

LIGHT METAL CASTINGS

**A MANUFACTURING
OPPORTUNITY IN GEORGIA**



by Ben W. Carmichael: Prepared for Georgia Department of Commerce
ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY

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L I G H T M E T A L C A S T I N G S

A Manufacturing Opportunity in Georgia

Prepared for
The Georgia Department of Commerce
Abit Massey, Director
100 State Capitol
Atlanta, Georgia

by

Ben W. Carmichael
Research Engineer

and

Walter Kennon
Research Economist

Industrial Development Branch
Engineering Experiment Station
Georgia Institute of Technology
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Foreword

The market for light metal castings in the area analyzed for this report offers an excellent opportunity for a manufacturer in Georgia. Like some of the earlier studies in this series, this has generated active interest on the part of manufacturers in the field. One small "home-grown" plant is already in the process of being established.

This study is designed to help answer questions which major manufacturers and local firms may have regarding opportunities which exist in the broad field of light metal castings. Subsequent reports will provide more detailed information on specific products or product complexes which can be profitably manufactured in Georgia. A report on die casting is in preparation now.

Comments and questions regarding the study are invited.

Kenneth C. Wagner, Head
Industrial Development Branch

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In particular we are grateful for the many firms who answered the two questionnaires sent out--one to producers and one to consumers of light metal castings.

Summary

This study evaluates the area market for light metal castings and the specific market for aircraft and missile castings in Georgia and five surrounding states.

In 1957 the area had an estimated market for commercial aluminum castings of approximately \$14 million. An increase of better than \$1 million or about 10 per cent a year is indicated. The commercial castings consuming industries such as automotive parts suppliers are moving into the area now more rapidly than they are growing nationally. However, relative to the nation as a whole the area is still below the average in industries that consume commercial light metal castings.

The area market in 1958 for aircraft and missile light metal castings was approximately \$10 million. This figure includes zinc and magnesium as well as aluminum. Since the commercial casting market included only aluminum, and since some, but not all of the aircraft and missile aluminum castings were included in the commercial castings analysis, the two figures cannot be combined simply. Nevertheless, the study indicates that the total six state market for light metal castings would be well over \$20 million for 1957.

The existence of this market is considered good assurance that a large castings firm capable of producing \$1 million or more worth of castings per year will find consumers for its products in the area. Such a firm is not now located here.

Statistical analysis was used to derive estimates of the southeastern market both by state and by industry. These estimates are for aluminum only, since data for other light metals are not available. The market is expressed in terms of pounds and dollar amounts.

A questionnaire was sent to some 700 plants in four digit categories listed by the Census of Manufacturers as consumers of aluminum castings. The replies answered many qualitative questions about the market. The quantitative results gave figures of a known portion of the total consumption, but these could not be expanded to derive total market figures.

The study of the general market for commercial light metal castings led to the realization of the substantial market potential that is developing in aircraft and missile castings. A rather detailed analysis was then made of this potential.

The six state market for aircraft and missile castings was expected to reach \$10 million in 1958 and is increasing by leaps and bounds. Since this section of the country has already developed a concentration of missile producing and testing facilities, it can be safely assumed that additional facilities of this type will locate nearby.

It has been estimated that better than 90 per cent of aircraft and missile casting consumption in the six states is produced outside the area. Many of these castings are supplied from California and from New Jersey. The present volume as well as the large amounts that will be needed by the new plants comprise a sizeable market that should be attractive to a well qualified producer.

Purchasing departments of aircraft and missile producers in the area have expressed strongly a need for nearby suppliers. They have at the same time stressed the necessity of quality production. Quality requirements are much more strict for aircraft and missile castings. The market is apparently open and can be shared by concerns that will furnish the necessary quality.

A local supplier could serve the six state market and could maintain the close contact desirable for engineering and design changes. The resulting good service to the consumers should place the qualified casting company desirous of capturing a portion of this market in an excellent position to do so.

I. THE LIGHT METALS CASTING INDUSTRY IN THE SOUTHEAST

The most promising prospects for future expansion in the castings industry are in light metals. Aluminum presents the best opportunity with new applications from tried and proven techniques of manufacture. Zinc has a large volume and growth primarily due to the increasing importance of die casting. Magnesium, important for special applications where light weight is an important characteristic, has its major use in missiles and aircraft. Its heat resistance is being improved through the development of new alloys. There is every indication that in terms of growth potential the light metal castings industry is in its infancy, with a promising future ahead. Yet it is a mature industry and has already developed many valuable capabilities.

Market Orientation

The raw material for the industry is economically available anywhere, since the producers of pigs and ingots will ship anywhere in the United States at the same price. Primarily for this reason the industry is market oriented. Since the southeastern market is increasing rapidly and new casting-using industries are moving into the area, it would be profitable for light metal foundries to be established in the area. This is not true for the ferrous metals, which are so heavy in relation to volume and value that there must be a price differential for freight. In this case the foundries tend to be located with a pull toward both the raw material and toward the market.

Production Facilities in the Southeast

Table 1 gives the location of the various types of foundries in the six state area by molding technique and by metal used in casting. The number of foundries for the years 1955 and 1957 are compared where available. The construction of 21 new aluminum foundries in the six state area (as compared with a national total of 65) in the three year period 1955 through 1957 is of particular interest. The increase in permanent mold and shell molding facilities indicates a progressiveness in the area's industry in adapting new techniques.

