate near its source of raw materials. Slaughtering, for example, is performed where fed beef can be readily supplied in marketable quantity and quality. Produce freezing is performed near the growing fields.

The reason for this raw material orientation is simple. It is cheaper to ship a 500-pound carcass than the 1,100 pounds of beef on the hoof. It is cheaper to ship a 50-pound case of frozen peas than the 15 to 20 bushels of peas in the shells. Reduction of bulk and added value of product are the essential requirements for economical transportation to a national market.

Land

Appalachia exhibits a range of soil conditions which vary extensively in their suitability for differing crops or other agricultural uses. Some areas would require unduly large amounts of fertilizers or chemicals to be commercially productive. Others, such as the alluvial valley soils need only shallow plowing and lime applications to balance their Ph factor for profitable productivity.

For the most part, Appalachia has vast stores of tillable land that is yet to be placed in optimum use. In several Appalachian areas, deserted strip mines have been rejuvenated to green pastures by planned legume growth and chemical applications. Mixtures of clay with sand can produce ideal growing textures in soil that will reduce leaching of fertilizers and yet develop healthy root systems for plant growth.

Terracing, contour plowing, and soil development can overcome many of the disadvantages of the rolling topography found in the foothills of Appalachia. Generally, the use of bottom land for heavily cultivated green crops and terraced, rolling uplands for orchards and berry bushes will make the best use of the land available. Farm mechanization has been limited within much of Appalachia because, in the past, other areas of the country could be more productive at lower costs. Supplying the future food requirements for the eastern half of the country may very well attract larger land areas into production that heretofore had been thought uneconomical.

Location experience shows a vast range of acid soil conditions on the foothills of Appalachia's eastern rainshed that would be ideal for the production of blueberries and strawberries. Rapid, one-year maturity for strawberry plants sometimes favors their cultivation over blueberry plants whose production increases threefold after 10 years.

Alkaline soil in areas of limestone underlayment produce green crops of alfalfa, corn, and soybean for cattle feed. Peas, peppers, white potatoes, okra, tomatoes, beans, and squash are some of the vegetables suitable for growing and processing. Among these, only tomatoes cannot be frozen, freeze-dried, or dehydrated.

Labor

A surplus labor supply with moderate wage patterns and only semiskilled or unskilled qualifications can meet the essential requirements of the industry. National unions in the meatpacking industry, as an example, maintain high wages for the skilled sectors of labor. Specialists in butchering, meat cutting, and trimming will be a necessary cost to the operator.

The skilled are in short supply in all labor markets and would require training or importing in many areas of Appalachia. On the other hand, automation has reduced the skill requirements for meatpacking, as stressed in Section II under "Employment" and in Section III under "Manufacturing Processes." Raw materials handling and fine processing, beyond the skilled tasks, would absorb the lower grade of labor skills readily available in many of the urban and rural communities of Appalachia.

In-plant training and occupation-centered curriculum for vocational training schools could, in the long run, assure an adequate supply of the higher skills necessary to the industry. Federal inspection and federal and state agriculture specialists will aid the small plant in establishing standards and labor production methods that tend to make a processing plant profitable.

Poultry and produce processing plants, in particular, place a great deal of emphasis on a female labor supply that is flexible and adaptable to seasonal work. Section III outlines specific trends in this respect.

Plant size and wage rates tend to offset one another in a cost-benefit analysis. Reports from the U.S. Department of Agriculture indicate that national packers operate under terms of a uniform national wage contract. The large plants of the national packers often compete with smaller local plants which may not be organized and enjoy the advantages of lower wages, fewer fringe benefits, and flexibility in job assignments.

Market Orientation

By its proximity to major population centers, Appalachia could overcome most of the production cost disadvantages inherent in its topography and soils.

Production and distribution of the food products suggested in this report are inclined to have greater cost benefits for Appalachian locations in general. In particular, east coast markets would contribute more to profitable distribution than the markets to the west, which approach the existing major sources of supply. Freight and production costs would tend to preclude distribution for many of the suggested agricultural products west of the Mississippi River.

Climate

Precipitation and temperature extremes are limiting factors for growing seasons and crop locations within Appalachia. Appalachian climate does not limit cattle or poultry production. The broad range of climate within Appalachia makes it difficult to stress anything but general location advantages.

Moisture-laden air masses from the Gulf of Mexico and the Atlantic precipitate on the southeastern slopes of the Appalachian Range and produce annual rainfalls of 52 to 80 inches in the southern end of Appalachia, and 36 to 52 inches generally north of the Virginia-Tennessee state line. Higher elevations collect the cold air masses that produce up to 20 inches of snow in a single storm in New York, Pennsylvania, and West Virginia. Alabama, on the other hand, has only 3 inches of snow on the average and collects its heaviest precipitation in thunderstorms.

Sudden thunderstorms on dry land cause rapid runoff, lower groundwater tables, floods, and soil erosion, which could be alleviated with land development, forestry management, and conservation practices. Maximum utilization of the available rainfalls suggest the building of reservoirs, irrigation canals, and pumping stations to allocate water at the time and place it will be most advantageous.

Growing seasons permit the harvesting of 2 hay crops in the northern climes of Appalachia, and with average rainfall, 3 hay crops are cut in the South. Vegetable crops have a 9-month growing period in southern Appalachia and only 4 months in New York. Frost settles in lowland areas and, therefore, many farmers allow for cold air runoff when planning their crop layout on rolling land.

Transportation

Hard-surfaced feeder highways to feedlots, poultry farms, and produce fields will open untapped potentials of raw materials in Appalachia. Often, isolated valleys harbor some of the finest alluvial soils for raising feed crops and produce.

The processing sector of the industry tends to locate central to its supply. It follows then that feeder roads from raw material sources must be complemented with primary roads to major interstate highways in order to place the finished products in the populated markets.

Rail transportation for major processing plants contribute to their flexibility and profit when volume carload shipments can be made to the market. Rail transportation for grain would generally be necessary into the area of beef and poultry feeding, but this is not necessary for supplying live beef or poultry to the processing plant. Trucks owned by the processor usually transport the raw materials for this industry from their growing area.

Barge transportation of grain contributes to intense competition with rail rates that, in effect, stimulate the growth of the poultry and beef industries. Rail rate reductions up to 60 percent have created dynamic growth conditions for poultry and beef feedlots in the southern Appalachian States.

Motor common carriers, with high overhead in terminals and services, are not attracted to the exempt agricultural products in this industry. The day-to-day quotation of rates or flat charges made by for-hire carriers apportions the traffic among them.

In general, the transportation carriers absorb about 9 cents of the retail food dollar or 13 cents of the marketing dollar.

Processing Plant Sites

Process water, power for refrigeration, and natural gas fuel should be readily available at all processing plant sites. Sites of 40 to 50 acres can satisfy the requirements of a beef slaughtering plant employing 150 people and processing 300 head per day.

At least 9 acres of the plant site might be used for waste processing with anaerobic and/or aerobic lagoons. Local sewage disposal facilities and regulations on pollution would determine the extent of waste processing necessary. Once the waste water has increased its oxygen content (suitable level of BOD--biochemical oxygen demand) to standard levels, the effluent might be readily discharged into an adjacent river. Minimum stream flows are generally used as criteria for establishing effluent standards.

A well-drained site is conducive to maintaining health standards and minimizing construction costs. Frequently, cattle are corralled in lots adjacent to the plant. Under these conditions, several modern plants have installed drained concrete aprons.

Poultry and produce processing plants have substantially smaller site requirements. A 100-man processing plant would need only 6 or 7 acres, if expansion were not foreseen. Major plants are likely to require 20 to 40 acres. Well water for processing is often used in place of or to supplement municipal supplies. Sustained flows of at least 500 gallons per minute for an 8-hour draw-down, or 170 gallons per minute for 24 hours, would support a typical 300-head-per-day slaughtering plant.

Power

Refrigeration demands of the food processing industry, particularly in dried and frozen produce, indicate a preference to locate near relatively low-cost power. While TVA areas have low-cost electric power, other areas may prove gas-powered refrigeration more economical.

Gas touts the advantage of uninterrupted service when storm-created power failures could be disastrous to freezer plant operations. Auxiliary generators are usually installed to be used in the event of power failure.

To relate the energy requirements for various types of processing plants, refer to Table 14.

Table 14.

Power use in selected food processing industries 1/

	Kwh per $ value added	Kwh per employee
Meatpacking plants	$1.08	9,445
Prepared meats	.85	7,653
Poultry dressing plants	1.07	5,355
Dehydrated fruits and vegetables	.64	6,125
Frozen fruits and vegetables	.78	3,765

1/ Source: Fantus Plant Location Files.

Financing

Agriculture spokesmen for several Appalachian States have repeatedly advised investment of local capital in beef feedlots and broiler growing. The eastern production deficit in beef, its growth patterns, and local feed resources create ideal investment conditions that will eventually be grasped (if local capital does not fill the void) by the large national packers, feed supply firms, and co-ops.

Generally, major packers and grain producers would supply the capital for slaughtering and processing plants from internally generated funds and private borrowing. Co-ops look to their participating membership for support in additional ventures, but rely heavily on long-term financing from local banks for capital expenditures.

In all cases, the profit and growth atmosphere is very conducive to high-grade ratings for revenue bond financing, practiced in several Appalachian States.

The poultry industry is especially integrated vertically in the hands of feed supply firms and co-ops. Financing of all facilities except the poultry growers plant and equipment is usually controlled by these feed supply firms and co-ops. They often make arrangements to facilitate the financing of growers. As mentioned in Section III, the broiler grower generally does not own the chicks he is feeding, and, therefore, his capital requirements are limited to plant and feeder equipment.

In the production of feeder cattle, the largest capital expenditure is for livestock. The variable cost of feed supplies is the next most important cash expense for cattle feeders. The fed beef producer must be financed sufficiently to pay for at least his cattle and 6 months of feed. Short-term financing until the cattle herd is sold is necessary. Usually, 2 cycles per year of buying calves and selling fed beef on the hoof will generate peak needs for short-term borrowing.

Other Locational Factors

Historically, slaughterhouses have located on the edge of large urban centers. However, the trend to locate closer to the source of supply has produced an irregular location pattern in regard to community size.

Community cooperation is necessary in the acceptance of slaughter, meat, and broiler processing plants. Manufacturers have a considerably higher sanitation standard today than their image has commonly reflected. Federal inspection and the industry's all-out effort to project good public relations have greatly enhanced their acceptance into communities.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

Previous sections in this report demonstrate a potential in Appalachia for increased development of the agribusiness sector of the economy. Indeed, the economic impact of such development appears very attractive and consistent with the objectives of the Appalachian Regional Commission. Those specific elements of agribusiness demonstrating the largest potential currently emphasize the processing of broilers and fed beef. The feeding of poultry and beef under controlled conditions will serve an important supporting role.

It has been noted that, generally speaking, the food processing industry will follow the raw material sources. Thus, it is logical to assume that as raw materials are increased within the region, one can anticipate the related industries would expand or seek new locations. Nonetheless, there appears to be an immediate potential for increased activity of these industries within Appalachia.

It is significant to note that the processing of broilers and fed beef was selected for inclusion in the Appalachia Location Research Studies Program as a result of a high correlation between industry requirements and the Commission's objectives. Specifically, the common areas of consideration include:

(1) A large labor requirement, initially unskilled, with suitable latitude for upgrading skill mix;

(2) A sensitivity to waterway development allowing for economical bulk transportation of required feed raw materials;

(3) The resultant establishment of competitive rail rates and extensions of rail service;

(4) The already established market development efforts by private segments of the economy (rail carriers);

(5) Established evidence of a significant trend toward decentralization within the industry;

(6) An already intense activity by the agricultural extension services of participating state universities;

(7) The heavy reliance placed on private investment for the growth and development of new facilities in the industry;

(8) A high degree of power orientation;

(9) Significant water requirements;

(10) A large economic impact resulting both from the development of supporting agricultural operations and the substantial attraction of these industries for satellite operations (i.e. poultry house fabrication, processing machinery, packaging materials).

Taking into account the key location factors outlined in Section IV, a series of public policies and/or activities are covered in succeeding paragraphs of this section and are designed to enhance the competitive position of Appalachia for these industries. In summary, these are:

(1) Highway and waterway development;

(2) Site/waste disposal requirements;

(3) Power and water;

(4) Attracting private investment;

(5) Vocational education.

Highway and Waterway Development

Motor and water carriers who exclusively handle agricultural products are called "exempt carriers". ICC policy that maintains this exempt category is generally keeping the transportation costs on a highly competitive basis. Thus, the frequency of rate hikes is reduced. Efficiency of exempt carriers is promoted by this competition. Farmers, beef and poultry packers depend on exempt carriers for nearly 70 percent of their transportation to markets within 500-mile limits.

Federal and state policies that direct funds to hard surfacing of rural roads will stimulate successful agriculture in Appalachia. Tributary highways that lead out from central Appalachia to Interstate Highways 20, 40, 64, 80, and 81 will open market potentials that depend on economical and rapid transportation. With good highways, delivery within 24 hours to major east coast markets would be possible from most Appalachian producing points.

Waterways in central and northern Appalachia require extension. Barge transportation of grain has compelled rail rates to be reduced as much as 60 percent in the southern portion of Appalachia. With the ultimate reduction in the cost of grain, broiler production increased in Alabama and Georgia. In like manner, broiler production in the central and northern portions of Appalachia could be attributed to increased barge transportation.

Site/Waste Disposal Requirements

Sections III and IV have outlined the plant site requirements, especially in the area of waste disposal. Community response to the site requirements of the industry should be evaluated on the basis of long-range growth potential.

Communities that center on potential agriculture developments, such as feedlots and cattle slaughter, should plan to design future sewage disposal plants that will accommodate large waste volumes with high BOD factors ($\pm$ 1100 mg/l). Processing plants would be attracted to communities that provide this built-in capacity.

Waste disposal requirements (as outlined under "Processing Plant Sites") entail frequent state and local consultations to assure a mutual understanding of intent and adherence to the legal requirements.

Power and Water

Areas that furnish low-cost power are attractive to this industry, which consumes large volumes for refrigeration and freezing. Dam projects that create potential hydroelectric power similar to TVA can sometimes serve the dual role of irrigating crops and generating low-cost power.

In areas where normal year-round stream flows are not sufficient to generate peak load requirements during the day, power companies have tapped built-in mountain reservoirs above the turbines to supplement the subnormal water flow. A second reservoir below the turbines collects the water. When peak load requirements are down, motors pump the water back to the mountain reservoir to repeat the cycle.

Irrigation potential from either the reservoir at the top or bottom of the mountain could conceivably open virgin land for agriculture.

As mentioned earlier, waterways that accomodate barges will tend to maintain low costs for fertilizer and grain transportation, which is essential to successful agriculture in Appalachia.

Attracting Private Investment

Encouragement of co-ops by federal and state agriculture agencies tend to place producers in a firmer bargaining position when dealing with other industries. Stability of costs and prices, which can result from co-op bargaining power, assist in the internal generation of financial reserves. Tax concessions for co-ops also promote their potential for internal financing capacity.

In addition, many states have enacted legislation allowing communities to form revenue bond financing organizations that will build plants for new industry locations. States that have enacted this legislation have attracted substantial industry that has broadened the base of their economies.

Historically, financing of feedlots and poultry growing has come from the private sector of the economy--specifically, grain growers and feed producers. To attract this investment, the region must demonstrate a suitable business climate with the potential for an adequate return on the investment. The region's strategic location provides access to all prime eastern markets. The industry's decentralization tendency will serve to assure a willing ear. Power, water,and labor requirements can be satisfied, and transportation improvements are already underway. The area's raw material position and potentials are currently the subject of extensive review and assistance programs at the state level. Remaining, is the critical and perhaps complex task of packaging these benefits in a manner which will be meaningful to the prospective manufacturer. This will certainly require, as a minimum, cost-benefit analyses of specific locations.

Vocational Education

In-plant training programs, common in the meatpacking industry, would enjoy substantial savings in time and money if occupation-centered curricula in secondary public schools prepared a young labor force for the higher skilled positions. Occupation-centered curricula would include the following courses: butchering, meat cutting, boning, trimming, electrical maintenance, plumbing, refrigeration, packaging, elementary marketing, and leadership.

Poultry processing plants have similar requirements for occupation-centered curricula; however, the proportion of skilled workers in the plant would be less than in meatpacking.

State agricultural schools and colleges now adequately prepare young men, and women for that matter, in animal husbandry, veterinary, food nutrition, sanitary engineering, economics, business administration, and other management-oriented and technical courses.

Federal and state assistance in forming community junior colleges could contribute to the long-range needs of middle-management personnel for the industry. Courses in agronomy, for example, train fieldmen, foremen, ranch owners, operators, and service salesmen.

Funds made available under the Manpower Development and Training Act have been used for training in areas where certain industry skills are in short supply.

Appendix A

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(29) Standard Listed Stock Reports, 1966, Standard & Poor's Corporation, New York.

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(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Growers and processors of beef, poultry, and produce inside and outside Appalachia.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

(7) Harvard University.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 22—THE PLASTIC AND POWDER METAL PRODUCTS INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian states must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically Standard Industrial Classification industry codes 3079, Miscellaneous Plastic Products, excluding plastic foams and foamed plastic products; 3841, Medical and Surgical Instruments and Apparatus, specifically, disposable supplies made from plastic or powdered metallurgy techniques; and, powdered metal parts classified under various codes by product end use.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

For the purposes of this study, industry selections include: all plastic products, not elsewhere classified, (SIC 3079) excepting plastic foams and foamed products; the production of disposable medical and surgical supplies made from plastic or powdered metals; and the production of other powdered metal parts. Plastic parts dominate the selected industries, representing over 90 percent of the total employment, value added by manufacture, and new capital expenditures.

In 1964, employment within these industries was estimated to approach 180,000. Other calculations placed the value added by manufacture in excess of $1.9 billion, new capital expenditures in the area of $184 million, and total shipments over $3.6 billion.

Products manufactured by these industries serve an extremely broad range of industrial and consumer markets. Industrial components make up the largest single classification, with heavy emphasis on the automotive, appliance, and other assembly-line marketing outlets. The packaging industry also claimed a large portion of plastics output.

Significantly, about 90 percent of all establishments employ less than 100 workers. However, a major trend is now apparent which involves the establishment of captive production by major end-using firms as well as diversification into the field by other leading U.S. companies. Such moves are expected to gradually change the size mix of these industries.

The preponderance of small firms generally represents the ease of entry into plastics production. When combined with the fact that raw materials are shipped freight prepaid, this has led to the rather ubiquitous development of these industries. No less than 48 states can claim a representative, and 16 states boast more than 50 establishments. However, detailed analysis of production locations will demonstrate a high degree of market orientation. While Appalachia specialization must be considered low, substantial concentrations in and around the fringe areas demonstrate a yet unrealized potential.

Growth prospects can best be summed up by the results of an independent research study. This study covered the potential growth of key U.S. industries and placed plastics in the lead over all others. An industrywide growth of 722 percent was projected over the next 14 years. Many individual product lines provide growth projections even more dramatic.

Market orientation and transportation considerations control the geographic positioning of new facilities. These two factors produce a varied effect on locational decisions since they combine under a wide variety of weighted values or degrees, depending upon the product mix and size of the individual establishment. Labor cost considerations follow in importance to the location-seeking executive.

These industries present little opportunity for effective public actions, investments or activities. Highways are of primary importance and industry will require direct, dependable access to markets in the East North Central and Middle Atlantic areas. Most effective, however, will be the evolution of an internal market for Appalachia resulting from industrial development efforts within the Region. New industries will do much to attract additional producers of plastic and powdered metal parts.

I. PROFILE OF THE INDUSTRY

Introduction

Selected industries covered in this locational analysis exhibit common characteristics or similarities in product orientation, growth outlook, manufacturing processes, skill requirements, and basic locational criteria. In essence, these industries serve an extremely broad range of markets with an even wider list of products. Unfortunately, they do not fit precisely into the Standard Industrial Classification system and thus statistics are frequently inadequate or completely unavailable.

The actual industrial coverage of this report includes the production of all plastic products (SIC 3079) with the exception of plastic foam (SIC 30792) and products made from foam (parts of SIC 30794 and 30798); the production of disposable medical and surgical supplies made from plastic or powdered metallurgy techniques (covered under SIC 3841); and the production of other powdered metal parts (classified essentially by product end-use under many different SIC codes).

Size

As indicated in the preceding paragraphs, these industries do not lend themselves to a precise determination of employment, value added, and other parameters of industry scope. Nonetheless, interpolation of data contained in the Census of Manufactures and various other publications does allow for the establishment of such factors within reasonable limits of accuracy. Accordingly, Table 1 provides a comparison of ranking nondurable goods industries and the production of plastic and powder metal parts. Significantly, plastic parts dominate the selected industries, claiming over 90 percent in all categories. Thus, the industry is classified and compared with the nondurable goods field. This is somewhat misleading, however, since many of the products find their ultimate end-use in such durable fields as automobiles, appliances, and building construction.

Table 1.

Ten ranking nondurable goods industries
compared to plastic/powder metal products, 1964 1/

(Numbers in millions)

Industry rank	Employment		Value added by manufacture		Capital expenditures	
1	Food	1.6	Food	$23,054	Chemicals	$1,876
2	Apparal	1.3	Chemicals	19,133	Food	1,419
3	Printing	0.9	Printing	11,065	Paper	886
4	Textiles	0.9	Apparel	8,150	Textiles	492
5	Chemicals	0.7	Paper	7,805	Printing	463
6	Paper	0.6	Textiles	6,736	Petroleum/ coal	412
7	RUBBER/ PLASTICS	0.4	RUBBER/ PLASTICS	4,984	RUBBER/ PLASTICS	400
8	Leather	0.3	Petroleum/ coal	3,774	Apparel	124
9	Petroleum/ coal	0.1	Leather	2,270	Tobacco	59
10	Tobacco	0.08	Tobacco	1,772	Leather	38
	PLASTIC/ POWDER METAL PRODUCTS	.18	PLASTIC/ POWDER METAL PRODUCTS	1,920	PLASTIC/ POWDER METAL PRODUCTS	184

1/ Source: 1964 Annual Survey of Manufactures, U.S. Department of Commerce, and Fantus Area Research estimates

In 1964, the total value of shipments for these industries was estimated in excess of $3.6 billion--an amount which represents 37 percent of the total shipments by the Rubber and Plastics Products grouping (SIC 30).

Products and Markets

Products made from plastics or powdered metals find their outlets in an extremely wide range of industrial and consumer markets. Table 2 demonstrates the relative significance of individual product classifications:

Table 2.

Value of selected product shipments 1/

Product class	Value of shipments ($ million)
Industrial plastics products	$882.1
Unsupported plastics film, sheets, rods, tubes, from purchased resins	579.1
Consumer and commercial plastics products, N.E.C. 2/	500.1
Packaging and shipping containers, plastics 2/	486.4
Powdered metal parts (estimated)	310.0
Construction plastics products	302.4
Laminated sheets, rods, and tubes	266.7
Plastics dinnerware, tableware, and kitchenware	170.5
Miscellaneous plastics products, N.E.C.	122.3
Selected medical and surgical supplies (estimated)	114.0

1/ Source: 1964 Annual Survey of Manufactures

2/ Includes foam products

The onslaught of new plastic products and applications during the past 20 years leaves few markets untouched. Invasion of the $27 billion packaging market now requires about 20 percent of the total plastics output. Plastic bottles, drums, containers, molded baskets, blister and envelope packaging all provide growing markets.

Industrial products make up the largest single production category and include such items as gears, bearings, bushings, and cams; motor vehicle, aircraft, missile, and appliance parts; plus many others too numerous to mention. The construction industry provides the major outlet for such products as corrugated and flat panels; doors and partitions; floor, wall, and counter coverings; plumbing fixtures and parts (including bathtubs, shower stalls, etc.); and plastic pipe and fittings.

Products designed for medical and surgical markets now number over 100. While the greatest impact has been made by disposable syringe-needle kits, plastics are now used to form disposable items which range from aprons to scalpels, urinary tubes, nursing bottles and many others. Powdered metal parts, as might be expected, are much more limited in applications. End products are characterized as industrial components and marketing outlets break down as follows:

	Percentage distribution
Automotive	60%
Appliances	16
Farm and garden equipment	8
Hardware, tools, and cameras	7
Business machines	6
Other	3

Plant Ownership and Size Structure

Table 3 presents census statistics indicating the overall character of these industries:

Table 3.

Number of establishments by employment size, 1963 1/

	SIC 3079 Plastic products N.E.C.	SIC 3841 Medical and surgical instruments
Companies	4,101	256
Total U.S. establishments	4,334	294
Establishments employing:		
1-19	2,660	177
20-49	854	51
50-99	423	31
100-249	294	22
250-499	78	7
500-999	20	5
1,000 or more	5	1

1/ Source: 1963 Census of Manufactures

As demonstrated by the foregoing data, about 90 percent of all establishments employ less than 100 workers. Much of the plastic products industry is made up of "mom and pop" establishments operating out of garages, lofts, and the like. A relatively small investment ($20,000 to $50,000) covers the equipment, and resin vendors are quick to provide all of the technical advice required.

Currently, about 25 fabricators are producing disposable hospital supplies. While much of the production is controlled by the recognized leaders of the medical supply industry, many of the firms are smaller, more highly specialized operations.

As best can be determined, there are 225 companies producing some form of powdered metal products in North America. Of these, 93 are manufacturers of powder metallurgy parts and/or bearings, with 69 establishments doing custom work, 19 representing "in-plant" operations, and 5 units performing in both categories.

A major trend toward captive production by major automotive and appliance makers has now become apparent. Significantly, this trend applies equally to both plastic products and powdered metal parts.

Geographic Prevalence

No less than 48 states, including Alaska and Hawaii, and the District of Columbia can claim a representative of the plastic products industry. Furthermore, 16 states led by New York, California, New Jersey and Illinois have more than 50 such establishments within their borders. The following table presents a geographic breakdown of establishments by census districts.

The Middle Atlantic, South Atlantic, and East South Central districts, when combined, account for 37 percent of the total U.S. plant count. Unfortunately, data is not available on the location of plants specializing in powdered metal parts.

Table 4.

Regional distribution of establishments 1/

	SIC 3079 Plastic products	SIC 3841 Surgical & medical instruments
New England		
Total	458	34
Employing over 50	119	10
Middle Atlantic		
Total	1,265	89
Employing over 50	227	21
South Atlantic		
Total	271	15
Employing over 50	47	2
East North Central		
Total	1,114	59
Employing over 50	261	17
East South Central		
Total	69	5
Employing over 50	25	2
West North Central		
Total	251	23
Employing over 50	42	7
West South Central		
Total	173	8
Employing over 50	20	-
Mountain		
Total	63	7
Employing over 50	2	-
Pacific		
Total	659	53
Employing over 50	77	7
Total United States	4,323	293
Employing over 50	820	66

1/ Source: 1963 Census of Manufactures

Appalachian Specialization

Appalachia's specialization for these industries is reflected in Table 5. While industry representation is low, there is an apparent substantial concentration of establishments in and around the Northern Appalachian fringes.

Table 5.

Establishments within the Appalachian region 1/

State	SIC 3079 Plastic products		SIC 3841 Surgical & medical instruments	
	Total	Employ over 50	Total	Employ over 50
New York	13	2	1	1
Pennsylvania	98	30	4	1
Maryland	2	-	-	-
Virginia	-	-	-	-
West Virginia	5	-	1	-
Ohio	29	12	2	1
North Carolina	3	1	2	-
South Carolina	5	-	-	-
Georgia	4	1	1	-
Kentucky	1	-	-	-
Tennessee	17	5	-	-
Alabama	10	6	-	-
Total	187	57	11	3
Percent of total U.S.	4.3%	6.9%	3.8%	4.5%

1/ Source: 1963 Census of Manufactures

A significant expansion of the Appalachian industry has been witnessed during the past 4 years. No less than 30 new establishments have been located in the Region with the majority employing between 50 and 400. Moreover, the area claimed 13 expansions during the same period.

Economic Impact

An indication of the economic impact created by these industries can be determined through analysis of the interindustry (input-output) tables (see Table 6). Further, for every 2 jobs created in plastics or powdered metals parts manufacture, an additional job is created in a supporting manufacturing operation and another in the service industries.

Table 6.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from other establishments	Rubber and miscellaneous plastics products
Broad & narrow fabrics, yarn mills	$ 21.09
Miscellaneous textile goods	66.71
Paper & allied products	4.12
Paperboard containers & boxes	7.28
Printing & publishing	3.11
Chemicals & chemical products	46.81
Plastics & synthetic materials	142.61
Rubber & miscellaneous plastics products	30.90
Glass & glass products	6.39
Stone & clay products	3.53
Stampings, screw machine products	3.28
Fabricated metal products	11.20
Miscellaneous manufacturing	4.51
Transportation & warehousing	21.72
Communications, except radio & TV	3.03
Electric, gas, water, sanitary services	10.31
Wholesale & retail trade	34.56
Finance & insurance	5.79
Real estate & rental	10.47
Business services	23.71
Imports of goods & services	38.40
Business entertainment & travel	8.65
Other industries	36.47
Total purchases	$ 544.65
Value added	455.35
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

A new establishment of these industries might typically employ 100 workers. Such a plant, if operating at the industry's national wage average, would disburse an annual payroll of $457,600. Using a factor of 3 for the "economic velocity" of new manufacturing employment value, the total impact produced on the local economy approaches $1.4 million annually.

Although these industries will have little attraction for new supporting or satellite operations, a relatively heavy reliance on wholesale and retail trade, transportation and warehousing, and business services will further the development of the local economy.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Consumption

The rather dramatic growth experienced by these industries in the past 8 years is indicative of things to come. This established trend is bolstered by rosy forecasts in virtually all end uses as well as a rapid pace of new technology providing a wealth of new applications. Past growth of the two primary product classifications of these industries are measured in the following:

	Plastic products (SIC 3079) Value added by manufacture ($ million)	Powdered metal parts shipments (Thousands of tons, approximate)
1958	$ 929.0	10
1959	1,093.7	18
1960	1,147.9	17
1961	1,254.3	19
1962	1,466.7	30
1963	1,660.9	38
1964	1,853.1	48

Things to come are most effectively measured through a review of major consuming outlets. The use of synthetic resins (plastics) in the production of hospital supplies is expected to grow at a 10-to-15 percent rate for the next 30 years. Thus, from a 1963 base market of $125 million, sales are expected to reach $300 million by 1970. Efforts by hospitals to offset the high cost of labor through utilization of disposable supplies will create further demand for new applications. The success of syringe-needle kits--a consumption which grew 200-fold between 1957 and 1965--demonstrates both the potential and acceptance of these products. As noted earlier, a whole range of "soft goods" applications is just in the development stage. Lending further weight to the potentials of this industry is the high rate of new hospital construction (in the area of $2 billion per year) and the higher utilization of both these and nursing home facilities expected as a result of the recent "Medicare" and other social legislation.

Plastic products markets provide many similar demonstrations of growth potential. Packaging applications, accounting for roughly 20 percent of the total plastics output, claim a growth rate of 25 percent per year for skin packages, and consumption of polyvinyl chloride bottles is expected to go from 125 million units now to 1 billion units by 1970.

Similarly, construction applications, which consumed an estimated 2.3 million pounds of rigid vinyl materials in 1964, claim a potential between 500 million and 1.75 billion pounds by 1974. Moreover, the use of plastic parts in the production of automobiles (now at 30 pounds per vehicle) is expected to at least double by 1970, and tooling commitments now under way shortly will double the output of metal plated plastic products.

A parallel to the above is found in powdered metal parts markets. The automotive industry, currently consuming 60 percent of the parts produced, is projecting an increase from the present 8-1/2 pounds per car up to as high as 25 pounds by the end of the decade. The same labor and material saving economics that is fostering increasing utilization of these parts by the automotive industry applies equally to the highly competitive appliance industry.

Profits

Historically, profits of plastic and powdered metal parts producers have remained on the low side. Both products have based a good deal of their past growth on providing cheaper substitutes in existing outlets. Moreover, the vast number of small producers, operating with a minimum of overhead, have kept prices at a low level as they moved to protect their volume against the onslaught of big company competition.

Powdered metal parts producers are looking toward increasing their volume as the primary means of improving the return on investment. A similar effect could be felt in the plastics field. In both cases, however, an extremely bright demand forecast, and rapidly rising labor and material costs might well mean an overall easing in the price competition.

Employment

An extremely rapid growth rate has more than offset the effects of improved technology, productivity, and automation, allowing for substantial, consistent employment gains within these industries. While precise historical data is not available for the industries as selected for this report, the following table is indicative of the growth experienced in the production of plastic parts. Distortion is limited to the inclusion of the approximately 12,000 workers (1965) of the foamed plastics industry.

Table 7.

Employment in the plastic products, n.e.c. 2/ industry - SIC 3079 1/

	All employees (1,000)	Women employees (1,000)	Production workers (1,000)	Average weekly hours
1958	101.2	-	79.7	39.8
1959	115.1	41.1	91.6	40.9
1960	121.4	42.8	95.7	40.2
1961	128.9	44.7	101.1	40.7
1962	147.7	51.2	117.0	41.1
1963	158.1	53.8	124.9	41.3
1964	170.9	58.2	135.4	41.5
1965	193.1	67.8	155.1	41.4

1/ Source: Employment and Earnings-Establishment Data, Bureau of Labor Statistics

2/ n.e.c.: not elsewhere classified

This same rapid growth, unanimously forecasted by both major producers and consumers, should allow for continued enjoyment of employment growth.

Investment and Locational Activity

Table 8 measures the locational activity of related standard industry classifications between 1958 and 1963 and indicates a growth of the Appalachian industry which exceeds that of the total U.S.

Table 8.

Locational activity for selected industries 1/

(Net Change)

Industries	Establishments 1958	1963	Net increase (decrease)	Percent change
Plastic Products, N.E.C. 2/				
Total U.S.	3,220	4,323	1,103	34.3%
Appalachian	122	187	65	53.3
Medical & Surgical Instruments				
Total U.S.	231	293	62	26.8
Appalachian	6	11	5	83.3
Total:				
United States	3,451	4,616	1,165	33.8
Appalachian	128	198	70	54.7

1/ Source: 1958 and 1963 Census of Manufactures

2/ N.E.C.: not elsewhere classified

As indicated in Section I, the period since 1963 has also seen a large amount of activity in Appalachia, with 30 new plants and 13 significant expansions in the plastic products industry alone.

A recent survey by a leading independent research organization covering the potential growth of key U.S. industries places plastics in the lead over all others. Results indicate an industrywide growth of 722 percent over the next 14 years. This projected growth has combined with the fact that today's markets are already substantial in size to attract the attention of many leading U.S. firms. Two extremely large and diversified companies are already looking at potentials for entering the hospital supply field. Plastic construction products can claim 13 chemical and 4 pipe companies which are buying-in or starting new operations, numbering among them some of the giants of U.S. industry. In essence, a general trend is developing where larger firms are diversifying or integrating into parts production.

Some of the new investment activity will be characterized by the earlier-mentioned trend to captive production by major assembly line consumers. Much of it, however, will simply be an attempt by these larger companies to capitalize on the industry's growth potential. In either event, investment activity will be high, and Appalachia should be in a good position to further attract new industry representation.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Plastic materials are subjected to a wide range of processing operations in order to arrive at the many different end products. Essentially, these parallel the metalworking field. Plastic resins, serving as the raw material, are usually purchased in pellet, powder, or granular form. These are subsequently heated to a molten or elastic state and then formed by such techniques as extrusion, blow molding, and impact or other molding procedures.

Typical methods of fabricating plastics include:

Injection Molding:

This process is similar to die casting of metals. A thermoplastic, in granular form, is heated to plasticity in a cylinder, then forced under pressure into a controlled temperature mold.

Compression Molding:

After thermosetting resins are placed in a heated mold cavity, the mold is closed, and heat and pressure are applied to the plastic. The material softens and fills the mold cavity while undergoing a chemical reaction that hardens the plastic into a finished form.

Transfer Molding:

This is a fabricating method of injection molding for thermosetting plastics. The material is heated to plasticity in a transfer chamber, then fed into a closed mold.

Blow Molding:

A thin cylinder of plastic is placed between the jaws of a split mold. The mold is closed to pinch off the cylinder. Air pressure forces the material against the mold faces.

Extrusion:

Thermoplastic molding powders are fed to a heated plasticizing cylinder, then driven by a rotating screw or plunger through a die of the desired cross section.

Thermoforming:

The material is heated until it becomes limp, causing the sheet to slump over the mold profile. Vacuum, air, or mechanical pressure is used to more closely conform the material to the mold.

Sintering:

Particles of the plastic are compacted under pressure into the finished shape, then fused by heating.

Machining and Casting:

Similar to metal operations.

Parts usually require little in the way of finishing operations outside of cutting, slitting, spray coating, or electroplating; however, many of the materials do lend themselves to various machining techniques.

In general, plastic sheet, film, pipe, tubing, and the like are extrusions. Most bottles made from the material utilize blow-molding procedures, while the wide variety of components, shapes, and parts will rely on the various other molding techniques.

New equipment is playing a large role in improving productivity and opening new markets. There is a definite trend to complete automation, and many of today's machine orders involve complete packages capable of receiving raw materials and taking the finished part to inventory. Centralized control stations moderate the operation, while programmed machines perform their function. Perhaps most significant from an application standpoint, however, is the introduction of new, larger machines. Extensive use of injection equipment smaller than 16 ounces is now obsolete, with new machines of 300-ounce capacities turning out items such as television cabinets, dashboards, and contour chairs.

At least one primary market is awaiting the industry's development of a completely satisfactory electroplating procedure. Problems are still experienced in attaining long-term durability in metal adherence, but once solved, there are well over 100 individual applications on each automobile. Present procedures now place a thin coating of nickel or copper on the plastic material. This forms a conductive surface for final, conventional plating with chromium or other metals.

Powder Metallurgy

Powdered metal parts are also benefiting from improved technology allowing the production of larger parts. The maximum size part for high volume items used to be about 4 ounces. Today's average now runs to 2 pounds; however, at least one producer is turning out a part weighing 40 pounds.

In theory, powder metallurgy techniques are simple; in applications they demand the highest degree of metallurgical knowledge and refinement. Basically, raw powders, principally iron and additives, are placed together in a blender and mixed thoroughly. The part is then compacted in a press to the required shape and sintered (furnaced) in a controlled atmosphere. Temperatures are in the area of 2050°F and time requirements run to 40 minutes. A finished part issues from the furnace. Further processing may be necessary in the form of repressing, or coining, followed by additional sintering.

New methods of compacting powders are presently being developed and are designed to overcome size limitations imposed by the mechanical and cost restrictions of conventional techniques. Other technological developments will emphasize techniques designed to increase the parts property requirements, probably dealing with tensile strengths of 150,000 psi and up.

The growing acceptance of powdered metal parts results primarily from the elimination of costly, machining operations associated with standard metal forming techniques, a savings in the reduction of material wastage, and the ability to design specific properties into the part, notably self-lubrication.

Raw Materials

Theoretically, there are as many different raw materials for plastic part production as there are synthetic resins. Thus, new resins, as developed, will allow the industry to benefit from whatever new properties or "alloying" potentials might be offered.

The differing properties of resins make some more oriented to certain applications than others. As an example, polyethylene (high density) currently holds more than 90 percent of blow-molded bottle production. Hospital items rely predominantly on polypropylene and polyethylene, although nylon is used in syringes for paraldehyde injections, surgical clamps, and transfusion sets, and silicon is used in tubes and catheters. Mylar is used in pressure sensitive bandages.

Other resins which claim significant portions of specific markets include the vinyls in the construction field and ABS in metal plated plastics. The impact absorbing qualities of the latter stands it in good stead for the forthcoming rise in consumption by the auto industry.

As might be expected, no one material can long claim an exclusive in any area. The rapid pace of research by the chemical industry is constantly turning out new products or "alloys" with improved properties. The most recent example is the development of a water-clear polyvinyl chloride blow-molded bottle which will certainly detract from polyethylene's position in this field, as it allows many new potentials, including the milk bottle market.

Since resins are supplied on a freight prepaid basis, parts producers have little incentive to locate near their supplies. However, smaller manufacturers rely heavily on suppliers for customer services involving technical advice on both materials and equipment and will assure open channels of communication.

Iron powder dominates the production of powdered metal parts, although copper and other materials are frequently used. The many different techniques used to produce these powders demand an awareness of differing characteristics on the part of parts producers.

Manpower Utilization

As noted earlier, the production of plastic products is already into a trend of increasing automation. While the cost of this equipment has a tendency to limit it to the larger firms, its long-range effect on the industry is obvious.

Manpower utilization in the production of powdered metal parts provides one of its primary advantages over solid metal competitors. Not only are fewer persons required to turn out powder parts, but in many stages of the operation lower skills can be applied. While manufacturing processes parallel the plastics field, automation has not yet reached the same degree of acceptance.

In both fields, productivity has been on the upswing, and gains will continue in future years.

Product Innovation and Interproduct Competition

In general, products made from plastic or metal powder have been faced with carving markets out of areas formerly dominated by other materials. Thus, most applications remain in direct competition with other substances and rely on cost benefits and/or unique physical properties to maintain and foster their position.

The development of new resins with improved qualities was noted earlier. Equally significant from the product marketing standpoint has been the general trend to reduced or stabilized price structures during a period of rapidly rising costs. The process nature of raw material production, together with the automated and simplified forming techniques, minimize the effect of increasing labor costs. The same is not true of some competitor materials and products, such as wood or a galvanized metal trash can.

For the most part, new developments will revolve around improved qualities or techniques. Recently announced examples of this include: the development of water-clear, rigid PVC bottles allowing invasion of the milk bottle market; 2 new high performance resins, one of which allows application in hot water distribution systems, self extinguishing electrical components, and mechanical parts operating under a wide temperature range; a new rigid, calendered vinyl for synthetic wood veneers; and a new trash can which is unbreaking in either subfreezing or tropical climates.

Significantly, the large commitment of chemical manufacturers to the plastic parts industry assures the development of new and improved resins as well as an increasing range of product applications.

Distribution

The large number of small producers in the plastics industry has resulted in a heavy reliance on distributors and jobbers in the marketing of products. Producers oriented to the large assembly-line consumers of both plastic and powdered metal products may negotiate supply contracts either directly or via manufacturers' representatives. Larger manufacturers of consumer oriented items may utilize their own sales force, distributors or, more frequently, some combination of the two.

A review of transportation statistics indicates that over 25 percent of the industry's output moves less than 100 miles, and close to 55 percent is delivered within a 300 mile radius of the plant. Motor carrier predominates for outbound shipments, and less than 25 percent utilize alternate means of transportation.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

Market orientation and transportation considerations are the major locational determinants of these industries. These two factors produce a varied effect on locational decisions since they combine under a wide variety of weighted values or degrees, depending upon the product mix and size of the individual establishment.

As noted throughout the earlier sections of this report, the automotive market provides a substantial outlet for both plastic and powdered metal parts. Accordingly, the locational analysis of new plants designed to serve that market are contained in The Appalachian Location Research Studies Program, Report No. 8, entitled "The Motor Vehicle Parts Industry". Subsequent discussion in this section will be limited to other plastic and powdered metal products.

Market and Transportation Relationships

The vast number of small establishments claimed by these industries provide examples of narrowly defined regional market orientation in virtually all product lines. Nonetheless, some of these examples must be considered as exceptions rather than the rule in that the majority of production within a specific product line might well be destined to serve a nationwide market. Treatment of such considerations in any study of this nature must logically be confined to general practice.

A relatively high impact of transportation costs on plant profitability and market penetration combine with varying customer service requirements to determine the degree of market orientation in the production of any specific product line. Thus, the relative value and the density of a product limit a plant's effective marketing territory. Low value items also low in shipping density (light, but bulky in size) provide the extreme in such restrictions. A prime example is found in the production of blow-molded gallon containers. Examples on the other end of the scale include higher valued surgical supplies (i.e., syringe-needle kits) and such high density items as vinyl building siding or floor coverings. Note that density considerations relate to the product as completely prepared or packaged for shipment.

Census of Transportation data indicate a heavy reliance on common motor carriers with over 67 percent of outbound plastic products shipments moving by this means. Private trucking ranks next with 12 percent and rail follows with 10.5 percent. While air transport holds less than 0.4 percent, other means of shipment, including parcel post, package, and mail services, etc., move close to 7 percent of the plastic industry's product.

While many exceptions can be cited, some generalities are available in regard to the degree of market orientation found in certain product lines.

Plastic Containers

Due to the foregoing considerations, plastic bottle manufacturers experience a high degree of market orientation, even to the extent of establishing over-the-fence operations. Most of these plants will be found near production centers of household chemicals, toiletries, cosmetics, and medicines. A 150-mile radius should provide markets for the vast majority of plant output.

Ice cream and other similar containers allow somewhat greater limits due to their stacking ability in shipment. Nonetheless, producers still feel the effects of shipping "great amounts of air" and 250 miles would normally extend to the outer limits of their effective marketing territory.

Closures

Plants producing such items as bottle tops, toothpaste tube caps, and the like, effectively service a much broader market. While many plants are shipping throughout the U.S., there is a growing trend of decentralization to regional territories. There is little doubt that this trend will persist.

Packaging Film

Plastic film produced for blister, bubble, vacuum, and other automatic packaging applications is generally made in plants which also are regionally decentralized. In this case, customer service requirements are of equal or greater import than freight charges.

Plastic film used in the familiar envelope covering of dry cleaners can be supplied by plants serving a national market. These thin sheets are shipped in large, compact rolls in a manner similar to paper.

Toys

Manufacturers of plastic toys are usually oriented to serve the national market from a single location, with the exception of some of the more staple, high volume products. On the other hand, producers of toy parts under contract to the primary manufacturer will obviously locate near such centers of production.

Industrial Components

Customer service requirements combine with transportation considerations to determine the market orientation for both plastic and powdered metal industrial components. Technical support is a demand of the high volume consumer, as is reliable delivery service and optimum inventory levels. As a result, manufacturers will generally locate within 300 miles of major markets, with territorial limits extending to 450 miles.

Construction Products

Manufacturers of plastic pipe are historically very market oriented,resulting, once again, from high shipping costs and extremely competitive pricing. Floor and wall coverings together with vinyl siding and the like are more prone to centralized production and warehouse distribution.

Hospital Supplies

Producers of hospital and surgical supplies generally service the national market. Products can many times be shipped via package or parcel services, thus minimizing freight costs. Moreover, quality control considerations enhance the benefits of centralized production.

Labor

Skill requirements of the industry emphasize the rather unsophisticated machine tending, packaging, and shipping occupations. Maintenance requirements of a plant employing 100 could easily be handled by 2 or 3 skilled individuals. Tool and die requirements, more than likely, will be farmed out to local services. As a result, the availability of a work force skilled in the production of plastic or powdered metal products is not a primary locational factor.

National wage patterns of the industry provided an average hourly earnings of $2.20 in 1965. When combined with fringe benefit payments, this element of operating expense accounts for as much as 88 percent of the geographically variable operating costs and is second only to market orientation as a locational determinant.

Many Appalachian locations offer direct payroll savings of 30 cents to 50 cents an hour over producing points positioned on the fringe of concentrated metropolitan markets. Adoption of prevailing fringe benefit patterns could add another 15 cents to 25 cents. Midpoint calculations then indicate annual wage savings for a 100-worker plant in the area of $125,000. This saving, however, must be balanced against increased transportation and customer service charges (if any) and market penetration differentials.

Sites

Site criteria of the industry are easily satisfied. Well-drained sites of 15 to 20 acres and utility services will satisfy most requirements. A rail siding is necessary for receipt of inbound materials as well as large volume, long distance outbound shipments. Neither water demand nor effluent disposal will create an unusual problem,and municipal facilities of most communities over 2,000 in population will be able to handle the requirements. Natural gas should be available for space heating and limited process needs.

Minimum development costs frequently run as the most important of site considerations.

Utilities

Differences in utility costs are of minor consequence. The level of demand on these services leaves little room for substantial cost savings, and geographical variances are usually insignificant.

The major utility consideration revolves around supply dependability. High speed, expensive, automated equipment makes downtime extremely costly. Not only are production losses and payroll costs encountered, but such interruptions may well involve set-up expenses of a fair magnitude.

Other Locational Factors

A relatively high investment in equipment and machinery dictate an awareness of state and local taxation policies on such items. Given equal consideration on other primary factors of location, new plants will move to the area where local taxation is restricted to real estate. Seldom, however, will tax considerations be proportionately great enough to overrule marketing, transportation, or labor factors.

State finance and equipment bonding plans will have much appeal, particularly in the field of plastic products. Since the industry is characterized by many small firms and profit ratios are generally low, private placement of debt is often difficult and premiums may be required. Revenue bond financing, based solely on the individual corporation's credit, will not be readily available to many of the smaller companies. Nevertheless, the judicious application of local subscription or mortgage financing procedures will allow most any locale to capitalize on new locational opportunities.

A heavy requirement for female labor will certainly draw attention to variances in state laws pertaining to their employment. These variances, as well as the effects of such other legislation as labor costs and working conditions, are well down the list of locational factors and will seldom play the role of a deciding factor.

Community size requirements for a new operation are not restrictive. While larger companies--establishing a sizable branch operation--will tend to gravitate to larger (10,000 to 40,000) towns with more fully developed amenities, this can in no way be considered axiomatic of the industry. Recent new plants, of equal size, can be found in communities of 1,300 to 181,000 population. The size of the community selected will more closely reflect management's personal preference than any established industry trend.