Table 1

GROWTH OF LIGHT METAL FOUNDRIES IN THE SIX STATES AND U. S.
1955-1957

<u>Kind of Metal</u>		<u>Ala.</u>	<u>Fla.</u>	<u>Ga.</u>	<u>N. C.</u>	<u>S. C.</u>	<u>Tenn.</u>	<u>Six State Area</u>	<u>U. S.</u>	<u>Six State as % of U. S.</u>
Aluminum	1955	39	45	32	43	16	36	211	3,046	6.9%
	1957	47	51	36	47	19	32	232	3,111	7.5
	Change	8	6	4	4	3	-4	21	65	
Magnesium	1955	1	2	1	2	2	3	11	245	4.5
	1957	1	2	1	-	1	1	7	218	3.2
	Change	0	0	0	-2	-1	-2	-4	-17	
Zinc (1955 N.A.)	1957	4	10	3	1	-	5	23	864	2.7
<u>Method Used</u>										
Permanent Mold	1955	7	11	10	3	-	7	38	680	5.6
	1957	6	14	9	5	1	6	41	755	5.4
	Change	-1	+3	-1	2	1	-1	3	75	
Investment Mold	1955	1	-	-	-	1	1	3	132	2.3
	1957	-	-	-	-	-	1	1	153	.6
	Change	-1	0	0		-1	0	-2	21	
Shell Mold	1955	4	1	5	-	1	2	13	396	3.3
	1957	12	7	3	3	1	6	32	590	5.4
	Change	8	6	-2	3	0	+4	19	194	
1955 figures were not available for the following:										
Die Casting	1957	7	11	8	4	-	8	38	1,080	3.5
Centrifugal Casting	1957	10	3	1	1	-	1	16	229	6.9
Plaster Mold	1957	6	2	5	2	2	1	18	217	8.3
Pattern Shops	1957	75	36	41	41	19	54	266	2,908	9.2

Source: Pentons Foundry List

Captive and Custom Molding

The casting industry is composed of captive and custom molding shops. Captive molding is done by the company using the casting in further fabrication and eventual assembly into the final product. The casting operation is one phase of the company's overall manufacturing activity. Molding is so closely integrated with other operations of the company that the economics of location are those of the company and not of an independent casting operation. Machinery manufacturers often have captive molding for certain parts.

The largest captive molder of light metals in the Southeast is the Ford Motor Company at Lister Hill, Alabama. In this case the Ford plant is located adjacent to the Reynolds Aluminum plant. Reynolds delivers the hot metal to the Ford plant where it is molded into finished parts without the necessity for remelting.

Custom molding is done by independent companies who contract for work. The customer gives the specifications for the molded part. Most consumers, even those with a large volume of castings consumption, purchase castings from custom molders. Companies often have neither the equipment nor the trained personnel for captive casting. In many cases they do not have the funds and the inclination to enter this field. These companies would rather devote their energies to assembling and selling the final product rather than casting basic component parts. Some companies have captive molding for their normal volume but depend upon custom molders for peak and special production. Thus custom molders have an established position where manufacturers cannot or do not care to make their own castings.

A comparison of the volume of custom molding is shown in Table 2. About half of all custom molding is by die casting. In 1947 only 110 million pounds were custom die cast. In 1957, 374 million pounds were custom die cast--an increase of over three times in 11 years. Custom die casting has also increased relative to the total aluminum casting by all methods. In 1947 custom die casting was only 25 per cent of the total. By 1957 it was 50 per cent. At the same time there was an increase in captive die casting. In the same 11 years the percentage of captive die casting increased from somewhat under 20 per cent to almost 30 per cent of total die casting. This gain in captive die casting over custom die casting is more than compensated for by the large and expanding total market.

Table 2

ALUMINUM CASTINGS--PER CENT JOB SHOP BY TYPE
(1,000 Pounds)

<u>Year</u>	<u>Total Castings</u>		<u>Sand</u>		<u>Permanent Mold</u>		<u>Die Casting</u>	
	<u>Total</u>	<u>% for Sale</u>	<u>Total</u>	<u>% for Sale</u>	<u>Total</u>	<u>% for Sale</u>	<u>Total</u>	<u>% for Sale</u>
1957	751,818	74.6	143,991	80.1	232,326	77.7	373,586	70.9
1956	794,581	74.8	171,781	78.6	245,421	80.2	376,230	69.8
1955	820,780	77.6	165,482	78.5	298,349	80.6	355,203	75.1
1954	623,054	76.8	156,555	82.7	214,407	82.4	245,291	70.4
1953	658,022	79.5	214,553	81.7	200,025	82.6	239,330	76.1
1952	518,979	78.5	194,616	81.5	146,883	79.9	169,732	76.4
1951	515,131	75.9	193,378	75.7	160,011	75.8	151,465	79.5
1950	543,082	74.9	184,782	72.0	181,366	73.8	167,201	82.7
1949	304,616	73.9	106,825	67.4	102,908	73.6	88,109	86.4
1948	424,490	73.1	139,781	69.8	161,334	69.0	118,738	84.0
1947	441,996	73.4	155,112	75.8	174,515	66.6	110,538	81.2

Basic Data Source: Facts For Industry

In contrast, custom casting for sand and permanent mold is gaining in relation to captive casting by these methods. In the last 11 years custom sand casting increased from 75 to 80 per cent of the total permanent mold from 66 to 77 per cent.