Many other factors will be of interest to the location-seeker, but few can be considered as determinants. Adequate tool and die services should be within one day's travel; however, ancillary industries, make-or-buy decisions, selection of vendors, and lead time in placing orders will have little effect on the final determination. Few companies will desire a dominant position in the community's industrial mix. Moreover, wage leadership is seldom possible and not more than a handful of firms are willing to pay the requisite price.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Plastic and powdered metal parts industries present little opportunity for public actions designed to foster Appalachian growth. The import of transportation considerations to the industry directs attention to furthering the development of highway facilities and services. Access to the East North Central markets is a must. Access to other centers of population is of almost equal importance.

Perhaps the most effective public action available, however, will be the results of industrial development efforts within the Region. A higher industrialization will mean new market outlets. Pharmaceutical or household chemical production is likely to attract a container manufacturer. Automotive and appliance assembly will almost certainly mean new industrial parts plants. Most consumer goods require packaging. In total, the development of an "internal market" holds out the largest potential for attraction of new plastic and powdered metal parts industries.

Since the addition of new facilities will naturally follow the development of new industry, plastic and powder metal products manufacturers are not directly sensitive to public investment policies and activities.

Appendix A

SELECTED INFORMATION SOURCES

Published Information

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(2) 1958 and 1963 Censuses of Manufactures, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

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Unpublished Information and Personal Contacts

(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(5) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 23—THE REFRACTORY METALS INDUSTRY

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian states must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically, the production of titanium, tungsten powder, and the ferroalloys of ferromolybdenum, ferrochrome, ferrovanadium, ferrocolumbium, and ferrotungsten.

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

The refractory metals have uses as additives to impart special qualities to basic steels or as pure metals where corrosion resistance and retention of strength at high temperatures are needed. The principal producers number less than 100, yet whole new structural design concepts rest on the alloys and other products of their furnaces.

Markets in spacecraft, missiles, electronics, and primary steel beckon for these products. Maintenance costs in chemical plants have been lowered because of their adoption in parts such as heat exchangers or pipes carrying corrosive fluids.

The common denominators of the group are few. The most common characteristic that can be applied to them generally concerns the advanced technology used in the reduction processes. Metals alloying uses place emphasis on eastern locations that can also provide good access to centers of metallurgical research technology.

Prominent centers of metallurgy and refractory metals are currently located in the Pittsburgh and Huntsville areas of Appalachia. And although there is no need for an over-the-fence orientation to steel producers, good liaison is a must for maintaining markets and satisfying customers.

Most reduction processes require high power consumption, and the availability of TVA power in selected areas of Appalachia supplies an incentive for locating there. Yet, mine mouth generation can extend the benefits of low-cost power throughout Appalachian counties.

I. PROFILE OF THE INDUSTRY

Introduction

The refractory metals include titanium, tungsten powder, and the ferroalloys of ferromolybdenum, ferrochrome, ferrovanadium, ferrocolumbium, and ferrotungsten.

Among the refractory metals, the most highly publicized has been titanium, a low-density, silver-white metal which provides resistance to corrosion and combines strength with lightness. Although 61 percent heavier than aluminum, the metal weighs only 56 percent as much as alloy steel, while its strength and hardness approach that of many alloy steels. Below 540 degrees centigrade, its strength-to-weight ratio exceeds either aluminum or stainless steel. Its resistance to corrosion promotes its use in chemical processing equipment.

The pure metal is produced from titanium sponge which is reduced from titanium tetrachloride, a volatile colorless liquid. Sponge is the metal product obtained from reacting the tetrachloride product with magnesium in the popular Kroll process, or sodium in a secondary process.

Another of the refractory metals is tungsten powder. The manufacture of tungsten powder now accounts for approximately 75 percent of all of the tungsten ore consumed in this country. Ferrotungsten and steel ingots consume the remaining 25 percent.

The growth of the business, which started shortly after World War II, has continued, except for setbacks in 1949, 1956, and 1963. Primary factors, several of them interrelated, behind this growth, are increased use of tungsten carbide cutting tools, military requirements, and broader uses of tungsten carbide.

Supply and demand require balancing during peacetime, but it appears that the U.S.A. will be dependent for some time to come on imported tungsten ore as the raw material for manufacture of tungsten powder.

Tungsten applications are based on its ability to retain hardness at elevated temperatures and its wearability--its melting point of 3410 degrees Centigrade (6170 F.) is higher than any other metal.

Ferroalloys give various alloy steels their respective qualities or serve important functions in the production of steel itself. The industry is closely associated with the iron and steel industry. Chromium, molybdenum, vanadium, columbium, and tungsten generally impart hardenability to steel.

Since refractory metals are parts of a broader industry classification, industrial statistics for employment, value added, and investment are not published. However, the important criterion from an area development standpoint is the industry's prospects for growth. Specific to Appalachia are the availability of water transportation, river sites, and low-cost power and fuels for energy generation.

Size

Three firms located in Henderson, Nevada; Astabula, Ohio; and Albany, Oregon constitute the producers of sponge titanium. Employment totaled about 2,000 in 1965, and the product value amounted to $45 million. In 1966, shipments should total over $50 million. Twenty-five firms produced tungsten, but continued to stay behind consumption needs of 11 million pounds in 1963. Projections for 1980 envision a demand of 25 million pounds. The ferroalloy industry is composed of 32 companies operating in 50 different locations, and 19 of these furnaces produce one or a combination of the ferroalloys referred to in this report. Total value of domestic ferroalloy shipments totaled $390 million in 1963. The mix approached 2 million short tons.

Products and Markets

Titanium

Titanium metal found a growing use in spacecraft and the missile industry. Use in military aircraft continued to show a percentage decline. Some reversal may be expected, however. The increased need for combat planes in Vietnam, the TFX orders, the SST prcject, and armor for the flying tank helicopter will add to the portion slated for military aircraft use.

Table 1.

End use of titanium metal 1/

	1963 Percent	1961 Percent
Military aircraft	52%	68%
Spacecraft	32	16
Commercial aircraft	9	13
Chemicals	4	3
Ordnance	2	-
Other	1	-
TOTAL	100%	100%

1/ Source: Mineral Facts and Problems, 1965, U.S. Department of Interior.

Selected Uses

Missile and space applications replaced military jet engines as the prime user of titanium. Sizable quantities were used in the Gemini spacecraft, the Titan III launch vehicle, and the lunar landing craft. Up to 50 tons of titanium may be used in the SST, the 2,000 mph aircraft. Skin temperatures at that speed are expected to reach 450 degrees Farenheit, and alternate aluminum materials lose most of their strength at that temperature. Titanium, in contrast, would be hardly affected by the heat. Present plans for 200 SST's would call for as much as 10,000 tons of titanium.

An expanding use in chemical processing appears to be one of the new growth areas. For example, one company willingly paid an extra $140 for a titanium heat exchanger used in cooling chlorinated brine. Because of longer life and less downtime, it expects to save $9,000 in replacement costs over 6 years. For similar reasons, a chemical plant being built at Charleston, Tennessee will use 1,750 feet of 3-inch titanium pipe and 500 feet of thin-wall 3-inch tubing.

The controversial TFX may use as much as 45,000 pounds of titanium. If the schedule of 1,000 planes is adhered to, a demand of 22,500 tons of titanium is forecast. The Minuteman missile uses 4,000 pounds in its second-stage casing alone. As much as 2,000 tons of titanium may be used there.

One company employs 100 miles of titanium tubing in a desalinization facility in St. Croix, Virgin Islands. A proposed desalinization plant in southern California projects the use of 3,000 tons of titanium.

Tungsten Powder

Tungsten powder products consist of two specific grades:

99 Percent Melting Grade (carbon-reduced)

Minimum tungsten content	98.80%
Maximum carbon content (free and combined)	0.25%

Premium Grade (hydrogen-reduced)

Tungsten	99.60%	Minimum
Carbon	0.20	Maximum
Lime plus magnesia	0.03	"
SiO_2	0.03	"
Mo	0.03	"
Fe	0.03	"
O_2	0.15	"

The principal uses of tungsten powder are as follows:

	Percent of total
Steel:	
High speed	18%
Hot work and tool	5
Alloy other than tool	4
High-temperature nonferrous alloys	6
Other nonferrous alloys	7
Tungsten metal:	
Wire rod and sheet	12
Other	7
Carbides:	
Cemented or sintered	33
Other (including cast or fused)	7
Chemicals	1
TOTAL	100%

The use of tungsten metal powder for the manufacture of cemented tungsten carbide is the largest application. This use has been influenced by a number of factors: increased machine tool activity, broader use of tungsten carbide in applications other than machine cutting tools, and direct military requirements.

The effect of increased machine tool activity is obvious and can be measured directly by metalworking production and shipments of machine tools. The principal cutting tool applications are broaches, drills, reamers, milling cutters, and shaper tools.

Tungsten carbide has many applications other than as metal-cutting tools. Two of rapidly increasing importance are for wear resistance and as rock drill bits. Many of the wear-resistance applications have been stimulated by the technique of hard facing or "flame-plating" with tungsten carbide in the form of welding rods or powder. Other fields of use are high-temperature applications and for chemical resistance. In the latter two fields, increased competition from titanium carbide and chromium carbide may be expected.

A direct military application of important physical volume is the use of cemented tungsten carbide as a core for high-velocity armor-piercing projectiles. Tungsten carbide provides high mass in a small projectile.

The importance of cast tungsten carbide relative to cemented tungsten carbide is less clear. Cemented tungsten carbide is made by powder metallurgy, using from 3 to 25 percent cobalt as a matrix metal. Some varieties also contain up to 10 percent tantalum carbide or titanium carbide, or both. Low molybdenum content generally is mentioned as an important requirement for tungsten powder to be used for cemented carbides. Both hydrogen and carbon-reduced powders are used. Some trade sources believe that the hydrogen powder accounts for the greater part of consumption.

The cemented product finds use as cutting edges in dies, and machine parts subject to wear. The largest market is machine tools. Significant quantities are also fabricated into carbide rock bits for the mining industry.

Cast tungsten carbide is made by melting down the ingredients in a graphite mold, using arc or induction heating. It is more brittle than cemented carbide and is not generally used for metal-cutting tools. It is used for wear-resistance applications, but principally for hard facing, as is also cemented carbide. Trade sources indicate that carbon powder is entirely suitable for cast carbide, although hydrogen powder may be employed.

For the manufacture of tungsten filaments, wire and fabricated forms of tungsten, metal of high ductility is needed. For these uses, the hydrogen-reduced powder is essential. It is estimated that about 19 percent of all tungsten powder production is consumed for these applications. At present rate of production, this amounts to 2 million pounds of powder per year. This may include heavy metal.

The use of tungsten powder for the manufacture of electrical contacts, such as automobile distributor contact points, is an established but small application of tungsten powder. These products are made by powder metallurgy techniques, using hydrogen-reduced powder.

Tungsten powder competes to some extent with ferrotungsten and scheelite in the manufacture of high-speed tool-steel ingots, magnet steel, heat-resisting steels, and stellite. Its competitive position depends on alloy requirements and the availability of high-purity scheelite. Substantial amounts of tungsten ore normally are charged directly to alloy steel baths. In the past, high-purity scheelite has so been used.

Carbon-reduced powder enters into the manufacture of high-temperature nonferrous alloys. Hydrogen-reduced powder is preferred for other nonferrous alloys used in diamond drill bit matrices, electrical contact points, and welding rods.

Ferroalloys

The markets for the ferroalloys in 1963 were as follows:

Table 2.

Consumption by end-use of ferroalloys as alloying elements in the United States, 1963 1/

	Short tons of contained alloying element				
	Ferro-chrome	Ferro-molyb-denum	Ferro-tung-sten	Ferro-vana-dium	Ferro-colum-bium
Stainless steel	127,766	1,027	-	32	217
Other alloy steel	45,550	1,007	119	1,500	194
Carbon steel	-	-	-	246	83
High-speed steel	1,064	323	306	279	1
Other tool steel	1,685	184	145	184	-
Gray and malleable iron castings	3,666	1,417	-	17	-
High-temperature alloys	5,258	135	29	16	147
Miscellaneous	1,826	463	8	28	14
TOTAL	186,815	4,556	607	2,302	656

1/ Source: Mineral Facts and Problems, 1965, U.S. Department of Interior.

Principal uses of ferroalloys and the alloys used were:

1. To deoxide - ferrovanadium.
2. To improve hardenability - ferrochromium, ferromolybdenum, ferrotungsten, and ferrovanadium.
3. To improve corrosion resistance - ferrochromium, ferrocolumbium, ferromolybdenum, and ferrotungsten.
4. For special magnetic or electrical properties - ferrochromium and ferrotungsten.
5. For high-temperature applications - ferrochromium, ferrocolumbium, ferromolybdenum, ferrotungsten, and ferrovanadium.
6. To increase strength - ferrochromium, ferromolybdenum, ferrovanadium, and ferrocolumbium.
7. To refine grain - ferrovanadium.
8. For toughness - ferrovanadium and ferromolybdenum.

Plant Ownership and Geographic Location

Titanium Sponge

The 3 national producers of titanium sponge located in Albany, Oregon; Astabula, Ohio; and Henderson, Nevada are corporate offspring of joint ventures entered into by chemical producers, steel producers, and refractory makers.

Tungsten Powder

In 1963, tungsten powder was produced at 19 locations in the United States. A large part of the production is captive and does not enter the commercial market. Principal producing locations and products include the following:

Euclid, Ohio:	Tungsten powder.
Cleveland, Ohio: (2 firms)	Powder for incandescent lamp filaments and tungsten phosphors used in fluorescent lamps.
Detroit, Michigan: (2 firms)	Powder manufacture of tungsten carbide and carbide cutting tools.
Niagara Falls, New York:	Tungsten powder
McKeesport, Pennsylvania:	Tungsten powder and tungsten carbides.
Latrobe, Pennsylvania:	Tungsten powder, heavy metal (a tungsten-rich alloy) and tungsten carbide cores for armor-piercing shells.
Washington and York, Pennsylvania:	Carbon tungsten powder and ferrotungsten.
North Chicago, Illinois:	Hydrogen tungsten powder, tungsten carbide, heavy metal, and fabricated tungsten metal.
Glen Cove, Long Island:	Hydrogen powder, synthetic scheelite and tungsten chemicals.
Ferndale, Michigan:	Tungsten powder and tungsten carbide.
Houston, Texas: (4 firms)	Crushed carbide powder.
Kenilworth, New Jersey:	Carbide powder.

Springfield, New Jersey:	Tungsten metal pellets.
Youngstown, Ohio:	Carbide powder.
Fallon, Nevada:	Carbide powder.
Whittier, California:	Carbide powder.
Towanda, Pennsylvania:	Powder and powder mill products.
Waukegan, Illinois:	Carbide powder.
Norwalk, California:	Crushed cast carbide powder.
Bloomfield, New Jersey:	Powder and powder mill products.

Ferroalloys

Most of the domestic industry capacity is found east of the Mississippi at points oriented to consuming steel centers, cheap electric power, and favorable transportation. Eleven companies operate 19 furnaces in 18 locations.

Plant Location	Product
Riverdale, Illinois	Ferrochromium
Langeloth, Pennsylvania	Ferromolybdenum
Beverly, Ohio	Ferrochrome
Washington, Pennsylvania	Ferromolybdenum, ferrotungsten, and ferrocolumbium
Woodstock, Tennessee	Ferrochromium
Brilliant, Ohio	Ferrochromium
Niagara Falls, New York	Ferrochromium, ferrotungsten, ferrovanadium, and ferrocolumbium
Calvert City, Kentucky	Ferrochromium
Charleston, South Carolina	Ferrochromium
Robesonia, Pennsylvania	Ferrotungsten, ferrovanadium, and ferrocolumbium
Newfield, New Jersey	Ferrovanadium and ferrocolumbium
Chattanooga, Tennessee	Ferrochromium
Rockwood, Tennessee	Ferrochromium
Alloy, West Virginia	Ferrochromium and ferrovanadium
Marietta, Ohio	Ferrochromium
Cambridge, Ohio	Ferrovanadium and ferrocolumbium
Vancorum, Ohio	Ferrochromium
Graham, West Virginia	Ferrochromium

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Consumption

Titanium

Titanium's unique capabilities held out a tremendous potential to the early producers. However, sharp fluctuations in demand, resulting in part from a heavy reliance on military markets, have produced a radical growth pattern with periods of vast overcapacity. Three tons of metal were produced in 1948. By 1955, 7,500 tons came out of the pots, and by 1957, a high mark of 17,200 tons was reached. Then, military markets evaporated and by 1958, production dropped to a low of 4,600 tons and in 1959, still lower. Ten producers were reduced to 3. And although output recovered to 6,700 tons in 1962, the glitter was rubbed off. Just as the situation began to improve, another producer announced the future closing of a facility.

In 1963, domestic production of sponge metal climbed 17 percent over 1962 to its second highest volume. Consumption including imported sponge leaped 24 percent above 1962 to 8,865 tons. Titanium ingots totaling 11,000 tons scored similar records. In the United States, rutile concentrate reached its highest output (11,900 tons) since 1956, while ilmenite concentrate, used chiefly for making titanium dioxide pigment, also achieved new highs (800,000 tons).

At that time, the 3 commercial producers of titanium sponge were located in Newport, Delaware; Ashtabula, Ohio; and Henderson, Nevada. Since then, the operation at Newport has ceased. Companies melting titanium to make mill products worked facilities at Torrance, California; Albany, Oregon; Henderson, Nevada; and Canton, Massillon, and Niles, Ohio. In addition to captive sponge metal operations, ingots and other shapes were cast in Albany, Oregon.

Annual sponge capacity for domestic producers totaled 14,000 tons in 1963. However, the closing of one plant in 1964 dropped capacity to 10,500 tons annually, compared to 1963 consumption of 8,865 tons, of which 1,468 were imported. New investment reported under "Investments" is boosting sponge production significantly.

Tungsten

Tungsten demand dipped 5 percent after registering a 23 percent gain in 1962. Production, consumption, and imports were all off in 1963. Yet, the spectacular jump in 1962 called for 12,000 tons, only 500 tons less than the Bureau of Mines 1975 estimate.

Ferroalloys

Production of ferroalloys totaled 268,152 short tons. The percentage of contained alloying element ranged from 66.08 down to 36.09. Consumption was shown previously. Production generally varies with steel ingot output. However, in some years, imports have been substantial since domestic supplies have often fallen short of needs. In 1963, imports of ferroalloys pinpointed in this report totaled 20,444 tons of alloying element content. At the same time, United States exports totaled 2,658 gross tons.

From 1962 to 1966, consumption of moly rose 40 percent, mainly because of its value as a steel alloy. Some high-speed steels contained a 9 percent molybdenum content. Molybdenum consumption increased slightly in 1963. The steel and chemical industries took 43 million pounds. Nearly 90 percent of the molybdenum used in the United States goes to the steel industry as an alloying material.

One estimate places ferrocolumbium additions to carbon steel at 25 million pounds. Since one pound or less of columbium per ton of steel gives steel improved strength, designers can use lighter cross sections in structural applications. Net savings obtained over carbon steel run as high as 35 percent.

Use of vanadium in steel accounts for 80 to 90 percent of the metal used. Since 1960, demand for vanadium has doubled to some 15 million pounds.

Profits

The 3 major producers of sponge reported varying profit pictures. One firm again suffered a loss, but it was reduced to $4 million in 1965. Another company showed a jump to profits of $288,000 on sales of $6.2 million in 1965, compared to profits of $22,000 on sales of $4.2 million in 1961. Net earnings per share were 17 cents and 1 cent for the respective years. The largest producer paid out $500,000 in dividends to each of its parent corporations in 1965 and $750,000 in 1966.

Of the leading independent refractory metals producers showing a profit in 1965, one showed a profit of $3.89 million on sales of $44.24 million, while another came in with a much lower ratio of $0.09/$23.23 million. The average return figured out to $1.54 million on sales of $28.69 million. Other companies in basic steel, chemicals, refractories, and nonferrous metals were also in the refractory metals business. However, profits-to-sales ratios for individual divisions are not available for inspection.

Investments

The 2 principal sponge producers showed the heaviest investment activity. The $50 million being poured into new facilities by one company includes $30 million rolling facilities in Toronto, Ohio (Appalachian Region) plus $6 million in forging and extruding facilities. The remainder was slated for increased ingot and sponge capacity in Henderson, Nevada. Ingot capacity will be up 50 percent to 18,000 tons per year. Sponge capacity at the same location will rise 60 percent to 16,000 tons per year by 1969.

The second largest producer, in a $70 million expansion move, pushed up sponge capacity from 2,000 to 5,000 tons per year in 1965, then to 7,500 tons per year in 1966. Since this producer, like the former, is integrated, a large part of the investment is directed toward additional billet making, forging, and ingot-melting facilities.

An Oregon producer, previously purchasing its sponge from Japan, now buys rutile for making its own sponge. The 1966 capacity of 1 million pounds of sponge is being augmented, and the company will have a 3-million-pounds-per-year capability by 1967.

A new entrant is spending $3 million on fabricating facilities at Akron, New York and Parkersburg, West Virginia. The Parkersburg operation will also include 1 million pounds of annual sponge capacity.

Although recent investment activity has been heavy, 1965 United States capacity was rated at only 23 million pounds, just 700,000 pounds above 1965 use.

One of the world's largest electric ferroalloy furnaces is under construction in Mason County, West Virginia. Power capacity of the 10-story facility will exceed 54,700 kva.

Employment

Production employment focuses almost exclusively on men. Present estimates place the work force at 2,550 in the production of titanium sponge. Newer processes such as the electrolytic operation in Henderson, Nevada are expected to reduce production requirements. However, labor cost will continue high because substantial man-hours are required in maintenance operations. Six leading companies in ferroalloys and powdered tungsten employ another 7,900 workers.

Locational Activity

Retrenchment from 1958 to 1963 was marked by a number of plant closings in titanium sponge production. By 1964, only 3 producers, one of these a captive operation, made sponge in the United States. Since that time, all 3 producers have expanded capacity significantly, and a new entrant is poised to set up sponge-making operations in West Virginia. Since the number of plants operating in the fractory metals field is limited, individual plant locations were pointed out previously.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Titanium Manufacture

Utilizing the Kroll process for commercial production, makers of titanium metal take a titanium mineral, generally rutile concentrate, chlorinate it to produce titanium tetrachloride, which is then purified and reduced to titanium metal with magnesium or sodium under an inert atmosphere.

Titanium tetrachloride is chlorinated in the presence of carbon. Coke and a finely ground titanium concentrate are fed into a chamber where gaseous titanium tetrachloride forms. The liquid is further purified through chemical treatment and fractional distillation.

The purified titanium tetrachloride is reduced to sponge metal by magnesium in an inert atmosphere of helium or argon. A reactor pot is loaded with magnesium ingots and heated to melt some of the magnesium. The lid is welded on, and titanium tetrachloride and helium feed into the sealed pot. Little additional heat is needed since the reaction is exothermic. As the reaction progresses, a tap on the bottom draws off molten magnesium chloride. Further heating draws off more magnesium chloride. Then the pot is cooled, the cover removed, and the metal sponge extracted.

In the sodium reduction process, sodium is added to the pot as a liquid. The tetrachloride is reduced and the sodium chloride removed at the final reduction. The metal forms needles, which must be purified by leaching with water.

In the magnesium process, purification of the sponge is carried out in 2 ways. By vacuum distillation, the residual magnesium and magnesium chloride are removed when a basket of sponge is placed in a partially evacuated retort and heated in an electric furnace to 1720°F. for 30 to 35 hours. The magnesium and magnesium chloride become volatized and condense in the upper part of the retort, leaving purified sponge in the basket.

In leaching, the sponge is placed in a rubber-lined steel tank. A diluted solution of hydrochloride and nitric acids leach the sponge and are then poured off gently. The purified sponge is washed with water and dried with a stream of air.

To produce one pound of sponge requires 2.5 pounds of rutile or concentrate of equivalent titanium dioxide content, 5 pounds of chlorine, 1.25 pounds of magnesium, and about 0.9 cubic feet of helium or argon. If the sodium process is used, 2.5 pounds of sodium replace the magnesium. Power requirements approximate 6 kilowatts.

When recovery operations are also carried out to save magnesium, sodium, and chlorine, only one pound of chlorine, 0.2 pounds of magnesium, or 0.4 pounds of sodium are needed in addition to the amounts recovered. However, power use jumps to 15 kilowatts.

Generally, manufacturers produce titanium ingots by arc melting, using consumable electrodes. Pressed to form semicylinders, the sponge, sometimes combined with alloys and scrap, is welded together to form a joined electrode. The heat of the electric arc between the electrode and the metal in the crucible melts the material. To insure homogeneity and soundness in the eventual mill product yield, 2 melts are employed. Ingots as large as 30 inches in diameter and weighing 8,500 pounds are fashioned in this manner.

Further processing of ingots into mill shapes or castings is carried out by firms often specializing in a particular type of fabrication or custom alloys.

Manufacture of Tungsten Powder

Tungsten is found in nature as tungsten oxide combined with iron and manganese oxides (wolframite), or combined with calcium as calcium tungstate (scheelite, named after its discoverer, C. W. Scheele). As mined, the tungsten bearing compounds seldom exceed 2 percent of the total ore, making necessary a concentration process to upgrade the ore to approximately 70 percent tungsten trioxide content. A typical process involves fine grinding of the ore concentrate, digestion in hot caustic, crystallization of the filtered sodium tungstate solution, precipitation as tungstic acid, conversion to ammonium paratungstate to remove the last traces of impurities, then air firing to tungsten trioxide.

Tungsten trioxide is charged into a furnace with a hydrogen atmosphere and reduced to metal powder. The metal particles range in diameter from 0.2 to 10. microns. By specialized techniques, particles as large as 200 microns can be made. The particle size and size distribution are vital factors in the physical and mechanical properties of both metallic tungsten products and cemented tungsten carbides. Particle size is maintained within tenths of microns on its powders by close control of such factors as reduction rate, hydrogen, and temperatures.

Manufacture of Ferroalloys

Ferromolybdenum is produced in an electric arc furnace from a charge consisting of 9 parts of technical grade molybdic oxide, 2 parts iron, 1 part coal, and 1.6 parts lime. Ferrochromium is made by direct smelting of ore, quartz, and coke to make ferrochromium silicon which is then crushed, mixed with ore, lime, fluorospar, and refined in an open arc furnace. Ferrovanadium forms from a reduction of carbon, a technical grade vanadium pentoxide, steel scraps, coke, and fluxes in an electric furnace. In the manufacture of ferrotungsten, a concentrate is reduced in an electric furnace with carbon or silicon. Ferrocolumbium is also made in an electric furnace, using columbite ore, silicon, and fluxing agents to form the furnace charge.

Technological Trends in Titanium Production

A substantial research effort has been aimed toward developing economic methods that will permit the production of a material from ilmenite having a high titanium dioxide content that could be chlorinated to make titanium tetrachloride as easily as from rutile. Rock deposits have a higher content of titanium than sand deposits from which rutile is generally concentrated. However, as demand increases, a more economic processing method of chlorinating ilmenite will be needed to successfully tap these rock supplies.

Despite many improvements in the Kroll process, it remains a batch operation, and it is unlikely that the method can be made continuous. Some research being carried out is focusing on the electrolytic process which may be acceptable to continuous operation. However, problems necessitate a complicated and expensive cell design.

Yet, out in Henderson, Nevada, a breakthrough in sponge production appears imminent. The first commercial plant utilizing the electrolytic process is scheduled to come on-stream. A departure from the Kroll magnesium or sodium reduction of titanium tetrachloride, the electrolytic procedure will mark a major operational change from batch production to continuous production. The company there expects this new development to exert a significant influence on the price and quality of titanium.

Although the exact details are under wraps, a similar research effort uses a lithium-magnesium salt mix as the electrolyte. This salt mix is expensive, but it was selected because operating temperatures must be kept low to reduce the corrosive effects of the process. Reasonable speculation points to the use of a less expensive salt in the commercial process with operations conducted at a temperature higher than 500 degrees Centigrade. A new corrosion-resistant refractory lining permits such an adjustment.

The continuous process separates the titanium tetrachloride, gathering titanium at the cathode and chlorine at the anode. While the cell remains in operation, the cathod is alternately pulled and cleaned of deposited titanium.

Raw Materials

Titanium Sponge

Australia produces most of the world's supply of rutile. In 1963, 203,800 short tons were concentrated there. World output totaled 220,100 short tons, with the United States (11,915 short tons) taking second place. Ilmenite production amounted to 2,222,000 short tons, of which 888,000 tons were accounted for by the United States.

Of the 33,325 short tons of rutile used in the United States in 1963, 14,021 tons were for titanium metal, with the largest segment (16,465 tons) of the remainder directed towards coating welding rods. Virtually no ilmenite was processed into metal, although manufactured titanium dioxide made from ilmenite or slag could be chlorinated to make titanium tetrachloride. However, economic justification is lacking. Financial and technical problems rear up. Nevertheless, extensive Canadian hematite-ilmenite deposits could provide the raw material source. In the Soviet Union, which has an estimated capacity of 10,000 tons per year, plants at Zaporozhe in the Ukraine and Ust-Kamenogorsk, east of the Urals, utilize their rich Ukrainian ilmenite materials deposits to make a good quality sponge.

In America, 7 companies mined and concentrated ilmenite and rutile at Piney River, Virginia; Starke and Lawtey, Florida; Lakehurst, New Jersey; Tahawus, New York; both rutile and ilmenite at Beaver Dam, Virginia; Vero Beach, Florida; and Skinner, Florida; and rutile alone at Jacksonville, Florida.

One raw material operation, having the largest potential, is carried out at Allard Lakes, Quebec where ilmenite-hematite ore is mined. The ore is smelted at Sorel, Quebec to make a high titania slag used for making titanium pigment by the sulfate process.

In a national defense emergency where cost factors would occupy a position of lesser importance, the titanium slag which has a 70 percent titanium content could be utilized for metal production. Ilmenite concentrate could also be used as in the U.S.S.R.

It should be noted that some of the raw material sources such as Amherst and Nelson counties in Virginia and areas near Aiken, South Carolina have good orientation to Appalachian regions.

Tungsten Powder

A large part of tungsten powder production appears to be based on imported tungsten concentrates for the following reasons:

1. Imported concentrates are cheaper.

2. Domestic production of tungsten concentrates is inadequate.

3. Much of United States production falls short of purity requirements.

4. High-purity domestic scheelite commands a premium for direct steel bath additions.

The chief tungsten ores are scheelite (calcium tungstate), huebnerite (manganese tungstate), wolframite (iron-manganese tungstate), and ferberite (iron tungstate). The commercial term "wolframite" covers a range of compositions from ferberite to huebnerite, most "wolframite" being intermediate in composition.

Scheelite is found in many countries, the largest deposits being in Korea, United States, Brazil, and Australia.

High-grade wolframite is the principal tungsten ore of China, which has tremendous reserves. Burma has substantial reserves. Bolivia has reserves which are small as compared with Burma. Some has been found in Belgian Congo. It is a minor ore in the U.S.A.

Heubnerite is often found in combination with scheelite and wolframite. In the U.S.A. it is a premium ore found in Patterson, Idaho and in North Carolina.

Ferberite has random occurrence but is not an ore in plentiful supply. Portugal is a principal source. Some is found in the U.S.A.

Ferroalloys

For 20 years the United States has been the largest producer of vanadium ore. Most of the output comes from the Colorado plateau area. However, additional economic sources will be needed, and South Africa may provide the most economical foreign source.

A growing shortage of vanadium shows signs of intensifying with the depletion of releasable material from United States strategic stocks. Planned production of a new plant in the Transvaal of South Africa up to the year 1972 has already been committed. Possibilities of future releases from stockpiles providing a large balancing factor appear slim since surpluses are down to 12 million pounds.

More than half of the world's supply of molybdenum has come from a single mine in Climax, Colorado since 1925. Other sources growing in importance are copper ores. In recent years, one-third to one-half of the world's annual output has been obtained as a by-product of copper in the United States, the U.S.S.R., and Chile.

An open pit mine near Questa, New Mexico has a moly ore throughput of 11,250 tons per day. Investment in the operation totals $44 million. Another company has budgeted a 5-year, $80 million expansion program at Climax, Colorado, adding 3 million pounds a year capacity; by 1967, a $25 million project will bring a new Colorado mine into operation with moly output expected at 7 million pounds per year. Two other projects also expect to come on stream--one in British Columbia rated at 4.5 million pounds in early 1966 and, as a by-product of Chilean copper operations, an additional 9.6 million pounds a year.

Norway, Canada, Brazil, Nigeria, Malaysia, and the Congo are the principal columbium ore-producing areas. Some intermittent domestic production came from pegmatite deposits in New Hampshire, North Carolina, New Mexico, Maine, and Colorado. Since 1960, there has been no domestic production of columbium concentrate.

Turkey, with an estimated reserve of 10 million tons, has been a major source of high-grade chromite. Reserves of 2 billion tons in South Africa and 600 million in Southern Rhodesia place the large portion of the free world's supply in Africa.

IV. PRIMARY FACTORS INFLUENCING THE SELECTION OF LOCATION

Introduction

Although divergent in many particulars such as ore supplies, chemical composition, specific comparative use advantages, and alternating periods of growth, slack, and resurgence, the refractory metals find a common denominator in primary factors of location.

Transportation facilities, markets, energy requirements, sites, and access to technological support are the chief locational determinants. Among these, however, there will be some opportunities for trade-offs. Labor, although a high-cost constituent, appears to provide little opportunity for cost reductions through geographical shifts in plant location since so much of the labor cost focuses on highly specialized maintenance efforts and professional-like metallurgical capabilities. Furthermore, the industry is highly organized and generally follows national patterns.

Transportation

Ore concentrates are available generally at respectable distances from consuming centers. Much of it is imported. Supplies from central Rocky Mountain areas would move by rail, but overseas shipments can move cheaper to smelters by transfer to river barge at ports of entry.

Two great river systems serve much of Appalachia--the Ohio and Tennessee. In addition, development currently under way on the Alabama-Coosa River and the Chattahoochee River Basin System will soon provide additional access to other areas of the Appalachian Region. Another river system experiencing heavy barge ore traffic is the Black Warrior in Alabama. Heavy movements of beneficiated Venezuelan ore move up the river to Port Birmingham and the great steel center there.

Overseas refractory concentrates landing at New Orleans can move up the Mississippi to the Ohio on to potential refractory metal-producing areas in Pennsylvania, Ohio, West Virginia, and Kentucky. Similar sailings could enter the Tennessee at Paducah, Kentucky for destinations in northern Alabama and eastern Tennessee. These latter areas will find their potentials enhanced by the 253-mile-long, 316 million dollar waterway connecting the Tennessee River to the Tombigbee. Tentative approval was given October 31, 1966 for this project. A direct navigable route from the port of Mobile would be provided to the Tennessee River cutting many miles from the circuitous Mississippi, Ohio, Tennessee river routing.

The Chattahooche River Basin project will eventually reach to east central and northwest Georgian Appalachian areas. To cite one example, rutile concentrate from Florida could be barged along the intercoastal waterway to Apalachiola, Florida and proceed up the Chattahoochee without transfer.

Overseas ore shipments landing in Mobile have river barge access to west central Alabama areas. Traffic up the Mobile, Tombigbee, and Black Warrior rivers would follow the present course of iron ore shipments destined for Birmingham. Access up the Mobile River to the Alabama-Coosa River System is now clear to about 23 miles of Appalachian regions in central Alabama. Present plans for improvements to the Coosa River portion of the system will provide entrance to the broad Appalachian area in east central Alabama.

Although river systems do exist in the East, underdevelopment of this water resource blocks barge penetration from east coast points.

Penetration into West Virginia extends 90 miles up the Kanawha River from its confluence with the Ohio. From its mouth at Pittsburgh where it joins the Ohio, the Monongahela provides a 9-foot channel for 115 miles, 13 short of Fairmont, West Virginia.

It can be seen that wide latitudes of the Appalachia Region can benefit from low-cost barge transportation of bulk materials. Comparative figures indicate that barge transportation costs will amount to 74 percent of rail costs. Furthermore, the existence of barge traffic will serve to reduce rail tariffs for bulk shipments. Comparative ore rates in one instance work out to \$0.0054 per ton per mile by barge and \$0.0086 per ton per mile by rail.

With substantial shipments arriving from overseas (see Table 3), the advantage of low-cost barge transportation becomes apparent.

Table 3.

Imports for consumption, 1964 1/.

Commodity and origin	Net quantity
Tungsten ore	3,148,244 CLB
Canada	37,532
Latin America	1,874,893
Western Europe	467,270
Asia	629,785
Oceania	115,358
Africa	23,406
Chrome ore (not more than 40% chromic oxide)	75,089 CTN
Western Europe	6,116
Asia	63,957
Africa	5,016
Chrome ore (more than 40% but less than 46% chromic oxide)	203,253 CTN
Western Europe	20,090
Asia	2,150
Africa	181,013
Chrome ore (46% or more chromic oxide)	298,170 CTN
Western Europe	16,087
Sino-Soviet European countries	145,357
Asia	1,666
Africa	135,060
Columbium ore	4,600,000 LB
Canada	1,940,133
Latin America	35,478
Western Europe	135,183
Asia	70,677
Africa	2,419,329
Molybdenum ore	94 CLB
Canada	94
Ilmenite	239,637,539 LB
Canada	182,993,315
Asia	22,400,000
Oceania	34,244,224
Titanium ore	221,962,125 LB
Oceania	221,962,125
Vanadium ore	41,130 CLB
Western Europe	41,130

1/ Source: U.S. Imports for Consumption and General Imports, 1964, U.S. Department of Commerce.

Notes: LB-pounds, CLB-contained pounds, CTN-contained tons.

Markets

Markets, principally for the ferroalloys, are found among producers of primary steel. Below in Table 4 are tabulated the blast furnaces and steel mills well within marketing reach of refractory metals producers in Appalachia. The high value and compactness of refractory products incur proportionally low shipping charges. Advantages come not so much from reduced freight costs as from liaison with customer metallurgists.

Table 4.

Blast furnaces and steel mills 1/

State	Total	Employing over 250
New York	19	11
New Jersey	4	3
Pennsylvania	82	57
Ohio	35	29
Delaware	1	1
Maryland	4	3
Virginia	13	1
West Virginia	7	4
North Carolina	2	-
South Carolina	1	-
Georgia	1	1
Kentucky	5	4
Tennessee	5	2
Alabama	14	7
TOTAL	193	123
UNITED STATES TOTAL	288	178

1/ Source: 1963 Census of Manufactures, U.S. Department of Commerce.

One case in point should be mentioned. Continuous casting, which appears to have the necessary attributes to revolutionize much of steelmaking, could open new markets for vanadium. In addition to making better and cleaner steels, vanadium overcomes various mechanical difficulties in pouring the molten metal. Estimates place potential consumption at 2 pounds of vanadium per ton of finished steel. By 1970, continuous casting of steel should reach 20 million tons per year.

Energy Requirements

The principal energy requirement is for electric power used in the electric furnace. Supplementary heat to start a reaction to make sponge may be obtained from gas, or the plentiful coal supplies in the Appalachian Region.

Titanium sponge uses 15 kwh per pound of product when recovery of magnesium and chloride is included. Without secondary recovery of these chemical products, power consumption runs about 8 to 9 kwh per pound of sponge. In an integrated plant where ingots are also produced, 2 kwh per pound of ingot would be added to the load. Total power needs from rutile to ingot amount to approximately 17 kwh per pound. For comparison purposes, aluminum demands 8 kwh per pound of output. Other ferroalloys are less demanding. Ferrochromium needs 2 kwh per pound of product.

Power rates in the Pacific Northwest are lowest, while those in the industrial Ohio River Valley will approximate 4.5 mills per kilowatt hour. A titanium plant producing 6,000 tons of sponge per year would have an annual power bill of $810,000 at a 4.5 mill operating rate. An effective mill rate of 4.2 to 4.25 would probably be obtainable in TVA territory, resulting in an annual savings of $50,000.

A possibility of further power cost reduction in the region could stem from a mine mouth power cooperative formed by a number of high-power-using industries. Savings of $100,000 a year might be possible over the 4.5 mill Ohio Valley rate.

Site Requirements

River sites permitting a 9-foot draft and served by rail will be a prime requirement for efficient operation. Previously, the advantage of barge delivery of raw material was stressed, and a 26 percent transportation cost advantage was projected. In one situation, an attractive site within 10 miles of a river was available. However, the comparative transportation cost advantage was reduced to only an 8 percent advantage by moving the plant location this 10 miles. Short haulage charges lost practically all the barge movement advantages.

The site of 150 to 200 acres should be flood-free. Suitable power supply facilities capable of meeting heavy loads should be nearby. To determine power reliability, a record of outages must be inspected. Desire for a looped system may also prevail.

Technological Support

Areas in the north of the Appalachian Region centering on Pittsburgh and areas oriented towards Huntsville or Atlanta can call upon university-oriented technological help. In addition, technical societies meeting in these areas provide an exchange of ideas and experiences. The large concentration of primary metal producers also provides a vast storehouse of technological exchange.

Labor Considerations

To operate a plant with economic capacity will require between 400 to 900 men. However, the exact determination depends on the particular refractory to be produced and the operations capacity. For example, titanium sponge production may call for the staffing equivalent of 0.15 persons per ton of production.

Wages paid will be close to basic steel or nonferrous metals patterns. A total average hourly labor cost including fringe benefits will work out to more than $4.00 per hour. In 1965, average hourly earnings just nudged the $3.00 mark.

Because of heavy organizing activity in the primary metals industry, wage differentials will not play a major role in most locations. However, in isolated instances, a new entrant may operate on a nonorganized basis and achieve considerable labor savings. For example, one plant of 300 workers has an annual labor cost advantage of $690,000 over its principal competitor.

Other Locational Determinants

A high percentage of technical, managerial, and professional personnel demands an area offering advantageous living conditions. The lack of adequate educational facilities, housing, or other community services will often directly result in recruiting difficulties. However, in general, the sophistication at the smelter is not as demanding or sizable as that found in the fabricating area of exotic metals. Thus, more comparative locational leeway exists.

Community size will vary, the important criterion being level of expected services. Community cooperation, availability of supporting services, and ancillary industries are moderating locational factors. Make-or-buy decisions are of no consequence. Process water is assumed to be available at a river site.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

Transportation, power, and markets are the location vectors laying first claim on the refractory metals industry. Public health, land stabilization, erosion control, forestry development, and land use planning would provide nothing in the way of an attraction. However, 2 areas of activity beneficial to the industry present themselves.

Transportation

It may be remembered that no penetration of eastern Appalachian regions by barge traffic was possible. A program of river development along the east coast would open barge lanes from seaports to a 4-state area.

Presently, the central part of Pennsylvania, which is drained by the broad Susquehanna, is without barge transportation. The same can be said for the state's eastern region where it borders the Delaware. In the South, the Savannah River, if channelized, would provide entrance from the port of Savannah to Appalachian locations in Georgia and South Carolina.

Extending a 9-foot channel on the Cumberland River to Burnside, Kentucky would augment the relatively good position of western and southern Appalachia for barge transport. However, completion of the Tombigbee-Tennessee connection should probably have the first priority, since it can provide immediate benefits to industries already located in the Appalachian Region.

Research

Over the past 3 years, expenditures by the Bureau of Mines for research programs continued to grow. During 1964, the $31 million in research obligations provided by the Bureau were divided--$19 million for applied research, $3.6 million for basic research, and $8.9 million for development. Total research funds obligated by the Federal government for metallurgy and material research totaled $201 million. Increased funneling of these funds to Appalachian regions would serve to stimulate an awareness of the area's mineralization.

In the Bureau of Mines, the Office of Mineral Exploration has matching funds for mineral exploration. An adjustment of the 50/50 ratio (e.g.70/30) for exploration within the Appalachian Region might well serve to expand operations in the area.

Additionally, ARC cooperation with the Bureau of Mines and other interested parties could result in the study of new production processes utilizing Appalachian ores. Such studies should be completed through the pilot plant stages. Worthy of note, the titanium sponge operations at Henderson, Nevada and Albany, Oregon are proximate to the Bureau of Mines Metallurgical Research Laboratory at Boulder City, Nevada and the Bureau of Mines Electro-Development Experimental Station at Albany, Oregon.

In areas not served by TVA power, area industry cooperatives, supported by Federal research funds, could be specifically aimed at more efficient coal utilization in power generation and provide the impetus for lower industrial power rates.

Appendix A

SELECTED INFORMATION SOURCES

Published Information

(1) U.S. Imports for Consumption and General Imports, Annual 1964, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

(2) 1963 Minerals Yearbook, Volume 1, Bureau of Mines, U.S. Department of Interior.

(3) County Business Patterns, 1964, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

(4) Employment and Earnings Statistics for the United States, 1909-65, U.S. Department of Labor, Bulletin No. 1312-3, Washington, D.C.

(5) Road Maps of Industry, May, June, and July 1966, National Industrial Conference Board, New York.

(6) Investment Statistics, Quarterly Survey Capital Appropriations, 1959-1965, National Industrial Conference Board, New York.

(7) Annual reports for individual companies.

(8) Mineral Facts and Problems, 1965, Bureau of Mines, U.S. Department of Interior.

(9) Moody's Industrial Manual, 1966, Moody's Investors Service, Inc., New York.

(10) Corporation Income Tax Returns, July 1962-June 1963, Internal Revenue Service, U.S. Treasury Department.

(11) Standard Listed Stock Reports, 1966, Standard & Poor's Corporation, New York.

Unpublished Information and Personal Contacts

(1) Dun and Bradstreet Data Bank.

(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(5) Labor union contracts.

INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 24—THE PRIMARY STEEL AND STEEL MILL PRODUCTS INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian states must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such family of industries, specifically those included under Standard Industrial Classification industry code 331, Steel Works, and Rolling and Finishing Mills.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

Although much has been written about the steel industry and its locational requirements, the industry's current high rate of capital expenditure, both within and outside of Appalachia, demands consideration in any program designed to foster regional industrial development.

Appalachian specialization in steel production is high. While growth projections for the overall industry appear at a somewhat unimpressive 2.5 percent, substantial investment will undoubtedly occur as obsolete facilities are replaced by new and more efficient equipment. Product coverage in the northern production center is extremely comprehensive. New private investment, over and above that designed strictly as modernization programs, will tend to gravitate to those production centers where an incomplete product mix is hampering market penetration. The southern district, therefore, presents the greatest potential for growth.

Definition of the steel industry, as used in this report, covers all segments of the Standard Industrial Classification (SIC) 331 "Steel Rolling and Finishing". Member companies of the American Iron and Steel Institute (accounting for 94 percent of steel capacity) employed an average of over 583,000 in 1965. Their shipments in that year ran to 88.2 million net tons of finished steel products.

Carbon steel accounted for over 90 percent of 1965 product shipments. Alloys (other than stainless) claimed 8.3 percent, and stainless steels ran to a small but significant 0.9 percent. Markets covered a broad range with the automotive industry consuming 21.5 percent of total output, and construction requiring 12.6 percent. Alloy and stainless steel markets vary somewhat from the foregoing, generally exhibiting increased emphasis on industrial machinery, equipment, tools, and construction purposes. Just under one-half of the stainless steel products are sold through service centers and distributors.

The 8 largest integrated manufacturers of the industry controlled over 75 percent of 1965's total steel output, while the industry's leader alone accounted for 24.8 percent. Firms specializing in the "specialty" steels fall farther down the ranks in terms of ingot production. Largest of these producers ranks twenty-third in ingot production but demands a respectable ninth place in terms of dollar sales.

Although 31 states have representatives of the steel industry, substantial production concentrations are found in no more than 8. When broad product classifications are grouped into 25 general categories, Pennsylvania and Indiana alone can boast complete coverage. Illinois, Ohio, California, New York and Alabama follow in that order, while 3 states produce no more than 1 product.

Economic impact of the steel industry is substantial. Wage payments, inclusive of premiums, average over $3.80 per hour and when consolidated with salaried employees, jumps to $4.05. High freight costs tend to attract consumers to close proximity of the supply source. Product requirements must be considered, however, and those centers exhibiting the most comprehensive product mix will provide the greatest potential for attracting new metal-working firms.

In 1966, the industry's production is expected to net a new record--something exceeding the 131.2 million tons of 1965. Although the long-term growth projection stands at the above noted 2.5 percent annual rate, such product lines such as stainless steel, silicon electric steels, the more exotic superalloys, and magnetic materials fall between 5 and 15 percent.

Industry profitability reached the low point in 1962 but now appears on the upswing. Modernization of plant and equipment is providing substantial production economies, and selected price increases are aiding the overall profit picture.

As productivity continues to improve at a rate substantially in excess of the total annual growth in production, automation is expected to reduce total industry employment. Nonetheless, specific growth areas of the industry, as noted in the foregoing, should provide a somewhat brighter picture.

The industry is expected to spend close to $2.3 billion in 1966 in the way of new capital investment. These investments generally emphasize quality of product and, once again, frequently entail modernization as opposed to the addition of new capacity. Accordingly, much of this investment is aimed at established production centers. Nonetheless, where a sufficient market can be demonstrated, new production facilities will be established.

Technological advances within the industry played a significant role in providing improved productivity. Outstanding improvements are found in the area of basic oxygen processing, continuous casting, and vacuum degassing. Each of these, however, will contribute to the general decline in employment.