Casting by all methods is expanding comparatively rapidly. Certainly this strong national trend is amplified regionally for, as we shall see, industries that are users of castings are moving into the area. The opportunity is developing in Georgia for a large, well-equipped custom castings producer.

II. THE MARKET FOR CASTINGS

Estimating and Forecasting the Market

National data on aluminum castings are available by year from 1946 until the present; data on other light metals are not given with much regularity. We shall therefore base our analysis of the market for light metal castings on the aluminum castings data and draw analogies concerning the other important light metal castings. The analogies are warranted by the similarity of the markets and from the fact that aluminum castings are the most important in terms of value and growth.

Data for aluminum custom castings are not available on the six state market basis. We must therefore work with the national data which are available for most years from the Census of Manufacturers, trade associations and industry sources.

Three approaches were used to estimate the southeastern market. (1) Aluminum castings consumption was correlated with a measure of manufacturing activity which was analyzed by state. This provided estimates of the total poundage for each state, and the estimates were totaled for the six state region. (2) Aluminum custom casting consumption by state and by industry was estimated from Census data on consumption per employee by industry, and from data on the number of employees in each industry by state. (2) Finally, estimates of casting usage and some qualitative factors concerning the market were obtained from questionnaires sent to specific companies.

Thus, there are market estimates at three different levels of detail: the total by state, by industry, and finally by specific consuming segments.

It is reasonable to believe that consumption is related to general industrial production, since castings are component parts of a wide variety of products. It follows from this hypothesis that the problem of market estimation becomes one of selecting a measure of industrial production which is closely related to casting consumption, and which is available by state.

These two conditions are more stringent than they may first appear. Most of the direct measures of production must be eliminated from consideration, as they are not available by state. For example, the Federal Reserve Bank Index of Industrial Production measures the relative change over time, but not the distribution of production among states.

A measure of industrial production found suitable for this purpose was manufacturing wages and salaries. These figures meet the first condition of

being available by state and of indicating the amount of industrial production over a period of time for purpose of regional analysis. Furthermore, aluminum castings consumption seems to have a functional relation to this measure of industrial production. The estimate of this relationship is that aluminum castings consumption in pounds is equal to 0.0102 times the dollar amount of manufacturing wages and salaries. (For details of this correlation see Appendix A.) This relationship, with a forecast of manufacturing wages and salaries, was used to forecast aluminum castings consumption for the six state market.

The real but indirect association between castings consumption and manufacturing wages and salaries may be shown as follows: wages and salaries, as might be expected, are very closely associated with the Federal Reserve durable goods production index,^{1/} which in turn is closely related to aluminum castings production.^{2/} This implicit relationship was used to estimate castings consumption from manufacturing wages and salaries for the six state market.^{3/}

The resulting first approximation was refined by introducing a correction factor to adjust for the differences in the composition of area industry in terms of the casting consuming industries as compared with national industry.

Actual wages and salaries for 1946-57 and the forecast through 1970 are shown in Figure 1. The forecast was made by a straight line projection, which is conservative and tends to lessen the influence of inflation.

Since the poundage of castings consumed increases by one pound for each \$98 increase in manufacturing wages and salaries, the total market for aluminum castings in Georgia would be about 13 million pounds by 1960. It would be 70 million pounds in the six state area.

The overall market estimate and forecast shown in Table 3 is a good indication of what consumption would be if the area consumed the same as the national average for all industry. It is based upon the manufacturing wages and salaries as a general measure of manufacturing. Yet this overall estimate does not apply to the area industries in one major respect: in the six state market the industry mix in terms of aluminum castings consuming industries is lower than the national total.