While steel has lost some markets to such competitors as aluminum and plastics during the past years, it is now beginning to fight back. Research and development efforts are coordinated with new marketing techniques as the industry strives to anticipate consumer needs. A broad range of new products are designed to regain lost markets or to protect existing outlets. The basic properties of steel serve to insure its continued position as a critical raw material.

The case for new primary steel capacity in the southern Appalachian Region turns on the expanding markets for stainless and alloy steel which presently lack significant regional production. Both existing integrated mill locations and river sites situated deeper within the Appalachian Region provide opportunities for economic production to satisfy this growing market. Excellent orientation to raw material sources and either private or public supplies of low-cost power for electric arc melting furnaces enhance the region's potential.

Principal public policies which may stimulate more immediate steelmaking capacity relate to aids for helping manufacturers achieve the required air and water pollution controls. In addition, commission policies directed towards reopening the investment tax credit laws on a selective basis or policies aimed towards the protection of the regional market from cheaper foreign products are discussed.

I. PROFILE OF THE INDUSTRY

Introduction

Much has been written about the steel industry. Many articles provide a fairly comprehensive and reasonably accurate analysis of locational patterns and requirements. Nonetheless, any program designed to further development of the Appalachian Region must give full consideration to this industry--one which invested $1.5 billion in 8 of the Appalachian States during the past 4 years.

That Appalachia claims 2 of the oldest and very significant centers of steel production is well known to all. Regional specialization is high. Moreover, the vast sums expended by the industry each year for new plant and equipment multiply its attractiveness for Appalachia.

Significantly, the very same specialization factors which demonstrate the potential for operating satisfaction in Appalachia can also work against the region. As the industry becomes increasingly market oriented, the flow of new private investment will tend to gravitate to those production centers where an incomplete product mix is hampering market penetration. To successfully further the development of steel production in Appalachia, a new and more specific approach must be made to those controlling the flow of capital investment funds.

In general, industry representation in northern Appalachia exhibits a high state of development and a comprehensive range of products. Thus, investment in this area will basically follow the trend to replacement of obsolete facilities. Resulting productivity improvements could well mean an overall decrease in industry employment. This can best be countered by an alertness of public action groups to new growth products and production voids within the markets serviced from the area. Some public investment opportunities are available which would certainly benefit the profitability, and thus the industry's long-term operating satisfaction within the area. These will be discussed briefly in Section V. Nonetheless, it is doubtful that this area will experience any noteworthy expansions of primary capacity in the near term.

Southern steel production provides the greatest opportunity for furthering development of the industry. Many areas of the rapidly growing industrial Southeast suffer from severe freight penalities on certain steel products. An analysis of product mix points up many production voids, while rudimentary calculations of steel consumption highlight the increasing demands of the area. Here stands the greatest potential for Appalachia.

Size

The steel industry, for the purposes of this report, is defined as those industries covered under Standard Industrial Classification (SIC) 331 "Steel Rolling and Finishing". Included therein are the following 4-digit industries: Blast furnaces and steel mills (SIC 3312); Electrometallurgical products (SIC 3313); Steel wire drawing, etc. (SIC 3315); Cold finishing of steel shapes (SIC 3316); and Steel pipe and tube (SIC 3317).

By definition, SIC 3312 encompasses a wide variety of operations ranging from coke ovens, through steel producing facilities, to fabricating activities. Accordingly, a precise breakdown between primary metal and rolling and fabricating data is not afforded by the standard governmental sources. Nonetheless, a comparison can be made among the overall steel industry and the ranking durable goods fields (see Table 1). Significantly, the steel industry (SIC 331) as a separate entity ranks well in employment and value added by manufacture. In terms of new capital expenditures, it takes second place only to the total primary metals industry (SIC 33).

More precise data, available from the American Iron and Steel Institute, indicate that member companies (accounting for 94 percent of steel capacity) had a total average monthly employment of 583,851 in 1965. During that year, these companies produced 123.3 million (net) tons of steel and shipped over 88.2 million (net) tons of finished steel products.

Table 1.

Rankings of the durable goods industries, 1964 1/

(Numbers in millions)

Industry rank	Employment		Value added by manufacture		Capital expenditures	
1	Transportation equipment	1.62	Transportation equipment	$23,971	PRIMARY METALS	$1,887
2	Machinery	1.54	Machinery	19,762	Transportation equipment	1,297
3	Electrical machinery	1.48	Electrical machinery	18,039	Machinery	946
4	PRIMARY METALS	1.18	PRIMARY METALS	16,732	Electrical machinery	889
5	Fabricated metals	1.12	Fabricated metals	12,636	Fabricated metals	728
6	Stone/clay/glass	.58	Stone/clay/glass	7,520	Stone/clay/glass	626
7	Lumber/wood	.56	Lumber/wood	4,361	Lumber/wood	369
8	Furniture	.39	Instruments	4,333	Instruments	165
9	Instruments	.31	Furniture	3,225	Ordnance	117
10	Ordnance	.23	Ordnance	2,871	Furniture	106
	PRIMARY STEEL & STEEL MILL PRODUCTS 2/	.60	PRIMARY STEEL & STEEL MILL PRODUCTS 2/	9,422	PRIMARY STEEL & STEEL MILL PRODUCTS 2/	1,363

1/ Source: 1964 Annual Survey of Manufactures, U.S. Department of Commerce, and Fantus Area Research estimates

2/ SIC 331

Products and Markets

Standard steel product classifications first differentiate between carbon, alloy, or stainless steel materials and then break down into separate product categories--i.e., structurals, plates, sheets, wire, etc. Shipment data for 1965 demonstrate the relative significance of the 3 material classifications:

	Percent of total steel products (net) shipments
Carbon	90.8%
Alloy (other than stainless)	8.3
Stainless and heat resisting	.9
	100.0%

A further breakdown into primary product classifications is provided in Table 2.

Markets serviced by the steel industry cover the broad range of metalworking fields, including industrial, consumer, military, and construction outlets. As will be noted in Table 3, the second largest market (over 17 percent of net mill shipments) is classified as service centers and distributors. Such outlets serve the same basic range of end-users as do steel producers themselves. Service centers purchase stock in volume quantities and usually perform certain small scale finishing operations, e.g., cutting and slitting. Primary advantages afforded the consumer include immediate delivery and, frequently, a price advantage on smaller orders. Moreover, the delivery considerations allow optimization of inventory levels.

Table 2.

Steel shipments in 1965 by material and product classifications 1/

(Net tons)

Steel products	Carbon	Alloy: Full alloy	Alloy: High strength low alloy	Stainless: Stainless steel	Stainless: Heat resisting
Ingots & stl castgs	208,245	154,051	13	3,978	-
Blooms, slabs, billets, etc	2,093,580	554,561	711	45,972	1,643
Tube rounds	12,830	3,308	9	73	2
Skelp	110,801	-	-	-	-
Wire rods	1,279,270	44,286	-	13,957	-
Structrl shapes	5,787,412	6,518	370,681	92	-
Steel piling	615,466	-	-	-	-
Plates	8,572,532	349,072	774,065	67,553	1,076
Rails, whls, axles, etc	1,505,506	4,349	-	-	-
Bars-hot rolled	6,989,194	2,190,770	106,066	56,369	1,144
-reinforcing	3,149,564	-	-	-	-
-cold finished	1,514,271	275,153	-	86,903	734
Tool steel	N.A.	118,242	-	-	-
Pipe & tubing:					
-standard	2,512,807	-	-	-	-
-oil country goods	1,227,278	346,416	-	-	-
-line	2,080,431	-	697,066	-	-
-mechanical	739,762	389,008	-	3,831	-
-pressure	229,007	61,372	-	29,627	6,298
-structural	364,584	-	-	-	-
All other products	-	-	-	-	566
Wire-drawn	2,776,245	37,153	-	27,784	-
-nails & staples	320,550	-	-	-	-
-barbed & twisted	106,623	-	-	-	-
-woven wire fence	111,914	-	-	-	-
-bale ties & baling	102,799	-	-	-	-
Blk, tin & terne plate	6,658,804	-	-	-	-
Sheets-hot rolled	10,215,308	12,001	364,418	38,581	-
-cold rolled	16,346,934	7,347	27,047	189,900	-
Sheets & strip galv					
-hot dipped	4,487,667	-	-	-	-
-electrolytic	361,949	668,346	-	-	-
-all oth metllc coated	570,923	-	-	-	-
-electrical	72,039	-	-	-	-
Strip-hot rolled	1,719,963	28,864	10,132	26,381	-
-cold rolled	1,274,155	28,849	2,115	276,695	-
All other products	-	12,950	23,660	11	-
TOTAL	84,118,413	5,292,616	2,375,983	867,707	11,463

1/ Source: Annual Statistical Report, 1965; American Iron and Steel Institute

Table 3.

Steel product markets by material classification 1/

(Percentages based on 1965 shipments)

Markets	Carbon	Alloy	Stain-less
Steel for converting & processing	4.4%	2.1%	7.4%
Forgings, n.e.c.	0.9	6.0	1.5
Bolts, nuts, rivets & screws	1.3	1.1	1.0
Steel service centers & distributors .	18.0	10.4	43.1
Construction - incl. maintenance	12.6	15.3	0.9
Contractor's products	5.9	0.5	2.7
Automotive	21.5	25.0	15.2
Rail transportation	3.8	7.2	0.2
Shipbuilding & marine eqpt.	1.1	1.5	0.2
Aircraft	0.2	0.9	1.5
Oil & gas drilling	0.3	1.8	-
Mining, quarrying & lumbering	0.4	0.7	-
Agriculture	1.7	0.7	0.1
Machinery, industrial eqpt. & tools ..	5.8	12.7	5.6
Electrical machinery	2.8	8.1	2.0
Appliances & utensils	2.5	0.1	5.7
Other commercial & domestic eqpt.	2.5	0.4	1.7
Containers, etc.	8.7	0.4	0.5
Ordnance & other military	0.3	0.6	0.6
Export 2/	2.2	2.5	6.2
Nonclassified	3.1	2.0	3.9
TOTAL	100.0%	100.0%	100.0%

1/ Source: Annual Statistical Report, 1965; American Iron & Steel Institute

2/ Reporting companies only

Plant Ownership and Size Structure

Census of Manufactures data from 1963 provides some insight into the prevailing size patterns and ownership concentration within various segments of the industry. Table 4 allows comparisons among the individual production categories as established by the SIC system.

Table 4.

Number of establishments by employment size 1/

	2/ SIC 3312	SIC 3313	SIC 3315	SIC 3316	SIC 3317
Number of companies	161	20	171	59	114
Total U.S. establishments ...	288	36	200	81	141
Establishments employing:					
1-19	41	6	67	13	26
20-49	20	5	36	15	29
50-99	6	2	35	11	20
100-249	43	10	33	25	40
250-499	41	7	24	11	15
500-999	40	3	4	5	9
1,000 or more	97	3	1	1	2

1/ Source: 1963 Census of Manufactures

2/ SIC 3312 - Blast furnaces and steel mills
3313 - Electrometallurgical products
3315 - Steel wire drawing, etc.
3316 - Cold finishing of steel shapes
3317 - Steel pipe and tube

Raw data reflected in the foregoing table must be tempered by production considerations to arrive at a true picture of industry concentration. Significantly, the 8 largest integrated producers (frequently referred to as the "big 8") accounted for approximately 75 percent of the total 1965 steel output.

The largest of the "big 8" manufacturers claimed 24.8 percent of the total 1965 U.S. ingot and castings production. Although its nearest competitor accounted for 16 percent, the industry's third largest firm dropped to under 9 percent of total production.

Production of specialty steels (stainless, silicon electric, tool and alloy) presents a somewhat different picture. The leading producer of these products ranks only twenty-third in ingot production when compared with all steel product manufacturing. Nonetheless, a similar comparison in terms of dollar sales results in a ninth place position for the firm. Since just under 75 percent of specialty steel output is produced by electric furnaces, data pertaining to SIC 3313 is much more indicative of this field.

Geographic Prevalence

State representation in steel production, as based on latest census statistics, can be summarized as follows:

	No. of states: represented	No. of states: with 10 or more establishments
Blast furnaces and steel mills	31	8
Electrometallurgical products	18	-
Wire drawing, etc.	27	7
Cold finishing of steel shapes	15	1
Steel pipe and tube	24	6

In 1966, the American Iron and Steel Institute indicates that no less than 36 states now claim finished product mills. Blast furnace production of pig iron or ferroalloys can be found in 17 states, and steelmaking facilities are located in 31.

A reduction of product classifications into 25 general categories leaves but Pennsylvania and Indiana to boast complete coverage. Illinois follows with 22 of the product categories produced in that state. Ohio is next at 21 and California, New York, and Alabama each claim coverage of 20. Three states can produce only one product. Hot rolled bars, pipes, and tubing are the most commonly produced items, with 26 states manufacturing in this category. Concrete reinforcing bars and plain wire follow with production facilities in 25 and 21 states, respectively.

Appendix A notes the regional distribution of establishments in 1963:

Appalachian Specialization

As indicated earlier, Appalachia claims a rather high level of regional specialization for these industries. Significant production centers exist in both northern and southern sectors.

Table 5 indicates the number of Appalachian establishments as of the 1963 Census of Manufactures.

Table 5.

Establishments within the Appalachian Region 1/

State	2/ SIC 3312 Total	SIC 3312 Employ over 100	SIC 3313 Total	SIC 3313 Employ over 100	SIC 3315 Total	SIC 3315 Employ over 50	SIC 3316 Total	SIC 3316 Employ over 50	SIC 3317 Total	SIC 3317 Employ over 50
New York	2	2	-	-	-	-	-	-	-	-
Pennsylvania	61	47	1	-	7	2	11	9	15	13
Maryland	1	-	-	-	-	-	1	1	-	-
Virginia	5	-	-	-	-	-	-	-	-	-
West Virginia	7	5	3	2	1	1	1	1	-	-
Ohio	9	9	7	7	-	-	2	2	-	-
North Carolina	-	-	-	-	-	-	-	-	-	-
South Carolina	-	-	-	-	-	-	-	-	-	-
Georgia	-	-	-	-	-	-	-	-	3	-
Kentucky	2	2	-	-	1	1	-	-	1	1
Tennessee	4	4	2	2	1	1	-	-	2	2
Alabama	14	13	1	1	-	-	-	-	1	1
Total	105	82	14	12	10	5	15	13	22	17

1/ Source: 1963 Census of Manufactures

2/ SIC 3312 - Blast furnaces and steel mills
3313 - Electrometallurgical products
3315 - Wire drawing, etc.
3316 - Cold finishing of steel shapes
3317 - Steel pipe and tube

By most criteria, both the northern and southern industry is characterized by completeness in product coverage. However, a careful review of production data indicates several significant voids in specific product lines within the southern sector.

Economic Impact

Undoubtedly, the most immediate and significant impact of new steel industry employment is in the area of wage and salary disbursements. In 1965, an average of 583,851 employees received in excess of $4.687 billion from member firms of the American Iron and Steel Institute. The average payroll cost per hour came to $3.826 (inclusive of all premiums) for wage employees. When consolidated with salaried employees, this figure jumps to $4.047.

A further indication of economic impact is derived from an interindustry (input-output) analysis (see Table 6). Moreover, a review of the interindustry employment structure indicates that for every 10 new steel employees, another 9 workers are required by supporting industries.

Table 6.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from other establishments	Primary iron and steel manufacturing
Iron & ferroalloy ores mining	$ 54.05
Coal mining	26.15
Maintenance & repair construction	6.59
Chemicals & selected chemical products	9.54
Petroleum refining & related industries	7.59
Stone & clay products	15.40
Primary iron & steel manufacturing	227.10
Primary nonferrous metals manufacturing	16.46
Stampings, screw-machine products & bolts	6.48
Other fabricated metal products	17.31
Metalworking machinery & equipment	6.63
Machine shop products	7.44
Transportation & warehousing	52.64
Electric, gas, water & sanitary services	24.02
Wholesale & retail trade	35.96
Finance & insurance	7.54
Business services	8.71
Gross imports of goods & services	11.83
Other industries	63.44
Total purchases	604.88
Value added	395.12
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

Examples abound which demonstrate the attraction of steel production for growth in local metalworking operations. High freight penalties provide a large advantage to those firms operating in close proximity to steel supply sources. What must be considered, however, is the product requirements of the individual metalworking operations. As an example, the availability of stainless steel mill products will have substantial pull for such industries as: food, drug, and chemical processing equipment; stainless steel tableware; and stainless steel cookingware. Production of grain-oriented silicon steel will attract manufacturers of electrical transformers and other electrical apparatus.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Production and Consumption

All indications point to a new record of steel ingot production in 1966--a figure exceeding 1965's 131.2 million tons. Although shipments will be down somewhat, consumption is also expected to reach record heights as the current tight money situation forces the reduction of user inventories.

Long-term growth rate projections for carbon steel remain at an unimpressive 2.5 percent annually. However, stainless and silicon electric steels come in at a much more respectable 5 percent annual rate projection, and the more exotic superalloys and magnetic materials are found in the 10 to 15 percent range. Selected products which have demonstrated growth potential through their performance in past years are indicated in Table 7.

Profits

Measures of profitability in the steel industry take on a somewhat different weighted importance from that of other manufacturing industries. Due to the extremely large capital requirements prior to experiencing a return on sales dollars, the return on investment ratio is considered of greater importance than return on sales. For instance, first-half 1966 figures for the industry's second largest firm indicate a sales ratio of 6.8 percent--con considered relatively good in the manufacturing field. However, the return on investment for the same period ran to a relatively poor 8.8 percent.

A review of the big 8 producers for the year 1965 provides an overall standard for the economic feasibility of establishing new or expanded steel mill operations. In that year, the 8 companies claimed an average operating margin (earnings before interest, depreciation, and taxes) of 17.8 percent. Interest and depreciation ran to 7.0 percent of sales, while net earnings on sales averaged 6.6 percent. Cash flow, as a percent of sales, was 13.0 percent.

Big 8 ratios above can be compared directly with the industrywide data contained in Table 8.

Table 7.

Growth of selected steel mill products 1/

(Percentages based on production tonnage)

Item	Total percent increase	Base year
Flat hot rolled products		
Universal plates		
48" width	72.3%	1961
Sheared plates		
48" to 90" width, over 1-1/2" thick	188.7	1961
128" width, over 1-1/2" thick	1063.7	1961
Hot rolled sheets		
Rolled on continuous mills		
48" to 60" width	77.2	1961
72" and over in width	81.8	1961
Galvanized sheets and strip	38.7	1961
Cold finished bars		
Carbon	53.3	1961
Alloy	55.8	1961
Stainless	55.2	1961
Tool steel (rolled or forged)		
High-speed	92.7	1961
Other alloy	43.5	1961
Carbon 2/	(18.8)	1961
Pipe and tubing	21.0	1961
Gasweld and spiralweld	37.0	1961
Mechanical tubing	48.7	1961
Seamless tubing		
Stainless	21.7	1964
Other alloy	32.1	1964
Buttweld and electricweld tubing		
Other alloy	114.3	1964
Electricweld, gasweld and spiralweld		
Galvanized or sherardized	137.9	1964
Stainless	15.4	1964

1/ Source: Annual Statistical Report, 1965, American Iron and Steel Institute.

2/ Note: Included for comparison purposes.

Table 8.

Profit ratios in the iron and steel industry 1964 1/

	SIC 331 Iron and steel integrated operators (58)
Net profits, percent	
On sales	6.35 5.07 2.59
On tangible net worth	11.81 9.34 6.39
On net working capital	23.32 16.85 10.80

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc.

Profits now appear to be on the upswing, primarily due to new plants and equipment coming on-stream. Continuous casting provides savings of up to $15 per ton, and other significant savings are being experienced through conversion to the basic oxygen furnace and adoption of new degassing techniques. Also playing a role in improving steel's profit picture is a new emphasis on modern marketing techniques designed to anticipate the consumer's needs. Stepped up research and development efforts are attuned to creating new alloys or processes to fulfill these needs, and the industry is moving strongly to regain some lost markets.

Employment

As is well known to all, employment within the steel industry is extremely sensitive to the ups and downs of the overall economy. Annual fluctuations of 40,000 to 50,000 are not uncommon in either direction, and a drop approaching 100,000 was experienced in 1958.

When viewing the steel industry in total, the consensus of opinion is that productivity gains will exceed production growth over the near term, and total employment will thus decline. This, of course, is barring any unforeseen changes on the national (or international) scene.

Taken separately, the outlook for increased employment opportunities in alloy and stainless steel manufacturing is somewhat brighter. While no precise projections are available, anticipated growth in production should far outstep improvements in productivity.

The following table presents Bureau of Labor Statistics data covering the steel industry between 1958 and 1965:

Table 9.

Employment in the steel industry 1/

Year	All employees (000)	Women employees (000)	% Females of total employees	Production workers (000)	Average weekly hours
1958	601.1	-	-	486.5	37.5
1959	587.3	26.2	4.5%	470.9	40.1
1960	651.4	27.7	4.3	528.4	38.2
1961	595.5	25.5	4.3	478.4	38.9
1962	592.8	25.2	4.3	476.3	39.2
1963	589.9	24.0	4.1	479.1	40.2
1964	629.4	24.5	3.9	515.8	41.2
1965	686.3	26.4	3.8	563.6	41.2

1/ Source: Employment and Earnings - Establishment Data, Bureau of Labor Statistics.

Investment and Locational Activity

Capital investments have grown rather rapidly up to an expected 1966 total of $2.3 billion. In 1960, the "big 8" spending was in excess of $750 million. Since 1963, their new capital investments have been at a rate better than $1 billion annually--reaching to an estimated $2 billion in 1966.

Significantly, new investments are generally emphasizing quality of product output as opposed to quantity. Consumers are demanding better service and quality which, in turn, requires new equipment. In addition, labor costs, one of the biggest factors in steelmaking, are leaping up, and foreign steel or other materials are gaining a foothold in some markets. Producers are placing a heavy reliance on plant modernization to absorb a good portion of increased costs while regaining some lost markets. However, suspension of the investment tax credit is affecting cash flows and could cause grave problems in the industry.

Any analysis of locational activity through a Census of Manufactures establishment count would be extremely misleading without quantification by capacity and employment data. In an industry such as steel, expansions are frequently as significant as new establishments. As best can be determined, the period between 1962 and 1966 saw 16 new steel industry facilities and an almost equal number of expansions within the Appalachian Region.

Current investment plans indicate the high rate of spending by the industry will persist. Much of this will be directed to the addition of new product finishing facilities at established locations of primary capacity. Undoubtedly, a large portion will be aimed at invading or enhancing a firm's position in production of the growth product lines.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

Pig iron, the basic ingredient in the making of all steels, is produced by some 236 blast furnaces in 17 states. Open hearth, electric, or basic oxygen furnaces convert the pig iron, bolstered by iron and steel scrap and alloying materials, into raw steel. Over 71 percent of steel production is made in the open hearth. Electric furnaces claimed 10.5 percent, and the basic oxygen process (BOF) accounted for 17.5 percent of the domestic steel produced in 1965. Stainless and alloy steel production is dominated by the electric furnace.

Three significant technological advances are pacing the industry to improved profitability: (1) basic oxygen process, (2) continuous casting, and (3) vacuum degassing.

The BOF is a pear-shaped vessel where 99.5 percent pure oxygen is blown at supersonic speeds into the molten iron and scrap. In a high temperature churning reaction, the oxygen combines with carbon, burns out the impurities, and converts the bath to steel. Product quality is improved while capital investment and operating costs are lowered. In 1965 and 1966, no less than 16 BOF's have come on-stream. In Maryland, 2 new 200-ton BOF's are now turning out what formerly required 12 open hearths, as conversion time is reduced from 8-10 hours to less than 1 hour.

Continuous casting is a procedure which converts molten steel directly and continuously into semifinished slabs, billets, or bars. While capital costs are reduced by one-third, the operation requires less plant space, fewer workers, produces a better quality product, and will trim scrap losses by 15 percent.

Vacuum degassing is a process which utilizes a vacuum vessel to draw gas impurities from molten steel. This process saves up to 15 percent of the ingot which previously had to be cropped and reworked.

Growth in the utilization of electric furnaces also demands brief consideration. Looking somewhat like teakettles, the refining takes place in a tightly closed chamber, with close control over temperature and other variables. Accordingly, these furnaces find widewpread application in the production of stainless or other high alloy steels which must be made to exacting specifications.

Advances made in finishing mill products once again highlight quality control and automation. Although equipment is being continuously developed, the advent of computer controls, x-ray sensors, and other automatic control systems allows more precision in tolerances on such rolling mill variables as temperature and pressure.