^{1/} r = 0.98

^{2/} r = 0.93

^{3/} r = 0.92

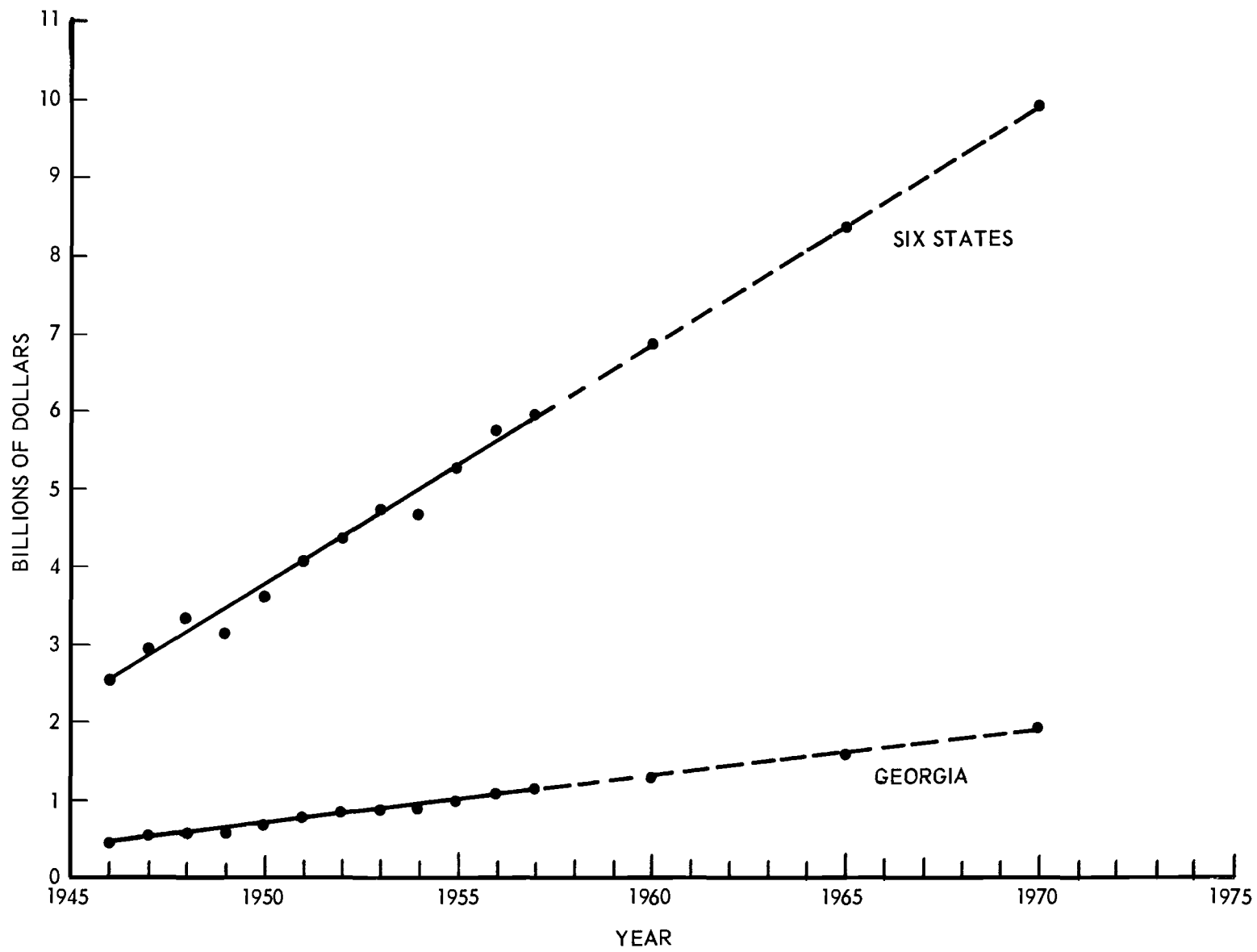


FIGURE 1
MANUFACTURING WAGES AND SHARES; GEORGIA AND SIX STATES

Table 3

SUMMARY OF DERIVATION OF ALUMINUM CASTING CONSUMPTION
IN GEORGIA AND SIX STATE AREA

	Manufacturing Wages and Salaries (million dollars)		Aluminum Castings Consumption Potential (million pounds)		Industry Mix Factor %		Consumption Corrected for Industry Mix (million pounds)		Value at .65¢/lb. (million dollars)		
	Georgia	6 State	Georgia	6 State	Georgia	6 State	Georgia	6 State	Georgia	6 State	
ACTUAL	1946	457	2,507	4.66	25.57	23.3	20.4	1.09	5.22	0.71	3.39
	1947	522	2,956	5.32	30.15	23.4	19.7	1.24	5.94	0.81	3.86
	1948	586	3,318	5.98	33.84	24.5	20.4	1.47	6.90	0.96	4.48
	1949	562	3,125	5.73	31.87	29.3	22.1	1.68	7.04	1.09	4.58
	1950	665	3,607	6.78	36.79	27.4	18.8	1.86	6.92	1.21	4.50
	1951	763	4,089	7.78	41.71	34.1	20.9	2.65	8.72	1.72	5.67
	1952	814	4,362	8.30	44.49	41.3	24.0	3.43	10.68	2.23	6.94
	1953	878	4,750	8.95	48.45	46.7	26.0	4.18	12.60	2.72	8.19
	1954	880	4,691	8.98	47.85	58.5	31.0	5.25	14.83	3.41	9.64
	1955	999	5,256	10.19	53.61	60.5	30.9	6.16	16.57	4.00	10.77
FORECAST	1956	1,087	5,723	11.09	58.37	58.0	32.6	6.43	19.03	4.18	12.37
	1957	1,104	5,983	11.26	61.03	59.1	34.8	6.65	21.24	4.32	13.81
	1960	1,293	6,820	13.19	69.56	75.2	37.5	9.92	26.09	6.45	16.96
	1965	1,596	8,362	16.28	85.29	95.6	44.8	15.56	38.21	10.11	24.84
	1970	1,900	9,905	19.38	101.03	116.0	52.1	22.48	52.64	14.61	34.22

Source: Industrial Development Branch Analysis

The Probable Market

To derive a mix factor, which may serve as a correction agent, manufacturing wages and salaries in the "castings consuming" industries^{1/} are compared to total manufacturing wages and salaries in Georgia, the six state area, and the U. S.

Thus

$$\frac{\text{Total Wages and Salaries for Consuming Industries in Georgia}}{\text{Total Wages and Salaries for All Industries in Georgia}} \quad +$$

$$\frac{\text{Total Wages and Salaries for Consuming Industries in the U. S.}}{\text{Total Wages and Salaries for All Industries in U. S.}} \quad = \quad \text{Index for Georgia}$$

Table 3 shows the values of the regional mix index for Georgia and the six state area for the period 1946 through 1957. Georgia leads the six state area largely because of the automotive and aircraft plants in the state. Straight line trends are fitted to the indexes and projections obtained to 1970. The mix factors are used to adjust the casting consumption estimates obtained by correlation with manufacturing wages and salaries.