Raw Materials

Approximately 2.75 tons of raw material is required for a single ton of ingot steel. Thus, the problems involved in moving and storing huge quantities of such material are a significant operating cost factor. Industry consumption of principal raw materials in 1965 ran as follows:

	Millions of net tons
Iron ore	139.8
Coking coal	83.9
Scrap	69.8
Limestone	30.2

In addition, the industry required 40.2 billion kwh of electricity, 547 billion cubic feet of natural gas, 1.6 billion gallons of fuel oil, and 138.8 billion cubic feet of oxygen.

Today, virtually all iron ore is crushed, screened, and washed. Large improvements in blast furnace efficiency are gained through such procedures (called beneficiation) which are designed to improve the physical or chemical qualities of natural ore. Beneficiation also allows utilization of lower-grade ores, previously considered unsuitable, through separation of impurities and concentration into pellets, briquettes, nodules, etc. of high iron content. These more efficient ores lower coke and limestone requirements while speeding up the reduction process.

Over one-half of the U.S. iron ore requirements come from the Great Lakes area. Most of the balance is imported from such areas as Venezuela, Liberia, and Labrador. Coking coal is found in over 24 states with West Virginia, Kentucky, Pennsylvania, and Illinois accounting for nearly 75 percent of the 1965 supply. Limestone is found in almost all states.

Manpower Productivity

New equipment coming into operation is resulting in productivity gains exceeding labor and material costs. The labor content per ton of steel in 1965 came to 10.5 man-hours--down from 11 in 1964. This trend will continue as steel companies move to reap the benefits of more efficient equipment and increased automation.

Automation experienced to date--limited as it may appear--has taken a toll of over 80,000 jobs since 1953 by one estimation. Similar reductions over the next decade are placed at a minimum of 100,000, and many union officials expect a far greater toll.

While growth in steel output has buffered the full impact of automation to date, a comparison of the 4.9 percent average annual productivity rate against the 2.5 percent production forecast yields good grounds for substantial concern. Moreover, the industry appears unanimous in expecting the annual productivity gain to move ever higher. Over the next 20 years, the industry is expected to add some 70 million tons of BOF capacity--tripling present capacity. With a crew size equal to that of the open hearth, the BOF turns out as much steel in one hour as the former did in 8-10 hours. Meanwhile, continuous casting could eliminate as much as 10-15 percent of the jobs in a typical steel mill.

Although the overall industry's employment outlook cannot be considered bright, increased emphasis on specialty steels is expected to move this area counter to the balance of the industry.

Production Innovation and Interproduct Competition

As noted earlier in this report, the steel industry has lost, or is in danger of losing large markets. Plastics and aluminum lead the list of competitive materials. One need only look at the growth in aluminum consumption by the construction or container fields to realize the magnitude of the problem. Similar comparisons are available for plastics.

Steel is fighting back. As mentioned in Section II, research and development efforts are being coordinated with new marketing concepts to anticipate the needs of consumers.

The list of achievements to date is impressive. A new steel siding is now on the market which is as cheap but stronger than aluminum. New superstrength alloys are beating aluminum in missiles and high speed aircraft markets, and "Prime Rib" galvanized sheet has been introduced for roofing and siding application.

Other developments are designed more to preserve existing markets. A rust-resistant galvanized rocker panel is replacing carbon steel in the automotive field, and the development of a galvanized paint container has been completed. New high strength alloys are becoming available which require much less material than a similar carbon steel application. A 55-gallon container which weighs one-third less than standard can now be made. Meanwhile, a new container material aimed at the beer and soda market offers a brilliant stainless surface and excellent corrosion resistance with a .0000001-inch electrolytic chromium coating. Significantly, it is priced below tinplate.

While many other developments could be cited, the above amply demonstrates the trend. However, every action has a reaction. Competitive materials will fight back. Nonetheless, steel has much to offer. It melts at 2900 degrees as opposed to 400 degrees for most plastics. It has high ductility, and thus is more suitable for structures likely to encounter stress than concrete. It is tougher than fiberglas or aluminum. Although sensitive to corrosion, new alloys or coatings are solving many of those problems. All in all, steel will certainly continue to play a dominant role in the economy.

Distribution

Most markets receive the bulk of their steel requirements directly from the mills, ordering through company sales representatives. The 2,500 steel service centers, aided by hundreds of distributing firms, service the balance of industry's needs for this basic raw material. Prorations of steel shipments to specific markets thus become somewhat distorted as the material is converted into intermediate products before reaching the end-user. A prime example is found in construction where steel requirements from warehouses, as well as products in the form of fasteners, conduit, etc., are not attributed to the construction industry.

Perhaps the most severe limiting factor in servicing the steel market is a relatively heavy transportation charge. While the pricing structure of steel mill products is extremely complex, consumers will always bear the load of these transportation expenses. In general, the purchaser pays freight from the nearest point where the specific product is produced. Since larger consumers are more frequently becoming fearful of reliance on a single source of supply, steel producers will increasingly be faced with absorbing some transportation costs. Nonetheless, supply and service economies force most consumers to maximize purchases from the closer mill. Detailed price calculations will determine the economies of service center purchases.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

The location of new primary steel capacity in the southern Appalachian Region can take 2 courses: expansion at existing integrated mill locations or establishment of free-standing electric furnace and rolling mill operations. Both roads provide economic means to exploit a regional market now being served from major producing centers in the North.

The chief consideration for a new mill location is the market, as has been amply demonstrated by recent locations aimed at penetrating the rich Chicago district demand.

Traditionally, because of the heavy raw material needs of iron ore, coal, and limestone, a location oriented towards supplies of the heaviest volume ingredient were favored. For example, more than 4 tons of raw material are required to produce 1 ton of steel. The tonnage of metallurgical bituminous coal exceeds all materials although, after it is reduced to coke, iron ore contributes the greatest weight. This explains the historic heavy concentration of steel firms in and around Pittsburgh.

To illustrate the volumes required, the charge necessary to produce 1 ton of pig iron consists of 5,400 pounds of iron ore, 2,150 pounds of coke, and about 800 pounds of limestone, or more than 4 times as much raw material as iron produced.

As may be surmised, the size of a market's potential establishes the case for a new location, while competitive market penetration advantages locate the general area of operation. Within these parameters, sites focused on lowest raw material assembly costs define the principal location criteria. The potential labor supply carries far more weight than existing numbers, since wages of the highest order will serve to attract the workers. The community size will have little bearing on a location selection for the same reason. Rather than requiring ancillary industries, the steel industry will create its own satellites.

The Case for the Appalachian Region

The need for additional investment in Appalachia revolves around unexploited market potential. The northern areas provide the home for a tremendous existing capacity. Within the central regions, markets are limited. However, in the southern portion of the Appalachian Region, growing metal markets and good orientation to expanding industry in bordering areas provide. a nucleus for expansion.

Among the mill products lacking in the area are steel strapping for packaging in the various industrial centers, sheet piling for Florida and Gulf Coast markets, and spring wire for furniture makers and producers of measuring instruments. The largest market potential is the demand found in a 7-state region for stainless and alloy steels for use in tools, electrical products, aircraft, automobiles, chemical processing equipment, paper and pulp machinery, and other products where metal used is subject to a hostile environment.

The Market for Stainless and Alloy Steel

Demand for Mill Products

The markets for various forms of stainless steel have undergone a change over the past 15 years. Plates, bars, and cold rolled sheet are experiencing increasing demand. At the same time, customer requirements for hot rolled sheets and cold rolled strip have slackened.

Most of the cold rolled strip finds its way as a direct mill shipment to appliance, automotive, cutlery, and utensil industries. On the other hand, over 70 percent of the cold rolled strip enters the fabricating market through service centers. Makers of aircraft, chemical industry apparatus, food processing equipment, and pulp and paper machinery provide the leading industrial buyers. Building construction, including builders' hardware, also takes a large part of the product.

Bars, both hot rolled and cold rolled, are largely used by the aircraft and electrical machinery industries. Approximately 50 percent of the cold rolled stock moves through steel warehouses, while almost 75 percent of the hot rolled product is a direct mill shipment. Plates find heavy use in the chemical and construction industries.

Chemical processors purchase large quantities of tubing for applications where corrosion resistance is necessary. Aircraft and missile markets also take direct mill shipments, especially in pressure tubing.

Part of the rapid growth in drawn stainless steel wire stems from the increasingly large portion of bolts, nuts, rivets, and screws being made of stainless steel. Projections of stainless and alloy steel demand by mill forms are shown below. It should also be noted that many special alloy steels are moving into the same markets as stainless steel. In addition, many of the end-use industries for these mill products such as aircraft, pulp and paper, chemical processing, and automotive are exhibiting outstanding growth in areas that can be advantageously served from an Appalachian producing point.

Table 10.

Comparative demand for various forms of stainless steel 1/

Mill product	Percent
Cold rolled strip	30.5%
Cold rolled sheets	22.6
Cold finished bars	10.6
Hot rolled bars	9.4
Plates	6.5
Drawn wire	5.2
Pressure tubing	4.4
Hot rolled sheets	3.9
Mechanical tubing	0.9
Hot rolled strip	0.8
Miscellaneous forms	5.2
	100.0%

1/ Source: Fantus records and Annual Statistical Report, 1965, American Iron and Steel Institute.

Table 11.

Comparative demand for various forms of alloy steel 1/

Mill product	Percent
Hot rolled bars	33.04%
Plates	16.16
Line pipe and tubing	10.03
Galvanized electrolytic sheets	9.61
Mechanical pipe and tubing	5.60
Structural shapes	5.43
Hot rolled sheets	5.41
Oil country pipe and tubing	4.98
Cold finished bars	3.96
Tool steel	1.70
Pressure pipe and tubing	0.88
Wire rods	0.64
Hot rolled strip	0.56
Drawn wire	0.53
Cold rolled sheet	0.49
Cold rolled strip	0.45
Miscellaneous	0.53
	100.00%

1/ Source: Annual Statistical Report, 1965, American Iron and Steel Institute.

Consuming Industries

Domestic stainless steel shipments should climb from 813,455 tons in 1965 to 925,667 in 1967. Although all consuming industrial markets will contribute to this demand, aircraft, applicances, automotive, construction, and untensils will claim a growing share of the output.

Aircraft:

Demand for stainless steel by the aircraft industry climbed roughly 60 percent during the past 10 years. Future growth, however, is highly dependent upon Federal Government defense and space exploration appropriations. To resist heat buildup and concomitant loss of metal strength at high speeds, increasing amounts of alloy steels are coming into play on airplane wing surfaces and spacecraft.

Appliances and Kitchenware:

This broad classification includes big ticket appliances such as washers, refrigerators, cooking ranges, and smaller items, particularly cooking utensils which represent the largest single market. New locations for appliances and pots and pans production easily served from a southern Appalachian producing point promise a regional market for stainless which will grow faster than the national one.

Automotive:

A growing number of parts firms have moved from the restrictive manufacturing belt to locations within the exclusive marketing territory of an Appalachian stainless and alloy steel producer. The past 10 years showed a sales growth of 64 percent in sales of stainless to manufacturers in this classification.

Chemical Processing Equipment:

Organic, inorganic, plastic, synthetic, and petrochemicals all contribute to the demand, which reached approximately 20,000 tons for stainless steel plus additional quantities of alloys. Chemical complexes along the entire system of navigable waterways and Gulf Coast sites will grow more extensive, especially if petroleum imports from the Near East, which would favor east coast chemical operations, remain curtailed.

Commercial and Home Equipment:

The gains established during the past 10 years, which saw the use of stainless and alloy steel in vending machines, furniture, restaurant equipment, surgical apparatus, and scientific equipment go from 42,000 tons to 86,000 tons, show no signs of abating.

Electrical Machinery:

The greater convenience and lower cost of electrical energy will continue to spur consumer demand. The power producers and communications utilities will translate this demand into more communication, distributing, electronic, and generating equipment. Present use of 18,500 tons of stainless will move up with the industry along with demand for silicon alloy steels.

Food Processing and Agricultural Equipment:

Farm operations will continue to mechanize. Broiler raising is becoming an automated factory operation, while truck farming sees less of the produce going to fresh markets. Stainless and alloy production going to food processing equipment more than doubled during the past 10 years. Slower paced, but still vital, agricultural machinery jumped its use of stainless steel 98 percent between 1957 and 1967.

Industrial Equipment:

The use of stainless and alloy steel in boilers, compressors, cranes, industrial engines, etc. continues on a high trajectory. The 10-year history shows a growth of 190 percent.

Construction and Builders' Hardware:

Heavy "Great Society" expenditures in public buildings will help maintain the 109 percent growth record of the past decade. Hospitals, nursing homes, and new school construction will require sanitary ware, air-conditioning and heating equipment, builders' hardware, and ornamental architectural products in greater quantities.

Paper and Pulp Equipment:

The rapid increase in paper and pulp production which rides along with the swift rise in disposable personal income has boosted requirements by the equipment producers to 7,500 tons of stainless steel. Much of the new capacity will be in quick pulpwood growing areas of the South with good orientation to a steel producer in southern Appalachia for stainless and alloy products.

Other industry use classifications also show a heavier demand for stainless steels. Projections for sales to these buyers directly from the mill and indirectly through steel service centers are shown below in Tables 12 and 13.

Table 12.

Projected direct mill shipments of stainless steel, 1967 1/

Industry use classification	Net tons stainless steel	Net tons alloy steel
Service center	348,349	1,116,483
Automotive	144,706	1,835,922
Appliances and ki. .enware	57,179	15,796
Forgings and castings (N.E.C.)	56,624	896,919
Industrial equipment	43,300	471,577
Construction and builders' hardware	38,119	251,976
Aircraft	33,585	84,054
Commercial and home equipment	24,056	31,823
Special industrial equipment	23,408	30,900
Electrical machinery	22,853	999,420
Metalworking equipment	19,614	422,343
Bolts, nuts, rivets, and screws	17,764	136,400
Food processing equipment	12,675	2,421
Chemical processing equipment	4,533	8,590
Marine and shipbuilding equipment	3,700	642,682
Containers	2,313	48,656
Ordnance	1,943	142,568
Rail transportation equipment	1,665	290,498
Construction equipment	1,310	251,988
Paper and pulp equipment	1,280	14,528
Other	65,691	284,099

1/ Source: Fantus records.

Table 13.

Projected service center shipments of stainless steel, 1967 1/

Industry use classification	Net tons stainless steel	Net tons alloy steel
Construction and builders' hardware	52,025	8,949
Commercial and home equipment	47,754	23,978
Industrial equipment	44,593	73,734
Bolts, nuts, rivets, and screws	32,021	21,104
Special industrial equipment	27,714	700
Metalworking equipment	23,720	258,449
Food processing equipment	23,026	6,315
Aircraft	21,951	89,118
Chemical processing equipment	11,981	15,230
Forgings and castings (N.E.C.)	10,627	4,507
Marine and shipbuilding equipment	9,550	13,116
Electrical machinery	8,647	62,101
Appliances and kitchenware	6,598	6,092
Textile equipment	6,355	977
Automotive	6,182	31,940
Paper and pulp equipment	4,897	10,749
Ordnance	3,125	4,107
Containers	1,840	994
Gas and oil drilling	1,111	430,856
Construction equipment	868	13,449
Other	2,535	38,150

1/ Source: Fantus records.

The Market for a Southern Appalachian Producer

The total number of metalworking plants operating within a 7-state area where an Appalachian based stainless and alloy steel producer would have an advantage has grown from 895 in 1953 to 1,895 in 1965. At the same time, employment in these establishments grew from 237,400 to 396,593. Although portions of these states lie outside the area of competitive freight advantage, the majority of plants are found in locales offering returns of close to $12.00 per ton.

Table 14.

Metalworking plants in the 7-state primary market area for stainless and alloy steel makers 1/

	1953		1957	
	Number of plants	Employment	Number of plants	Employment
Tennessee	225	62,500	211	53,546
North Carolina	139	28,300	177	40,731
South Carolina	33	5,100	38	12,982
Alabama	188	71,000	200	88,521
Mississippi	42	9,000	54	9,610
Georgia	159	40,200	174	44,842
Florida	109	21,300	152	20,306
TOTAL	895	237,400	1,006	270,538

	1962		1966	
	Number of plants	Employment	Number of plants	Employment
Tennessee	321	66,967	337	86,026
North Carolina	300	48,600	319	50,946
South Carolina	91	15,293	110	21,854
Alabama	259	68,301	272	80,941
Mississippi	103	21,395	112	24,431
Georgia	282	55,519	291	59,552
Florida	417	62,608	454	72,843
TOTAL	1,773	338,683	1,895	396,593

1/ Source: Steel, The Metalworking Weekly, State Analysis of Metalworking Markets, 1953, 1957, 1962, and 1966 editions, Penton Publishing Company, Cleveland, Ohio.

The bulk of new stainless and alloy steel plants have concentrated in the manufacturing belt, lacing Chicago on the west to Boston on the east. Growth rates in this area are outstanding and the consuming base high.

Nevertheless, the markets within the 7-state area, although rising from a smaller floor, exhibit outstanding growth potential also. In some instances, consumption has pushed up spectacularly, especially for alloys at the port cities of Jacksonville, New Orleans, and Tampa (see Tables 15 and 16).

Table 15.

Growth of major regional stainless steel consuming markets 1/

Markets in descending order of size	Markets east of Chicago % increase 1957-1967
Detroit, Michigan	40%
New York, New York	75
Chicago, Illinois	80
Cleveland, Ohio	65
Philadelphia, Pennsylvania	60
Boston, Massachusetts	90
Hartford, Connecticut	70
Cincinnati, Ohio	95
Buffalo, New York	40

Markets in descending order of size	Markets advantageously served from an Appalachian producing point % increase 1957-1967
Birmingham, Alabama	104%
Atlanta, Georgia	86
Chattanooga, Tennessee	99
New Orleans, Louisiana	134
Memphis, Tennessee	110
Miami, Florida	88
Knoxville, Tennessee	80
Nashville, Tennessee	93
Jacksonville, Florida	89
Tampa, Florida	107

1/ Source: American Iron and Steel Institute and Fantus computations.

Table 16.

Growth of major regional alloy steel consuming markets 1/

Markets in descending order of size	Markets east of Chicago % increase 1957-1967
Detroit, Michigan	31%
Chicago, Illinois	49
New York, New York	72
Cleveland, Ohio	76
Philadelphia, Pennsylvania	59
Flint, Michigan	42
Boston, Massachusetts	119
Pittsburgh, Pennsylvania	35
Cincinnati, Ohio	137

Markets in descending order of size	Markets advantageously served from an Appalachian producing point % increase 1957-1967
Birmingham, Alabama	71%
New Orleans, Louisiana	248
Chattanooga, Tennessee	108
Memphis, Tennessee	116
Jacksonville, Florida	257
Atlanta, Georgia	77
Miami, Florida	189
Nashville, Tennessee	112
Tampa, Florida	240
Knoxville, Tennessee	78

1/ Source: American Iron and Steel Institute and Fantus computations.

Although outside the 7-state territory, New Orleans was included in the market since it falls well within an area to which an Appalachian producer can ship at a competitive freight advantage. Within this marketing territory, 10 major consuming markets will demand more than 18,000 tons of stainless steel and 88,000 tons of alloy steel (see Table 17). The total 1967 market for the entire territory is estimated at 40,000 tons of stainless steel forms and close to 200,000 tons of alloy mill products.

Table 17.

Estimated 1967 consumption of stainless and alloy steels in markets which could be served at a freight advantage from potential southern Appalachian shipping points 1/

Major consuming markets	Net tons Stainless steel	Alloy steel
Atlanta, Georgia	3,160	5,320
Birmingham, Alabama	4,550	23,750
Chattanooga, Tennessee	2,500	12,500
Jacksonville, Florida	435	5,360
Knoxville, Tennessee	950	1,600
Memphis, Tennessee	2,125	7,140
Miami, Florida	1,130	3,770
Nashville, Tennessee	690	3,400
New Orleans, Louisiana	2,325	22,270
Tampa, Florida	380	3,060
TOTAL	18,245	88,170

1/ Source: Fantus projections.

Defining the Territory

A number of principal manufacturing centers of stainless steel forms such as Baltimore, Maryland; Washington, Pennsylvania; Massillon, Ohio; Cambridge, Ohio; New Castle, Indiana; and Chicago, Illinois are best oriented to compete with a proposed stainless and alloy facility located in the southern Appalachian Region. Although some production takes place at Owensboro, Kentucky, it is limited to bars and forging billets.

Comparative shipping charges were equalized to develop a territory within which a southern Appalachian producer could enjoy a freight advantage. At first glance, the area's freight advantage extends into rich Texas Gulf Coast markets, but growing primary capacity in Texas might also make it attractive to install a small electric stainless and alloy furnace there to serve a southwest regional market. Hence, a shaded area extending through Arkansas and Louisiana could conceivably limit the western extent of the proposed Appalachian plants' territory of competitive freight advantage.

Transportation Costs

Producers located at the proposed location would enjoy freight differentials ranging from $4.60 to $12.30 per ton (see Table 18). Competitors shipping into this market would suffer a reduction in "net mill return" by the amount of the freight penalty they would absorb to match delivered costs to a customer.

Table 18.

Comparative shipping costs per ton and comparative per-ton freight penalty for stainless steel sheet, strip, bars, and plates, Appalachian producing point vs. present locations 1/ 2/

Major consuming destination	Shipments originating from: Appalachian Region	Massillon, Ohio: Cost per ton	Massillon, Ohio: Penalty per ton
Atlanta, Georgia	$ 5.10	$13.60	$ 8.50
Birmingham, Alabama	2.70 3/	13.60	10.90
Chattanooga, Tennessee	4.70	11.90	7.20
Knoxville, Tennessee	6.70	11.30	4.60
Jacksonville, Florida	9.30	17.60	8.30
Memphis, Tennessee	6.70	14.00	7.30
Miami, Florida	14.40	20.60	6.20
Nashville, Tennessee	5.30	11.30	6.00
New Orleans, Louisiana	7.90	18.20	10.30
Tampa, Florida	11.70	19.40	7.70

Major consuming destination	Shipments originating from: Baltimore, Md.: Cost per ton	Baltimore, Md.: Penalty per ton	Washington, Pa.: Cost per ton	Washington, Pa.: Penalty per ton
Atlanta, Georgia	$13.40	$ 8.30	$14.40	$ 9.30
Birmingham, Alabama	15.00	12.30	14.40	11.70
Chattanooga, Tennessee	13.10	8.40	12.50	7.80
Knoxville, Tennessee	11.70	5.00	12.10	5.40
Jacksonville, Florida	14.60	5.30	17.60	8.30
Memphis, Tennessee	17.40	10.70	14.60	7.90
Miami, Florida	19.00	4.60	20.60	6.20
Nashville, Tennessee	15.00	9.70	12.10	6.80
New Orleans, Louisiana	19.00	11.10	19.00	11.10
Tampa, Florida	17.00	5.30	19.40	7.70

1/ Source: Fantus records.

2/ Rates are based upon 100,000-pound carloads and published commodity rates in Tariffs S.F.A. 240-I and T.L.- C.T.R. E/S-704-C. Neither bargeload nor specific point-to-point rail commodity rates have been used. Appalachian producing point taken ~ Central Southeastern location.

3/ Applicable for distance of 50 miles.

On shipments to the major consumption centers in the freight advantage territory, an Appalachian producer would maintain a competitive outbound transportation advantage of approximately $5.85 million annually. Yet, these marketing centers constitute less than half the potential within the marketing area.

Technological Impetus to Exploit the Market

In 1965, 94 million tons of steel came from open-hearth furnaces and 23 million from BOF (basic oxygen furnace) installations. Comparable capacities in 1959 when open hearth production amounted to 82 million tons and BOF output totaled 2 million tons, indicate that BOF producing facilities made outstanding gains in steelmaking. One source points out that BOF installations achieved production costs of $5.00 per ton lower than open-hearth furnaces. In addition, capital costs per ton of installed capacity are as much as one-fourth lower. It should also be noted that during this period, newer open-hearth furnaces were equipped with oxygen lances which helped to bring their operating costs down.

Nevertheless, it takes 8 to 10 hours to make steel in an open hearth, but only about 50 minutes in a basic oxygen furnace, and it appears likely that older open-hearth facilities will be replaced with BOF furnaces. However, a problem of primary steelmaking interrelationship enters the picture.

An issue challenging the metallurgists stems from the interaction of iron production, steelmaking, and scrap utilization. The open hearth can take a full charge of scrap, if necessary, although generally scrap makes up roughly 42 percent to 60 percent of the metal charge with the balance coming from hot metal. On the other side of the coin, the BOF has an upper limit of about 28 percent scrap, since the energy for the process is provided chiefly by the oxidation of silicon in the hot metal.

From the pouring of molten steel to its fabrication into sheet, strip, plate, and bars, about 21 percent of the furnace production ends up as scrap. Where continuous casting replaces ingot casting, the scrap rate is reduced to about 10 percent. Scale loss in both techniques amounts to about 2 percent. But continuous casting is not an unqualified success in all types of operations, so an overall reduction of scrap to 12 percent of a ladle pour is not presently in the cards, and at least part of the scrap rate of 23 percent on many facilities will continue.