The Dollar Amount of the Castings Market

The dollar value of castings varies with type and use. Castings used for supports require only simple casting and finishing and are relatively inexpensive. This is true for many castings used in sheet metal work and woodworking machinery. In other cases, and especially in the aircraft industry, aluminum castings are used in applications where strength is important or where the use is for moving parts which must be cast and machined to close tolerances. These differences are reflected in the per pound value of castings, illustrated in Table 4.

The value varies from \$0.46 to \$1.29 per pound, with an average of \$0.65 per pound. This average is further verified by the total dollars and pounds of consumption in 1954 for the United States for 65 industries included in the census figures. This average cost was \$0.68 per pound, which is quite close to the \$0.65 per pound for the 20 industries. Since only the overall poundage of castings are available and projected, this \$0.65 value is used to convert

^{1/} Automobile, Other transportation, Machinery (except electrical), and Electrical Machinery.

Table 4
 JOB SHOP CONSUMPTION OF ALUMINUM CASTINGS - 1954
 (U. S. Total)

<u>S.I.C.</u>	<u>Industry</u>	<u>Pounds (1,000)</u>	<u>Value (\$1,000)</u>	<u>Value Per Pound</u>
1900	Ordnance and Accessories	8,429	\$ 7,715	\$ 0.92
3439	Heat and Cooking Equipment	3,126	1,731	0.55
3442	Metal Doors and Sash	9,997	4,793	0.48
3444	Sheet Metal Work	4,596	2,103	0.46
352	Tractors and Farm Machinery	14,889	8,773	0.59
3551	Food Products Machinery	2,843	2,402	0.84
3552	Textile Machinery	1,569	1,139	0.73
3553	Woodwork Machinery	3,807	1,767	0.46
3559	Special Industries Machinery	2,588	1,779	0.69
3581	Domestic Laundry Equipment	23,587	12,752	0.54
3589	Service and Household Machines	2,675	2,077	0.78
3613	Electric Measuring Instruments	2,328	2,097	0.90
3621	Electric Appliances	15,757	10,176	0.65
3661	Radio and Related Products	14,930	8,267	0.55
3715	Truck Trailers	1,073	838	0.78
3717	Motor Vehicles and Parts	145,925	80,333	0.55
3721	Aircraft	13,197	17,064	1.29
3722	Aircraft Engines	15,418	15,109	0.98
3729	Aircraft Equipment (nec)	14,752	16,025	1.09
3821	Mechanical Measuring Instruments	11,812	7,803	0.66
	Total	<u>313,298</u>	<u>\$204,743</u>	<u>\$ 0.65</u>

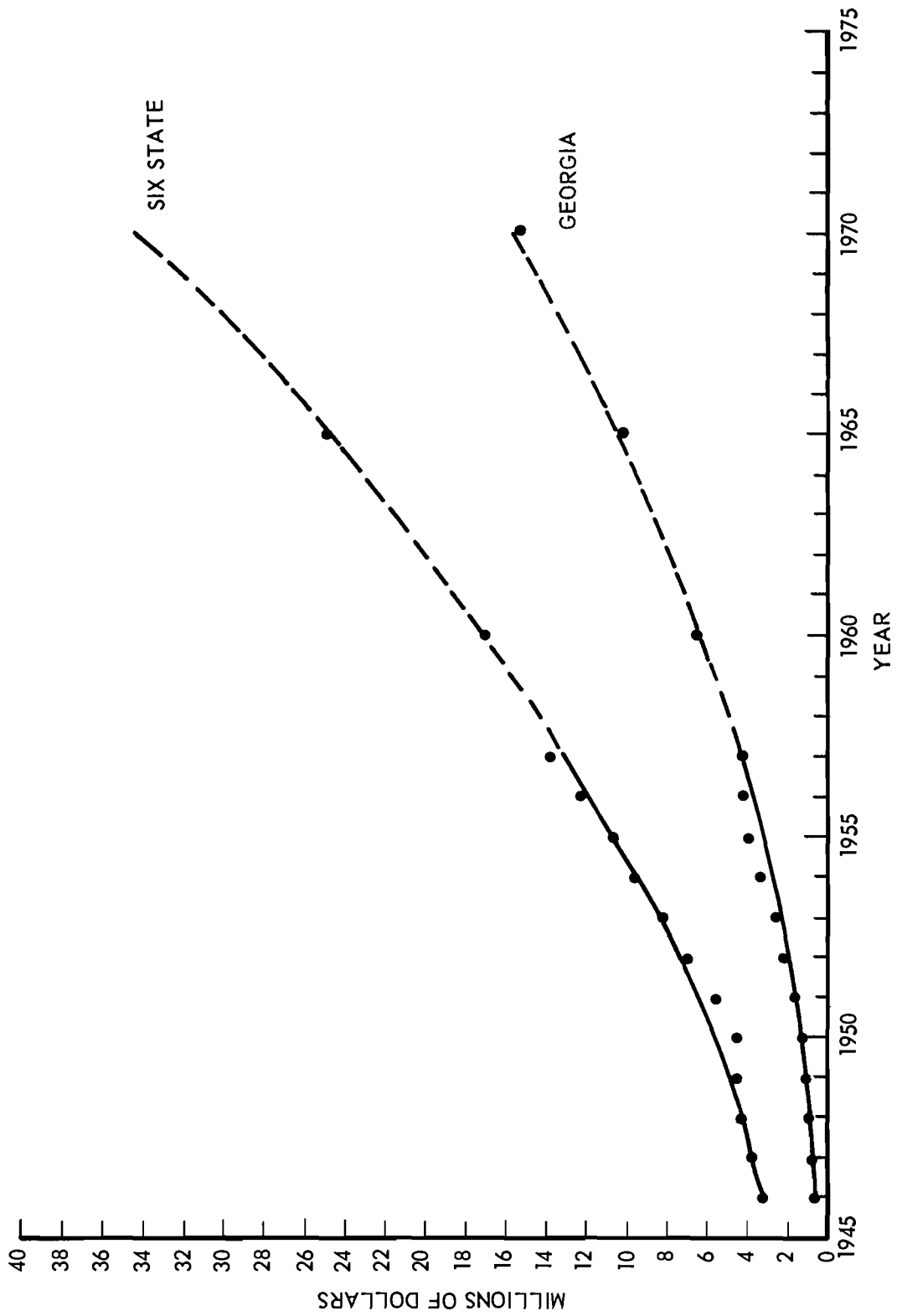
Source: 1954 Census of Manufactures

from pounds to dollars. The derivation of the dollar amount of the aluminum castings market is presented in Table 3, and the results are illustrated in Figure 2.

The results indicate a Georgia market of \$6.4 million by 1960, with the six state area consuming \$17.0 million by that year.

The leading position of Georgia in this analysis is due in part to the large automotive and aircraft assembly plants that have been established in the area in recent years. Some of this estimated market is not yet developed. For example, the regional automotive assembly plants buy few castings directly. They are secondary consumers and buy castings as component parts from suppliers. The primary castings consumer is the component parts manufacturer. The addition of these satellite industries to supply the automotive plants with components will therefore be necessary to develop the regional market for castings.

FIGURE 2
POTENTIAL CONSUMPTION OF ALUMINUM CASTINGS



III. CONSUMPTION BY INDUSTRY OF ALUMINUM JOB SHOP CASTINGS

The Market by Industry, Based on 1954 Census Data

The market estimates derived in Section II are based on a correlation with manufacturing wages and salaries in the region with a mix factor used to adjust these estimates. Castings are somewhat selective in industrial applications and are not used by all industries in the same quantities. Moreover, it is particularly desirable to know the consumption in Georgia and the Southeast by industry.

The Census of Manufacturers of 1954 reports the national consumption figures of custom or job shop aluminum castings by industry. From these data the value of consumption per plant worker for each industry has been calculated.

An estimate of the 1957 market by industry was made by multiplying the dollar amount of casting consumption per employee by the number of employees in each industry. The results of such an analysis for the six state markets are presented in Table 5.

The 20 industries tabulated are the major casting consumers in the Southeast and account for about 80 per cent of the six state market and for about 60 per cent of the national market.

With a custom aluminum casting consumption of \$6,294,853 indicated for these 20 industries, the total list of consuming industries consumed about \$8 million, as the 20 industries represent only 80 per cent of the consumption. Custom castings are 75 per cent of total aluminum castings consumption on a national basis. If we assume this proportion maintains in the six state area, then total aluminum castings consumption would be about \$10.7 million. To this we must add still one more figure, because the missile industry was not included as a consumer in the list. When we add in the amount of \$5 million, the 1958 estimate of consumption of aluminum castings by the missile industry determined in a later section of this report, we obtain \$15.7 million.

This figure checks closely with the \$13.81 million obtained in the first section.

This analysis of aluminum castings consumption by industry indicates that the aircraft industry is the largest consumer, with Georgia a leader in this industry. Tennessee has the largest consumption of all the six

Table 5

**ALUMINUM CASTINGS CONSUMPTION BY INDUSTRY
SIX STATE MARKET - 1957**

Old SIC Code	Industry	Consumption Per Plant Worker 1954	Number of Plant Workers (1957)						Six State Total	1957 Six State Consumption
			Alabama	Florida	Georgia	N. C.	S. C.	Tennessee		
3721	Aircraft	\$ 53.21	5,231	70	11,865	-	-	-	17,166	\$ 913,402
3729	Aircraft Equipment NEC	120.39	-	880	-	-	-	5,793	6,673	803,362
3581	Domestic Laundry Equipment	783.01	-	-	-	-	-	800	800	626,408
3442	Metal Doors, Sash and Trim	166.20	467	2,413	498	50	100	66	3,594	597,322
352	Farm Machinery and Tractors	86.00	858	376	910	755	-	2,472	5,371	461,906
3821	Mech. Measuring Instruments	168.37	20	43	250	50	-	1,650	2,013	338,928
3661	Radios and Related Products	38.26	145	360	140	6,862	400	65	7,972	305,008
3717	Motor Vehicles and Parts	148.07	700	60	400	475	-	314	1,949	288,588
3552	Textile Machinery	43.52	21	-	824	3,408	1,624	159	6,036	262,686
3589	Service and Household Machinery	333.19	50	80	25	40	-	526	721	240,229
3439	Heat and Cook Appt. NEC	31.63	995	58	799	200	-	4,661	6,713	212,332
3444	Sheet Metal Work	72.02	243	394	748	652	215	475	2,727	196,398
3715	Truck Trailers	66.57	828	120	1,341	67	22	373	2,751	183,134
3559	Spec. Industrial Mach. NEC	57.42	1,145	20	794	295	-	322	2,576	147,913
3621	Electrical Appliances	270.28	20	90	-	400	-	-	510	137,842
3722	Aircraft Engines	129.20	-	947	70	-	-	-	1,017	131,396
3613	Electrical Measuring Instruments	89.64	-	165	-	1,198	-	-	1,363	122,179
3553	Woodworking Machinery	219.33	75	-	-	263	-	195	533	116,902
1900	Ordnance and Access.	45.47	821	60	200	795	-	440	2,316	105,308
3551	Food Products Mach.	110.33	-	509	271	45	-	114	939	103,599
Total for 20 Industries										
Number of Plant Workers			11,619	6,645	19,135	15,555	2,361	18,425	73,740	73,740
Dollar Consumption of Castings			\$788,907	\$859,299	\$1,205,273	\$965,155	\$119,549	\$2,356,668	\$6,294,853	\$6,294,853
Average Dollar Consumption per Plant Worker			\$67.90	\$129.32	\$62.99	\$62.05	\$50.64	\$127.91	\$85.37	\$85.37