As scrap consumption is lower in BOF operations, supplies will build up, thus favoring continued use of some open-hearth facilities, or directing efforts toward alternate uses of the high-grade scrap. One avenue open to present operators is to establish electric furnaces at the integrated mill site for the production of stainless and high alloy steel.

Although scrap can be shipped within Appalachia to areas of low TVA power costs, certain advantages lie with keeping the operation close to the fully integrated facilities. Investments in rolling mill facilities have already been made. Secondly, the gaseous by-products of the blast furnace ironmaking operations would provide the fuel to produce steam for operating a steam turbine. The turbine would drive the generators, and the current thus produced converted by motor-generator sets to direct current would power the electric furnace.

TVA areas, especially in the upper Tennessee, would permit deeper penetration of the growing markets in the Carolina Piedmont industrial areas. Since cold metal charging is preferred in electric furnaces, scrap or pig iron would need to be transported to the site. Furthermore, rolling mill facilities would be needed. Favorable to such a location might be a nucleus of trained metalworkers now employed in the aluminum industry. As the pressures on overcapacity operation due to Vietnam eventually subside, workers would be released to the available work force rolls.

Sites

Included among the advantages at presently operating integrated steel mill sites is the orientation to navigable rivers for transporting Venezuelan ore from Gulf Coast ports by barge to consuming centers for processing into pig iron.

In the area around Cerro Bolivar in Venezuela, there are 560 million tons of rich (65 percent iron) ore. In contrast, taconite ore used as a raw material by many northern producers must undergo the expense of pelletizing to make it economical to use. Even then, the iron content of 70 percent is only 5 percent greater than the raw Venezuelan ore. However, Canadian and other imported ores are available, but at increased transportation costs.

At present rates, the Venezuelan ore is being extracted at 14.2 million tons a year. Another supply in the same general region has estimated reserves of 2 billion tons, indicating that present sites will continue to be advantageously located to receive these ore supplies for many years in the future.

The long-term supply of rich ore plus plentiful local supplies of coal and limestone assure raw materials availability at competitive assembly costs. Ore pelletizing and sintering operations planned for the South American mining areas will reduce the bulk of the shipments and should drop inbound freight costs further.

Under these circumstances, there is no reason to believe that present steelmaking operations in southern Appalachia will cease in the foreseeable future. With the regional industrial markets continuing to grow, the future production of carbon steel and its generation of scrap for an electric alloy and stainless steel producing furnace appears to have outstanding potential.

If an electric furnace were to be established at a river site within TVA territory, the same barge transportation advantages for iron and alloying ores and pig iron or scrap would apply. Ferroalloys for addition to the cold charge in the steelmaking furnace might also be made in the electric arc furnaces from the alloy ore, fluxing materials, etc.

Barge transportation cost will give a 26 percent to 30 percent cost advantage over rail. However, any site considered would have to provide rail facilities. Rail service by a carrier providing single-line movements for raw materials is highly preferred.

The present integrated mill sites near a river also provide a supply of raw water. For every ton of iron ore charged into the blast furnaces, close to 25,000 gallons of water will be used in an integrated operation. This demand underscores a second reason for a river site for primary steel production. However, a separate electric furnace operation would not demand water of such quantity. For example, coking operations would not be required. Nevertheless, a large water supply potential must be assured if long-range plans would gravitate toward an integrated steel mill operation.

A site of at least 200 acres for future rolling mill expansions and storage areas is recommended. In some cases, even a larger site would be desirable, since many fabricators still like to locate near the steel supply source. It stands without saying that the tract must be flood-free and have utility connections. Preference would be given to a looped power system.

Power Needs

A 40-ton electric arc melting furnace will need 10,000 kw of power, while supporting rolling mill equipment may take another 7,000 kw for a total power demand of 17,000 kw. In TVA territory, an average rate of 4.5 mills per kilowatt hour will give a producer here an advantage over private power rates. Power demand at an integrated mill site would be supplied from the mill's own power generation system.

However, power costs are not a prime factor of location. Access to markets and raw materials takes precedence. Nonetheless, where 2 sites have relatively equal orientation to markets and raw materials, power costs can then become a determining factor. For example, power costs in the Illinois Great Lakes area will come to 8.9 mills, but electric furnace operations continue there because of a good market and raw materials location.

Natural gas may aggregate 25 million cubic feet per month principally to fire continuous gas annealing furnaces.

Labor

The potential for male labor fills the chief labor consideration. Since wages paid by steel companies are among the highest in industry, and the fringe benefit package the richest, job opportunities attract workers from a broad geographical area. In 1966, wages for hours worked figured out to $3.90 per hour. Fringe benefits such as holiday pay, vacation pay, pensions, insurance, etc. raised this to about $4.87 per hour. Wage differentials will bring no locational benefit since steelworker contracts will be the same throughout the industry.

Other Factors

Community cooperation particularly as it relates to property protection and the solving of problems of pollution control is most important. Although the industry has gone to great lengths to meet both air and water pollution control requirements, community insistence in immediate compliance to abruptly changed policies can have a devastating effect. In addition, because of its large investment, the industry is sensitive to local tax policies and must operate in harmonious cooperation with local government officials.

Community amenities, size, housing, and existing school facilities will occupy a minor rung on the scale of locational determinants.

The role of make-or-buy decisions can influence the location, but its effect is encompassed within the orientation of the plant to raw materials. Lead time in placing orders and short-term financing play little, if any, role in siting a facility. However, long-term financing may assume a greater part in the location decision. State enabling legislation can permit the expansion of a facility for a company not able to generate sufficient cash flow to internally finance the expansion. At present, when the credit squeeze is drastically affecting the money markets, community financing such as recently completed by Middletown, Ohio for a steelmaking facility provides the oil to lubricate expansion moves.

Vocational training facilities will be valued for their ability to impart a knowledge of basic industrial processes and discipline.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Public policies can be directed towards helping this industry grow both in the northern and southern areas of Appalachia. Recently, however, Congress voted to place a suspension on the 7 percent investment tax credit which was highly beneficial to the steel industry. According to steel spokesmen, the government gave too little consideration to the worldwide steel conditions when Congress passed and the President signed the revocation law.

The general situation is that the world is plagued by overcapacity. Furthermore, some foreign governments subsidize their local industry for exports to the U.S. Much of U.S. capacity is still obsolete by modern standards.

After meeting the decisive needs of both World War II and the Korean conflict, the steel industry faced a decline in domestic demand from 1952 to 1962. During this same period, the demand for steel rose 70 percent in the European Coal and Steel Community, and 300 percent in Japan. With that sort of market for their products, ECSC and Japanese firms found no shortage of funds for investment purposes, and spent heavily for more efficient capital equipment. By 1962, BOF capacity in Japan comprised 30 percent of the output. Although still far behind, the ECSC took off and followed suit.

But in the U.S., with demand down for 10 years, the domestic steel industry was limited to what it could do with restricted investment funds, and equipped open-hearth furnaces with oxygen lances. This helped bring down costs and enabled the U.S. industry to compete with foreign BOF operations. The important fact is that this was a period of declining domestic demand. Both the industry's inability and its reluctance to invest heavily in new capital equipment are understandable.

However, business picked up following 1962 and aided by investment tax credits, the steel industry began a heavy modernization program.

Until the cancellation of the 7 percent investment tax credit, the millions the steel industry put into new facilities since 1962 had so advanced its efficiency that it was beginning to close the cost advantage gap held by foreign producers. BOF steel production, for example, will account for 25 percent of the output this year, up from about 4 percent in 1962. Despite this improvement, much of today's steel capacity depends upon marginal equipment. Foreign producers will further thrive on exports to the U.S. which may reach 10.6 million tons, about 11.5 percent of U.S. shipments in 1966.

Now that the 7 percent investment credit is suspended until 1968, steel must continue to compete on unfavorable terms. Not even tariff protection is offered.

Customers do not buy all their supplies from the lowest price bidder, but the bulk of the business goes that way. Even the Federal Government will buy from the cheapest source.

Sources of steel products are not limited to U.S. producers. The product is made worldwide, and U.S. industry is competing in an international market. Withdrawal of the tax credit was designed to reduce private investment in a period of inflation, although arguments can be made that consumption should have been curtailed and investment encouraged. Nevertheless, if the policy was deemed appropriate for its purpose, it could have been selectively applied.

The effect on southern regional producers is demonstrable. The docks at Mobile are crowded with imported bars, shapes, and wire. Appendix C shows the import total pouring into this 7-state region.

Since public investments will play, at best, a relatively minor role in attracting new "specialty steel" production to Appalachia, efforts might well be more effective if directed toward easing the above situation. Whether this takes the form of a return to the tax credit allowance or a temporary tariff adjustment until the tax credit is reinstated will probably depend upon domestic and international political realities.

Other supporting public investment policies and activities are tabulated in Appendix D.

Appendix A

Regional distribution of establishments 1/

	2/ SIC 3312	SIC 3313	SIC 3315	SIC 3316	SIC 3317
New England					
Total	6	-	35	15	2
Employing over 50	5	-	24	11	-
Middle Atlantic					
Total	105	5	53	21	45
Employing over 50	85	3	17	18	28
South Atlantic					
Total	80	4	15	3	3
Employing over 50	72	3	7	3	-
East North Central					
Total	8	13	60	30	50
Employing over 50	6	9	35	20	36
East South Central					
Total	31	5	4	-	6
Employing over 50	13	5	3	-	4
West North Central					
Total	25	1	4	-	3
Employing over 50	22	1	3	-	1
West South Central					
Total	5	1	6	-	9
Employing over 50	5	1	1	-	6
Mountain					
Total	5	1	2	-	3
Employing over 50	3	-	-	-	1
Pacific					
Total	22	6	21	12	20
Employing over 50	15	3	7	1	10
UNITED STATES					
Total	287	36	200	81	141
Employing over 50	226	25	97	53	86

1/ Source: 1963 Census of Manufactures

cont'd

Appendix A - cont'd

Regional distribution of establishments

2/ SIC 3312 - Blast furnaces and steel mills
3313 - Electrometallurgical products
3315 - Wire drawing, etc.
3316 - Cold finishing of steel shapes
3317 - Steel pipe and tube

Appendix B

Steel mill product imports for customs districts in seven state regional market 1/ 2/ 3/

(net tons)

	North Carolina	South Carolina	Georgia	Florida	Mobile
Steel mill products:					
Ingts, blms, bllts, slbs, etc	-	-	-	-	-
Wire rods	594	-	12,003	108,433	23,820
Strctrl shps (pln 3" & over)	7,144	28,872	6,481	79,468	13,801
Sheet piling	-	-	-	7,418	-
Plates	6,188	791	14,000	31,352	20,634
Rails & track accessories	-	-	-	219	1,458
Wheels & axles	-	-	40	-	-
Concrete reinforcing bars	3,092	1,501	507	82,823	13,813
Bar shapes under 3"	5,190	47,358	3,105	40,297	30,974
Bars-hot rolled-carbon	3,616	10,956	1,746	38,407	23,745
-alloy	-	-	-	7	-
-cld fnshd (carbn & alloy)	121	-	16	1,153	632
Hollow drill steel	10	-	-	-	-
Pipe & tubing-welded	12,975	3,285	7,418	40,177	30,253
-other	142	723	622	4,304	3,481
Round & shaped wire	18,380	2,725	20,514	9,999	23,104
Flat wire	181	189	62	138	3
Bale ties	299	65	5	14	90
Galv wire fencing	3,038	1,516	5,228	2,760	4,535
Wire nails	19,076	7,757	11,586	14,523	15,626
Barbed wire	3,007	2,015	3,177	3,258	8,622
Black plate	102	-	43	384	-
Tin plate	-	-	-	-	-
Terne plate	-	-	-	-	-
Sheets-hot rolled	322	173	693	8,731	3,946
-cold rolled	93	68	350	2,374	1,636
-galv	209	2	788	15,048	20
-oth ctd or pltd	-	-	-	-	-
Strp-hot rolled	130	90	100	1,376	727
-cold rolled	565	393	207	377	224
-hot & cld rolled-alloy	-	-	39	99	4
-coated	-	-	-	-	-
TOTAL STEEL MILL PRODUCTS	84,474	108,479	88,730	493,139	221,148
Other steel products:					
Wire strand	1,732	1,866	573	9,882	1,456
Welded wire mesh	329	80	135	4,437	2,730
Other nails & staples	1,192	482	705	1,057	1,094
Cotton ties & other ties	420	677	2,436	-	182
Iron products & ferroalloys:					
Ferromanganese (Mn cont)	-	-	-	-	20,559
	3,673	3,105	3,849	15,376	26,021

cont'd

Appendix B - cont'd

Steel mill product imports for customs districts
in seven state regional market 1/ 2/ 3/

(net tons)

	New Orleans	Total region	Total U.S. 4/	Regional % of total
Steel mill products:				
Ingts, blms, bllts, slbs, etc	752	752	279,925	0.3%
Wire rods	162,765	307,615	1,276,956	24.1
Strctrl shps (pln 3" & over)	50,207	185,973	883,041	21.1
Sheet piling	2,773	10,191	33,554	30.4
Plates	95,617	168,582	764,134	22.1
Rails & track accessories	-	1,677	20,811	8.1
Wheels & axles	-	40	3,156	1.3
Concrete reinforcing bars	42,158	143,894	488,676	29.4
Bar shapes under 3"	27,390	154,314	508,992	30.3
Bars-hot rolled-carbon	29,846	108,316	484,191	22.4
-alloy	1,024	1,031	27,654	3.7
-cld fnshd (carbn & alloy)	728	2,650	23,893	11.1
Hollow drill steel	-	10	5,782	0.2
Pipe & tubing-welded	40,365	134,473	723,377	18.6
-other	28,765	38,037	177,263	21.5
Round & shaped wire	7,826	82,548	410,213	20.1
Flat wire	71	644	15,811	4.1
Bale ties	25	498	1,622	30.7
Galv wire fencing	2,860	19,937	38,259	52.1
Wire nails	17,639	86,207	308,503	27.9
Barbed wire	8,655	28,734	72,273	39.8
Black plate	111	640	22,946	2.8
Tin plate	3,611	3,611	75,193	4.8
Terne plate	-	-	-	-
Sheets-hot rolled	102,446	116,311	1,795,789	6.5
-cold rolled	21,313	25,834	1,256,056	2.1
-galv	11,861	27,928	381,396	7.3
-oth ctd or pltd	-	-	2,964	-
Strp-hot rolled	329	2,752	25,374	10.8
-cold rolled	549	2,315	19,599	11.8
-hot & cld rolled-alloy	58	200	7,034	2.8
-coated	-	-	690	-
TOTAL STEEL MILL PRODUCTS	659,744	1,655,714	10,135,127	1.6%
Other steel products:				
Wire strand	3,099	18,608	37,697	49.4
Welded wire mesh	2,525	10,236	17,184	59.6
Other nails & staples	1,032	5,562	15,113	36.8
Cotton ties & other ties	5,996	9,711	32,912	29.5
Iron products & ferroalloys:				
Ferromanganese (Mn cont)	59,096	79,655	198,113	40.2
	71,748	123,772	301,019	41.1%

cont'd

Appendix B - cont'd

Steel mill product imports for customs districts in seven state regional market 1/ 2/ 3/

1/ Source: American Iron and Steel Institute

2/ Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee

3/ Data includes New Orleans District

4/ Excludes offshore

Appendix C

Supporting public investment policies and activities for the primary steel and steel mill products industry

	Importance of activity				Level of government action		
	Major	Minor	Variable	Unimportant	Federal	State	Local
Highways & access roads	X1/				X	X	X
Rail	X						
Waterways transportation	X				X2/		
Air transportation		X					
Land use planning			X3/		X	X	X
Land stabilization			X4/		X	X	
Conservation & erosion control			X4/		X	X	
Forestry development				X			
Vocational training facilities			X			X	X
Technological resources				X			
Public health programs				X			
Pace & timing of community planning efforts			X3/		X	X	X
Flood-free sites	X4/				X	X	X
Serviced sites	X						X
Utility services	X						X
Processing water	X						
Recreational resources				X			
Pollution control	X5/					X	X

NOTES:

1/ These are important from a customer service standpoint. In addition, the selected plant site may be remote from access roads and could require connectors to major highways.

2/ Action on the Tennessee-Tombigbee waterway connection would provide a more direct routing for ore shipments to the upper reaches of the Tennessee River.

3/ These factors are of importance principally to prevent the establishment of a residential district adjacent to the industrial site and thus forestall possible future public complaints against the noise and other peace-disturbing influences of heavy industry. In addition, after the industry's commitment of a

Appendix C - Cont'd

Supporting public investment policies and activities for the primary steel and steel mill products industry

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large initial investment, future expansion must hinge on economic considerations not the protests of neighboring residents. Initial planning grants could be supported by matching federal contributions for continued planning.

One other area of importance will be the effectiveness with which any planning program anticipates the need for moderate cost housing developments so crucial to a major expansion of industrial employment. Subdivision regulations, often used to limit or prevent tract building rather than direct it, must be drawn up with a knowledge of the problems facing multiple house builders.

4/ Since river bank sites are important, the value of these sites must be preserved by flood and erosion control, land stabilization, and conservation measures. These efforts can involve dams, dikes, bulkheading, and ripwrapping.

5/ Pollution control is becoming a greater cause for concern by industry. Standards promulgated must be reasonable, showing an awareness of industry's economic concerns. Double standards must be avoided at all costs. A greater assumption of the burden is needed from communities and states benefiting from the industry's economic impact. Abrupt demands for immediate industrial clean-up can be avoided by scheduled programs of abatement. Supporting federal government fast tax write-offs on pollution control equipment and special low-cost loans would help lick this problem.

One southern Appalachian steelmaker faces a $10 million expenditure, $1 million per open hearth furnace, for air and water pollution control using electrostatic precipitators and scrubbers. From a balance sheet viewpoint, these expenditures will add nothing to the company's operating efficiency. Yet, if the law granting an investment tax credit were still in effect, the cost of buying a more efficient and cleaner operating BOF furnace might be more economical than putting $1 million into cleaning up less efficient and older steelmaking facilities.

Appendix D

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INDUSTRIAL LOCATION RESEARCH STUDIES:

REPORT NO. 25–THE PLASTIC RESINS, ADHESIVES, AND RELATED COMPOUNDS INDUSTRY

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INTRODUCTION

This report is one of a series of Appalachian Location Research Studies prepared for the Appalachian Regional Commission by The Fantus Company under Contract No. C-273-66 (Neg.).

The objective of this research is to identify, examine and evaluate all significant elements of industry location decisions as they relate directly or indirectly to public investment policies and activities that may be considered as economic growth stimulants for the Appalachian Region.

When Fantus began work on this program, agreement had been reached by the Commission that the individual Appalachian states must have available to them a means for reducing the concept of growth to specific kinds of growth. It was further agreed that this could best be accomplished by:

(a) Selecting for study specific types of industry likely to invest in Appalachia as a result of the improvement of advantageous locational factors through public investments. (This report deals with one such industry, specifically Standard Industrial Classification industry code 2821, Plastic Materials, Synthetic Resins, and Nonvulcanizable Elastomers.)

(b) Dealing with industry locational determinants not on the plane of theory but with a deep and incisive understanding of how such determinants operate in the commercial marketplace, including the relative significance of each and, where possible, their quantitative importance.

(c) Examining alternative courses of action that might be taken in the public sector, establishing priorities that appear reasonable and attainable, and likely to stimulate favorable responses in the private sector of the economy.

(d) Presenting findings that are generally meaningful for the entire region rather than specific to individual locales.

Accordingly, this report is presented from the viewpoint of the locational consultant charged with the responsibility of investigating all factors likely to influence management's long-term satisfaction with locations for new facilities.

As necessary background, this report presents information on the structure of the industry, its economic impact, prospects for growth, and developments in technology that are germane to locational activity. The emphasis is on trends now shaping industry growth rather than historical developments which no longer may be significant in the outlook.

A separate summary report contains the methods, procedures, and analyses of industry trends used in the selection of industries for individual location studies.

The judgments expressed in these reports are those of The Fantus Company and do not necessarily reflect the views of The Appalachian Regional Commission.

SUMMARY

This family of industries formulates raw materials for many of the other industries that have growth potential within or near Appalachia. Textiles, paper, softwood plywood, shoes, tufted carpets, and packaging are a few of the major industries buying volume amounts of plastic resins, adhesives, latexes, rosin and related compounds.

The industry tends to locate near its market so that service and supply are closely coordinated. The need for liaison with the customer suggests excellent highways and general air service to accommodate company size aircraft.

Sites to accommodate this industry are readily found near almost any of the Appalachian urban areas. Well developed, fully serviced communities that can furnish amenities to attract and hold scarce technical employees will be a prime location factor.

Occupation-centered training for the long-range needs of the industry should stress attainment of a high school diploma. Prospects for job applicants are heightened by technical courses in chemistry and physics that might be offered at the junior college level.

Improvements in feeder highways, inland waterways and general aviation facilities will contribute to the long-run satisfaction of this industry's needs.

I. PROFILE OF THE INDUSTRY

Size

The manufacture of plastic resins, adhesives, sizing formulations and related compositions represents a very small but important part of a complex of several overlapping industries.

An estimated 350 manufacturers of plastic and resin materials in the U.S. produced 10.1 billion pounds of product in 1964 with sales of approximately $8.7 billion. Only the producers of crude chemical products, such as petroleum and natural gas (their cyclic and acyclic derivatives), exceeded this sales figure in the organic chemical industry.

High volume resins and plastics can be broken into two main categories: (1) thermoplastics, i.e., those plastics which melt with heating, and return, on cooling, to their rigid state usually deformed; (2) thermosetting, i.e., those plastics which retain their form with heating to high temperatures. The 1964 and 1965 production figures are shown in Table 1.

Table 1.

Comparative size relationships of plastics and resins

Product	Type	Production (million pounds) 1964	1965
Polyolefins	Tp	2,883	3,421
Vinyls	Tp	1,920	2,312
Styrenes	Tp	1,729	2,033
Phenolics	Ts	833	922
Alkyds	Ts	594	640
Ureas and Melamines	Ts	570	621
Coumarone-Indene and petroleum polymer	Ts	354	324
Polyesters	Ts	317	399
Acrylic, fluorocarbon, polycarbonate, polyoxymethylene, and miscellaneous	Tp & Ts	233	N.A.

Note: Tp = Thermoplastic; Ts = Thermosetting

It is difficult to keep track of all the end uses for plastic and resin materials. As nearly as can be determined, Table 2 reflects the major market outlets.

Table 2.

Estimated end use markets 1/

End uses	Percent deliveries (pounds) to end use	
	Thermo-setting	Thermo-plastics
Plastics fabrication	12%	58%
Protective coatings	22	2
Bonding, adhesives, textiles, paper, and plywood	28	13
Miscellaneous, including floor tile, rubber, export, and uses not specifically reported	38	27
	100%	100%

1/ Source: Fantus estimates

In 1964, these end uses consumed 3.0 billion pounds of thermosetting resins and 7.1 billion pounds of thermoplastics.

In addition to these synthetic plastic resins, the field embraces natural rosin, synthetic latexes (based upon copolymer resins, synthetic rubbers as well as natural rubber latexes). Excluded are plastic products that are molded, extruded or foamed.

Products and Markets

This report deals specifically with that sector of the industry formulating plastic resins, adhesives, and related compositions that supply the textile, paper, carpet, wood products, packaging, and shoe industries. These materials are supplied to customers as solutions, emulsions, or dry powder.

Textile Industry

In the textile industry, resins and resin compositions are used to make fabrics waterproof or water-repellent, to coat fibers for moisture absorption, to orient fibers for crease resistance, to make fabrics pliable and stain resistant, and to act as fillers in the fabric finishing process. Generally, the compositions for the textile industry fall within the following basic structures:

(1) Acrylic resins.
(2) Melamine-formaldehyde resins.
(3) Polyvinyl acetate resins.
(4) Urea-formaldehyde resins.
(5) Fluorocarbon resins.
(6) Other copolymers.

Paper Industry

Resins used in the paper industry provide protective and decorative coatings and add wet strength properties to paper towels and tissues. The paper industry also uses these compounds to laminate papers, to provide better printing properties, and to control vapor transmission.

Resins, impregnating paper fibers, allow towels and tissues to retain 50 percent of their dry strength. They also replace paper sizes which, after long exposure to fluids, often lose their paper-protecting properties.

Paper converters use a variety of synthetic compounds in surface coating of paper for both decorative effect and physical properties.

Consumption of adhesives by converters in the paper industry is impressive, especially on a weight basis. The predominant adhesives for the paper industry are traditionally inexpensive and include starch, animal glue, and sodium silicate.