Source: Consumption per plant worker: 1954 Census of Manufactures
Number of plant workers by industry: 1957 Iron Age Basic Marketing Data on Metalworking

states, primarily due to the manufacture of domestic laundry equipment, mechanical measuring instruments, aircraft equipment, and farm machinery and tractors. There is a substantial castings market in Florida for metal doors, and aircraft equipment and engines. North Carolina has a large market for castings in radios and textile machinery.

The Market by Industry, Based on Questionnaire Results

To identify specific customers and to estimate their purchases, a questionnaire was sent to over 700 different companies who consume castings.^{1/} The results of this questionnaire are summarized in Table 6. The consuming firms are indicated by industry to preserve their identities.

Over \$1.5 million in custom aluminum castings and over \$1 million in zinc castings can be identified by consuming companies. Since these figures represent only 31 per cent of the consumers contacted, the actual market is assumed to be somewhat larger.

The questionnaire also revealed \$155,000 spent in the purchase of captive castings in the six state region, mostly in textile and farm machinery production. A light metals custom foundry in the region with the requisite equipment and quality production may be able to obtain as part of its market many of the castings now produced in these captive shops.

Although some of the aircraft consumption is contained in Table 6, none of the consumption by missile producers is included.

Aircraft and missile castings are in reality a separate market from commercial castings. The castings are of a different and generally higher quality which requires special production techniques and more exacting quality control. A special analysis has been made for this market and is set forth later in this report.

Expected Increase in Consumption and Additional Facilities Desired by Consumers

To get some indication of the expected increase in light metal casting consumption and foundry facility requirements, the questionnaire sent to potential consumers in the Southeast contained three questions:

- (1) What increase in use of castings do you now contemplate?
- (2) What additional casting facilities would you like to have in the Southeast? (Indicate your preferred location.)
- (3) How would additional casting facilities close to you affect your consumption?

^{1/} See Appendix C for the questionnaire form.

Table 6

FOUND CONSUMPTION OF LIGHT METAL CUSTOM CASTINGS
SIX STATE MARKET - 1959

(Based on Questionnaire)

S.I.C.	Industry	Aluminum			Number of Consuming Plants	Zinc	
		Sand	Permanent	Die		Die	Number of Consuming Plants
3433	Heating Equipment (Except Electric and Water Heaters)					\$ 585,000	2
3442	Metal Doors, Sash, Frames, Molding	\$300,000			1	425,000	2
3444	Sheet Metal Work		\$50,000		1		
3522	Farm Machinery and Farm Tractors	2,000			2	4,000	1
3551	Food Products Machinery	32,200			4		
3552	Textile Machinery	26,800		\$10,650	11		
3553	Woodworking Machinery		5,000		1		
3559	Other Special Industry Machinery	5,409			6		
3589	Other Service Industry Machines	5,150		500	2	4,500	2
3611	Electric Measuring and Test Instruments			400,000	1		
3631	Major Household Cooking Equipment	5,000			1	2,500	1
3634	Minor Electrical Appliances	18,000	7,500		1		
3662	Radio and TV Transmitting Equipment Signal Devices			3,000	1		
3679	Electronic Components NEC	2,000		64,800	2		
3721	Aircraft	440,000	140,000		2	7,200	1
3821	Measuring and Control Instruments	5,000			1		
	Total	\$841,559	\$202,500	\$478,950	37	\$1,028,200	9

Note: Includes only amounts obtained from 31 per cent response to the questionnaire.

Most of the firms using castings predicted an increase of about 10 per cent per year. A few firms indicated an even larger increase. One company in the steel construction industry indicated an increase of 50 per cent during each of the next two years. One branch manufacturing plant of electrical equipment in the area anticipated an increase of 200 per cent during each of the next two years. Some firms replied that they were not planning increased consumption. One anticipated a decrease.

Die and precision molding facilities seem to be the principal requirement for the area. Seven replies listed them as a requirement but volunteered no details. As expected, most companies expressed a need for a foundry close to their company. One company in Johnson City, Tennessee, indicated a need for a magnesium foundry in Johnson City. A water conditioner manufacturer in Jacksonville, Florida, indicated a need for a foundry in Jacksonville. In Miami two manufacturers of aluminum building material indicated a need for an aluminum foundry as near Miami as possible.

According to the questionnaire replies, additional casting facilities would have very little effect on the amount of castings consumed. There would be added convenience, reduced freight cost, and more rapid delivery. The customer could work closer with the supplier for a better product designed to meet exacting specifications. This is especially advantageous for new and high quality products.