Packaging Industry

In packaging, the hot melts have extremely high growth potential because they speed sealing production. Hot melts include the following basic compounds:

(1) Polyvinyl acetate.
(2) Polyethylene.
(3) Vinyl acetate/ethylene copolymer.
(4) Polyamide.
(5) Acrylic.

Corrugated container manufacturers have long been using large volumes of sodium silicate, asphaltum products, and various starch adhesives. They will continue to use these products, except that growing sophistication in the shipping container business has created a great number of end uses for synthetic resin compounds--some of which are used as solutions and others as hot melt adhesives.

The corrugated board industry is hesitating to enter the hot melt sealing market only because of the 60 cents per pound price range. Package quality and high-speed production, available in hot melts, will eventually open this broad market.

It is estimated that the folding carton industry alone consumes $20 million per year of adhesives. Envelope manufacturers consume 25 million pounds of starch, dextrin and polyvinyl alcohol each year.

Shoe Industry

The shoe industry has increased production speeds by replacing nailing and stitching operations with automated adhesive applications. Alternative compounds for the shoe industry include the polyvinyl and styrene-butadiene copolymer resins.

More than 600 million pairs of shoes are produced annually in the U.S. The market here is always growing for neoprene and natural rubber compounds, which are germane to this study.

Wood Products

Manufacturers of plywood, particleboard, hardboard, glued lumber, and structural timber, all use adhesives as basic binders in raw materials. The growth of the softwood, plywood, and laminated timber industry in the Southeast, based on southern pine, is a fresh opportunity for adhesive materials.

Southern plywood companies expect to boost their combined capacity nearly 5-fold, from 800 million square feet per year in 1964 to 4 billion square feet by 1970. More than 30 units are now under construction or planned. Table 3 shows a heavy concentration of expansions within the marketing scope of Appalachian adhesive manufacturers.

Producers of phenol-formaldehyde resins stand to prosper from this boom, because 160 pounds of adhesive (30 pounds of resin) are used in every 1,000 square feet of 3-ply plywood. One of the larger mills alone will consume 40,000 pounds (a trailer tankload) of resin-in-water each day.

Table 3.

Plywood expansions in the South 1/

State	2/, 3/	On-stream	Under construction or planned
Alabama	(24)	1	11
Arkansas	(7)	3	4
Florida	(14)	-	2
Georgia	(24)	1	4
Louisiana	(10)	7	2
Kentucky	(7)	N.A.	N.A.
Maryland	(1)	1	1
Mississippi	(17)	3	2
North Carolina	(76)	2	1
South Carolina	(28)	-	-
Texas	(8)	3	2
Tennessee	(11)	N.A.	N.A.
Virginia	(22)	1	1
West Virginia	(5)	N.A.	N.A.

1/ Source: Fantus files

2/ Source: 1963 Census of Manufactures

3/ Note: Figure represents number of veneer and plywood plants as of 1963.

4/ Note: N.A. = not available

Carpet Industry

Latexes based upon synthetic copolymers, such as neoprene, hold the loops in tufted carpet. This industry has all the earmarks of doubling its production between 1966 and 1970. This market has a large potential around Dalton, Georgia.

Plant Ownership and Size Structure

Plant ownership is spread among an estimated 350 manufacturers, each with product specialization that fits a particular customer's needs. Among 8 of the large organic chemical producers, only two concentrate more than half of their production in resins. Of these 8 large firms, 4 had net sales exceeding $1 billion, but none of these 4 specialized in resin production beyond 20 percent of their sales.

One of the large specialists in the industry grossed approximately $123 million in 1965 and concentrated 76 percent of their sales in resins.

Geographic Prevalence

The Midwest and Eastern Seaboard harbors the major share of plants formulating resins, adhesives, latexes and related compounds. About 11 phenol and melamine-formaldehyde producers specializing in formulations for the plywood manufacturers of the Pacific Northwest have located there. Table 4 shows the geographic prevalence for SIC 2821 that is specific to manufactures of plastics materials, synthetic resins, and nonvulcanizable elastomers.

Major chemical firms invariably ally their compounding of plastic resins with styrenes and similar plastics used in molding and extruding shapes. In view of this, Table 4 must be considered as a sample representation of the industry's geographic prevalence.

Table 4.

Regional distribution of establishments manufacturing in SIC 2821 1/

	No. of establishments
New England	75
Middle Atlantic	156
East North Central	99
West North Central	14
South Atlantic	47
East South Central	17
West South Central	20
Pacific and Mountain	81
	509

1/ Source: 1963 Census of Manufactures

In Appalachia, establishments in the SIC 2821 category number 32, with 15 of the firms employing over 100 persons. Appalachian counties in 6 states (Alabama, North Carolina, Ohio, Pennsylvania, Tennessee and West Virginia) have large plants employing over 100 persons.

Economic Impact

Over one-third of the resin formulator's gross output dollar flows to the primary producers of acetal resins, A.B.S. (Acrylonitrile-butadiene-styrene) resins, epoxy resins, vinyl acetate monomers, polyvinyl chloride resins, urea and formaldehyde. Buying in bulk, basic chemical commodities are formulated by the resin fabricators as a housewife would mix a cake batter.

Table 5.

Direct requirements per $1,000 gross output 1/

(Producer's prices, 1958 dollars)

Purchases from other establishments	Plastic and synthetic materials
Coal mining	$ 5.37
Maintenance & repair construction	6.20
Paper & allied products, except containers	45.24
Paperboard containers & boxes	5.50
Chemicals & chemical selected products	340.87
Plastics & synthetic materials	26.82
Drugs, cleaning & toilet preparations	10.62
Paint & allied products	6.20
Petroleum refining & related industries	13.00
Rubber & miscellaneous plastic products	17.62
Transportation & warehousing	30.70
Electric, gas, water & sanitary services	9.55
Wholesale & retail trade	19.66
Finance & insurance	7.01
Real estate & rental	5.74
Business services	12.57
Gross imports of goods & services	8.38
Other industries	34.29
Total purchases	605.34
Value added	394.66
TOTAL	$1,000.00

1/ Source: September 1965, Survey of Current Business

The foregoing table shows the proportionate share of expenditures by chemical fabricators for all goods and services.

Employees in the chemical industry enjoy a high average annual income of $6,876. A comparison of earnings for all employees within the durable and nondurable goods industries follows:

	Average earnings	
	Annual	Weekly
Chemical industry	$6,876	$132
Durable goods industries	5,824	112
Nondurable goods industries	4,946	95

Needless to say, the location of a resin plant in a community will attract workers because of the relatively high wages paid.

The formulators do not attract their major suppliers of raw materials nor their customers. In fact, the formulators follow the locations of their customers. Primary producers which supply the materials for the formulators locate near their own bulk raw materials in clusters such as the Gulf Coast and West Virginia.

Service firms and mill supply houses specializing in fluid controls, electric motors, and plumbing hardware will flourish as the result of a formulator plant location.

II. THE INDUSTRY'S PROSPECTS FOR GROWTH

Sales

Future growth for the formulators of plastic resins, adhesives, sizing formulations, and related compounds will focus on and grow with the manufacture of paper, textiles, tufted carpets, wood products, shoes, and packaging.

Leaders in their respective industries anticipate future growth to 1970 as shown in Table 6. The index uses 1965 as the base year.

Table 6.

Anticipated growth of target markets 1/

Industry Product	1970 Index of production (1965 = 100)
Paper manufacturing	
Printing papers	118
Sanitary and tissue papers	140
Paper converting	
Coated papers	130
Coated papers using polyvinyl chloride	250
Packaging	
Containerboard consumption of polyethylene	140
Plywood	
Softwood plywood in general	152
Southern pine plywood	500
Shoes	
All footwear	115
Carpet	
Tufted carpet	200

1/ Source: Fantus files and interviews.

Tremendous potential is anticipated in the southern pine plywood industry, which will produce 20 percent of the nation's 20 billion feet of softwood plywood by 1970. Coated papers and latexes for the tufted carpet industry also portend large markets attracting expansions and new plants for the resin and adhesive formulators.

6

Other market potentials have been shown in Section I under "Products and Markets."

Profits

The 8 leading producers in the industry increased their net profits an average of 43 percent between 1963 and 1965. Not one of the 8 increased its profits less than 33 percent over the 3 years.

Typical 1964 profit ratios for the primary and formulating sectors of the industry are represented in Table 7. The range of net profit on tangible net worth is apt to be even higher in the formulating sector than the figures in Table 7 might indicate. Relatively low capital requirements typify the formulating sector of the industry.

Table 7.

Profit ratios in the plastic materials industry 1964 1/

	SIC 282 Plastic materials and synthetic resins (30)
Net profits, percent	
On sales	7.60 5.22 3.01
On tangible net worth	23.33 12.69 9.56
On net working capital	48.72 33.88 19.62

The top figure in each line is the upper quartile, the underlined figure is the median, and the bottom figure is the lower quartile. The number of reporting companies is given in parentheses.

1/ Source: Dun & Bradstreet, Inc.

Employment

Employment in the industry has increased 32 percent in 7 years, with a tendency to increase nonproductive workers slightly more than productive workers. Technical employment is likely to represent much of this increase. Figures in Table 8 give a perspective of employment growth for the synthetic resins industry (SIC 2821).

Female labor represents about 10 percent of the overall employment assigned primarily to office work.

Table 8.

Employment in the plastic resins, adhesives, and related compounds industry 1/

Year	All employees (000)	Women employees (000)	Production workers (000)	Average weekly hours
1958	67.0	-	42.9	41.6
1959	70.0	7.4	45.4	42.7
1960	72.2	7.6	46.2	42.3
1961	71.8	7.2	46.2	42.3
1962	75.8	7.5	49.2	42.3
1963	80.0	8.0	51.2	42.1
1964	81.2	8.0	51.7	42.9
1965	88.1	8.3	55.8	43.5

1/ Source: Employment and Earnings - Establishment Data, Bureau of Labor Statistics.

Productive capacities can be increased substantially without a corresponding increase in employment. Larger batches of formula can be mixed in larger tanks with little additional effort.

It must be kept in mind that while national figures are often useful in measuring growth, they in no way reflect the spurts of growth for specific sectors within the industry. This report has selected sectors of the overall industry which currently demonstrate a growth in excess of the national industry as a whole. Employment trends in the future will have a tendency to follow the growth trends of the target markets, viz; softwood plywood, tufted carpet, coated paper, and packaging.

Locational Activity

Appalachia actually enjoyed a higher percentage increase for plant locations between 1958 and 1963 than that of the entire United States. Table 9 summarizes the location activity within Appalachia between 1958 and 1963.

Table 9.

Locational activity for plastic materials and synthetic resins 1/ (Net Change)

Industry	Establishments 1958	Establishments 1963	Net increase (decrease)	Percent change
SIC 2821				
Total U. S.	349	509	160	45.8
Appalachian	21	32	11	52.4

1/ Source: 1963 Census of Manufactures.

Appalachian locations represent only 6.3 percent of the United States total. Beaver and Allegheny counties in Pennsylvania, and Wayne and Mason counties in West Virginia counted sizable new plant locations between 1958 and 1963.

Since 1963, major plants within Appalachia have been announced as follows:

Location	Announced	Product
Cullman, Alabama	3/65	Paper-coating emulsions
Pittsburgh, Pennsylvania	12/64	Flaked resins
Chattanooga, Tennessee	12/64	Carpet latex
Anderson, South Carolina	4/62	Resins for fiber glass
Point Pleasant, West Virginia	11/65	Polyvinyl chloride

Many resin plant expansion, particularly those for surface coatings and adhesives, go unreported or are masked by other expansion announcements. In most cases, market considerations govern the selection of the plant sites.

The overall growth rate of adhesives is 6.77 percent, figured on a dollar basis. This is far ahead of the rates for the Gross National Product (4 percent) and paper (2.2 percent). Total consumption for all types of adhesives grew from $320 million in 1955 to an estimated $660 million in 1965.

III. TECHNOLOGY AND TRENDS

Manufacturing Processes

The following describes a typical manufacturing process. Raw materials such as phenol, formaldehyde, urea, and caustic soda generally arrive at the plant site by rail and then are pumped into storage tanks. When a new batch of resin is being prepared, the phenol and formaldehyde flow from the storage tanks to feed tanks, where control equipment measures the correct quantities and then charges them into the reactor kettle. The addition of caustic soda follows.

A pump maintains a vacuum in the kettle. Steam moving through the reactor coils raises the temperature of the mixture to the reaction point. The rate of temperature increase is controlled, and the reaction temperature is held within narrow limits for a period of time. Then a gradual lowering of the temperature takes place, and the vacuum is shut off.

The addition of sulphuric acid at this point neutralizes the resin. Steam passes through the coils again and dehydrates the mixture. Cooling and filtering action follows. The finished resin is transferred to storage tanks.

After batching operations, a 2 percent to 3 percent solution of caustic soda is boiled through the reactor kettle to clean the system for the next batch.

Raw Materials

Raw materials depend upon the resin being produced and the use to which it will be put. For example, one plant requires the following amounts per month for its recipes:

Phenol	500,000 lbs.
Urea	200,000 lbs.
Resourcinol	40,000 lbs.
Formaldehyde, 37%	2,000,000 lbs.
Caustic soda	140,000 lbs.
Ethanol	60,000 lbs.
Ammonia	3,300 lbs.
Sulphuric acid	2,900 lbs.

Other important inputs include:

Filtered water	570,000 cu. ft.
Power	25,000 kwh
Steam	270,000 lbs.

Water use amounts to 0.44 cubic feet per pound of resin made.

To make an 8,000-gallon batch of a typical phenol-formaldehyde resin requires:

Phenol	34,780 lbs.
Formaldehyde, 37%	44,540 lbs.
Caustic soda, 50%	1,368 lbs.
Sulphuric acid, 66^{O}Be	838 lbs.

The materials for an 8,000-gallon batch of urea-formaldehyde formulation, which eliminates the staining in thin veneers experienced with the phenols, consist of:

Urea	17,800 lbs.
Formaldehyde, 30%	59,250 lbs.
Boric acid	2,900 lbs.
Caustic soda, 50%	Varies

Manpower Utilization

Males constitute the principal part of the work force. In an operation involving 50 people, approximately 10 percent would be female, generally clerical workers.

The largest number of workers engage themselves in management and maintenance duties. Smaller numbers involve materials handling, 8 percent; production, 8 percent; quality control, 4 percent; applications testing, 8 percent; and the remainder on customer services. Because of problems relating to product consistency, extensive quality control is required. The control section not only tests the resin to see that it meets constituent specifications, but mixes it with a catalyst, water, and flour to make glue and subjects it to application breakdown testing.

Product Innovation

In recent years, new resins have led to the tremendous expansion in southern pine plywood. In a broad coastal sweep from

Maryland to Texas, 50 new plywood plants are on-stream or planned. It was only in 1964 that the first pine plywood plant in the South went into operation.

The technical problem which had to be overcome stemmed from the rough surface evident on the plies of southern pine plywood. Instead of continuously common surfaces, the washboard facing of southern sheets provided only intermittent contact bonding. However, the resin producers developed a new phenol-formaldehyde formulation suitable for holding the laminations together.

Sizable efforts are being directed toward specialized adhesives to utilize the wood waste. As much as one-third of the wood is normally wasted. Efforts to recover these materials and use them in hardboard or other types of bonded wood products continue to grow in importance. Closely related to wood adhering, but broadened to join dissimilar materials, are the innovations leading to rapid growth in the building industry.

In the packaging field, other uses of resins being uncovered by applied technology include seals on flour bags. Here, preapplied adhesive strips on flour bags are reactivated by a machine after being filled with flour. The packaging machine then folds down and compresses the top into a siftproof seal. Not only is the seal siftproof and stronger than older stitched closings, but it also protects against the entrance of insects.

Technology precipitating cost reductions will open up a 300-million-pound market for sealing corrugated boxes.

Protein and carbohydrate glues have been found wanting, particularly in their resistance to water. Although some had written off their use as the new thermosetting and thermoforming resins came on the market, technology entered the picture on the side of the agricultural derivatives and came up with hybrids through chemical cross-linking from resin donors to obtain water resistance. Urea and melamine resins often act as these insolubilizing agents.

Distribution

Resin-makers like to locate right in the middle of their projected market. Outbound shipments are chiefly made by rail or tank truck to large users in the plywood, furniture, paper converting, paper and foundry industries. Producers will be often found in city or metropolitan areas well oriented to their customers. Smaller shipments of granules, beads, rod, sheet, and blocks are packaged in bags for LTL transport.

IV. PRIMARY FACTORS INFLUENCING SELECTION OF LOCATIONS

Introduction

New locations for formulating plants in this industry follow their markets. For example, growth in the Pacific Northwest plywood industry created a demand for adhesives that attracted plant locations of eastern suppliers.

General plant sites can usually accommodate the smaller plants. Wherever bulk commodities are concerned, such as in this industry, waterways and railroad spur tracks reduce the cost of materials and materials handling.

Water supply for processing and waste disposal capacities are major criteria for locations. Electric power and natural gas are additional factors that must be considered, particularly where heat is required to reconstitute compounds.

Community living conditions, regional amenities for attracting and retaining specialized personnel, and the probability of finding some local help with technical skills are also considerations given to location decisions.

Ramifications of these and other factors are evaluated in this section.

Market Considerations

Proximity to their major market is of prime importance to the formulators of plastic resins, adhesives, latex, or rosin. As a result, the industry will tend to locate in those areas where growth outlets are available and will thus be sensitive to industrial development within Appalachia. Two major considerations influence this high degree of market orientation: (1) the necessity for close liaison between the formulator and the consumer; and (2) the fact that most outbound shipments are made with freight prepaid.

As with many chemical formulations, minor discrepancies in the raw material mix or in the mixing process itself, can mean significant distortions of product properties. Moreover, the peculiar nature of an individual customer's machinery may require specialized mixes for efficient operation. In all, customer service considerations are extremely important in gaining and holding new markets.

The cost impact of absorbing outbound shipping charges is self-evident and could mean the difference of profit or loss to the small-time formulator. As an additional consideration, the plant located proximate to its markets can provide deliveries with minimum lead time and allow customers the benefit of optimum inventory levels.

Transportation

The close customer-supplier relationship requires consistently frequent and dependable passenger transportation by air or highway. Nearby general aviation airports might also benefit large companies who fly their own planes between plants and customers.

Excellent highway transportation is most important. Roads with weight limits in excess of 70,000 pounds to accommodate bulk tank trucks are most necessary.

Specialized tank truck carriers handle the greater share of this bulk traffic. Common carriers often are necessary to handle the less-than-truckload shipments of materials in bags or drums.

A railroad spur is most essential to allow for low-cost inbound shipments of the bread-and-butter raw materials. Specialty formulators may penetrate distant markets in volumes that would require rail tank or hopper car service outbound as well.

Low-cost water transportation is sometimes a means of competing for heavy volume business where costlier transportation might eliminate a profit margin.

Plant Sites and Utilities

General purpose sites of 30 to 100 acres are usually adequate. Some very sizable formulating plants have selected navigable river sites for inbound raw material transportation. They must be flood-free at the plant level.

Clean water from local systems or nearby well water often must be stabilized to exacting limits compatible with the chemical process.

Seven to 20 acres of land might be necessary for anaerobic lagoon processing of waste water before emptying into community systems or river flows. State and local sanitation requirements should always be assessed before locating. River flow or community systems might not be capable of handling unusual effluents with high BOD or insoluble materials.

Power sources vary considerably by the heat requirements for a particular chemical reaction. Emulsions and common compounding often require no heat, and the limited power for small motors is all that is necessary. The power range is too broad to be meaningful when described as "typical."

Gas heat is an alternative that formulators might consider in a location. Where power failures might ruin a costly batch of materials or freeze the materials in a machine, gas or auxiliary power units might prove their value.

Labor

Male labor with at least a high school diploma is often an employment prerequisite. Since costs of materials are high and equipment is expensive, quality labor is readily paid well. High employment selection ratios of 12-to-1 are not uncommon.

Technical labor skills are limited in number for a formulating plant. The process and quality control limits can easily be maintained by semiskilled workers once the limits have been established by the lead chemists and engineers.

Maintenance crews for plumbing and electrical work must have at least one master in the trade with several assistants who are capable of improving their skills. Cleaning crews need only low-skilled labor.

Community Environment

Communities must have better-than-average amenities in order to attract and retain the few highly skilled chemical engineers and the technical management that perform the key roles in a formulating plant. Plant locations tend to locate near large urban areas where services are complete.

Landscaped, trim residential areas with neighborhood parks, recreation areas, and nearby shopping centers are normally expected by the management personnel in this industry.

School systems that have a record of placing a high proportion of graduates into colleges and universities are always measured before a location decision is made. Technical management, themselves college graduates, cannot expect much less for their children. Communities with poor records are overlooked.

Fire protection is necessary at a plant location. Modern extinguishing equipment using foam, carbon dioxide, and spray nozzles is desirable for combating fires. Generally, however, the industry is formulating nonvolatile materials.

Police protection is anticipated as a routine location factor and goes along with the other conditions that tend to attract the industry toward well-established urban areas.

State and Local Taxes

Taxes are relatively minor factors in locating when a volume market is nearby. Economies of primary location factors offset most tax advantages. A stable tax policy is more often considered than enticements of low taxes. Communities where the tax base is limited to real property are preferred over those that tax goods in process and/or equipment.

V. SELECTING PUBLIC INVESTMENT POLICIES AND ACTIVITIES WHICH WILL ENHANCE THE COMPETITIVE POSITION OF APPALACHIA

Introduction

Location factors cited in Section IV adequately outline the possibilities for improving local conditions that will tend to attract this industry.

This section of the report emphasizes those areas where public investment and activities by federal, state, and local agencies can enhance the attraction of Appalachia for this industry.

Market Development

The industry's sensitivity to its markets was indicated in Section IV. Market orientation prescribes a locational pattern which characterizes this industry as a "follower." Thus, the most effective public action possible will be oriented to the industrial development of the Region. As a result, activities recommended in separate reports covering the "Pulp and Paper" and the "Textile" industries would have a beneficial effect on this industry. Similarly, efforts directed to gaining new footwear or wood products establishments will also create new markets.

Transportation

Improved feeder highways are essential for this industry. It may not engage in interstate business as much as it does in intrastate business. Highways to rural areas that accommodate paper mills, plywood plants, and furniture factories would be highly beneficial.

Waterway channels that can take drafts of 9-foot depth will add to the attractiveness of riverside sites sought by the bulk formulators.

Rail transportation is essential for inbound raw materials even though a waterway source may handle most of the traffic. Policies leading to improved through-car service reduce the volume requirements of inventories in transit and in bulk storage.

General aviation airports that might accommodate two-engine company aircraft are in need of improvement in numerous Appalachian communities. Radio facilities, runway lighting, maintenance hangars, and 8- to 12-hour operations control are future possibilities for improvement.

River Sites

Flood control projects combined with channel dredging could fill flood plains with river sand to levels well above flood stage. Impacted with stone dikes and piers, a very attractive plant site for this industry might be developed. Of course, substantial subsurface soil conditions must first be explored for bearing ability.

Skill-Oriented Training Programs

Technical labor requires a high school diploma at a minimum. The formulating of resins, adhesives, latexes, and related compounds requires very highly skilled lab technicians and quality control supervisors in the critical batching processes. Working with formulas, weights, and measures, a highly skilled person is required to commit thousands of dollars in irretrievable raw materials to a blender.

Lab training, supported with a chemistry and physics background, is almost mandatory for long-run employment security in this industry. Further education at a junior college level would develop better qualified technicians.

In addition, requirements for electricians, plumbers, and inventory and shipping personnel demand technical skills not common in most secondary education today.

Training programs must be oriented to the needs of industry. Frequent consultation with industrial managers in an area can often prepare or adjust curricula that will make a trainee a more valuable employee capable of earning a higher income.

Labor Considerations

The relatively high labor selectivity ratio noted in Section IV mirrors the heavy emphasis on technical skills within the industry. Since manning requirements are generally small but strict, detailed labor statistics will only be pertinent if measurements of quality are included. Morevoer, the reliance on technical skills tends to further the urban orientation of the industry.

Community Environment

Because of the prevalence of managerial, supervisory, and technical skills, new locations of this industry will gravitate to the more fully developed, attractive communities.

In reviewing the suitability of a community, heavy emphasis will be placed on general attractiveness, standards of education, community facilities, and cultural and recreational amenities.

Appendix A

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(15) Waterborne Commerce of the U.S., 1964, Department of the Army, Corps of Engineers.

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Unpublished Information and Personal Contacts

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(2) Fantus dossiers of manufacturing corporations.

(3) Fantus economic geography files for states and communities.

(4) Manufacturers of resins, plywood, carpets, footwear and containers.

(5) Area development organizations (state, local, railroad, electric and gas utilities, TVA, etc.).

(6) Labor union contracts.

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