Although the replies for the most part indicated that no increase in consumption was expected from locating a foundry close to the consumer, in fact, there probably would be an increase if the foundry were actually so located. With freight savings and a closer contact with the supplier, consumers would probably substitute light for heavy metal castings or for other types of parts. Two consumers specifically indicated that they would redesign their product to use more castings and take advantage of lower costs if a foundry were located closer.

IV. AIRCRAFT CASTINGS--A VERY SPECIAL CASE

So far this analysis has been of commercial castings. These are the standard grades used for lawn mowers, automobiles, vacuum cleaners, and other mechanical products. There are only ordinary quality requirements for these castings.

Aircraft castings are quite different. Extremely high quality is essential. Special X-ray examinations for quality are ordinary procedures for aircraft castings but are almost unknown for commercial castings. Shops equipped for commercial castings are usually not equipped for aircraft work. The skills of the workers are quite different. Aircraft and missile plants in the region do not have captive plants and in fact are encouraging the establishment of job shops to supply them with castings. Company executives will readily discuss their needs with a potential supplier. They will give technical specifications and references and engineering assistance in starting production when needed. Of course the foundry itself would need a full-time engineer experienced in aircraft castings.

As might be expected, aircraft castings are the most expensive in the industry, with values exceeding \$1.00 per pound. (The average value of commercial castings is only \$0.65 per pound.)

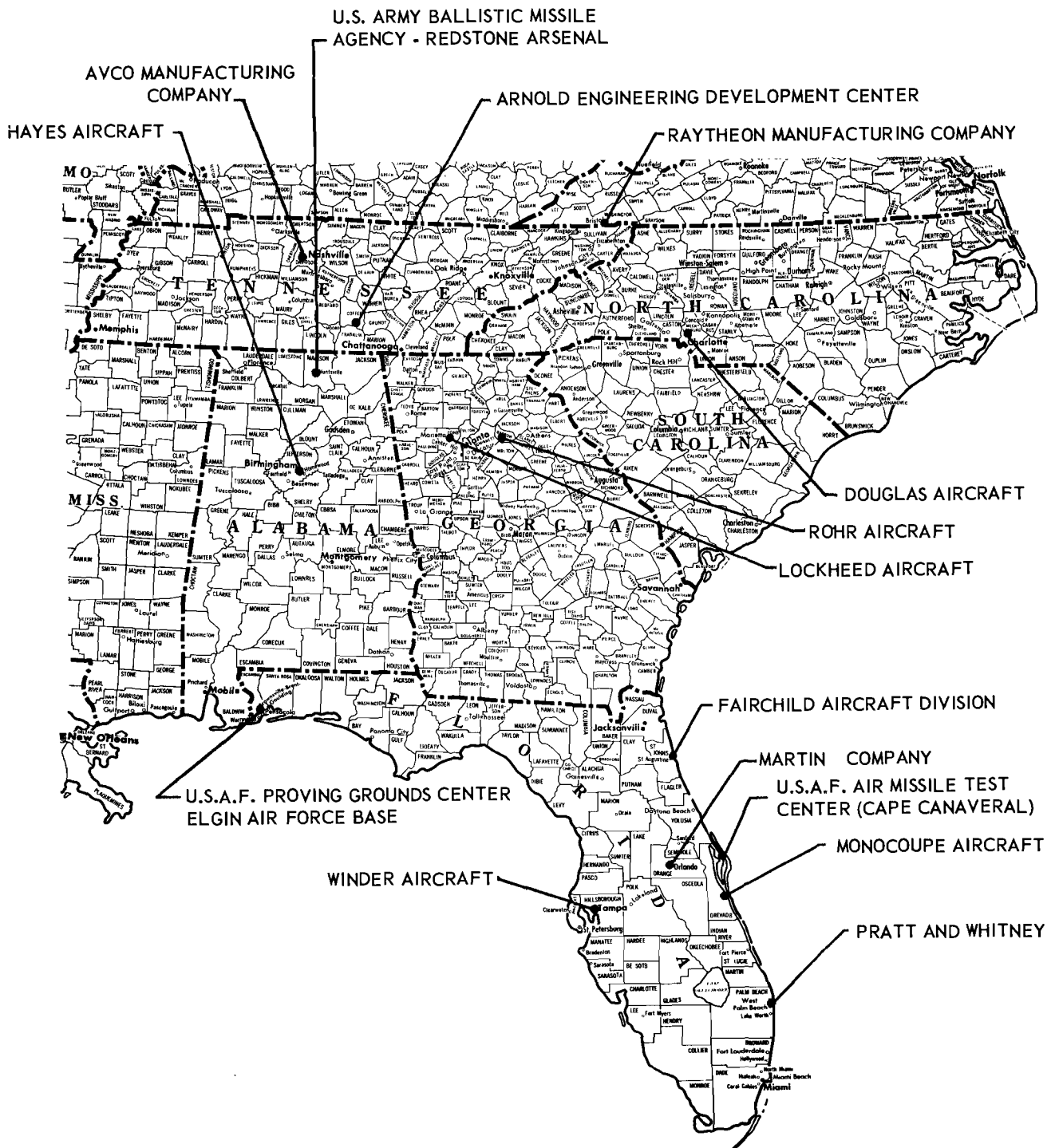
There is a good market in the six state area, yet it is estimated that over 90 per cent of these castings are purchased outside. Figure 3 shows the location of the aircraft and missile plants in the Southeast.

Growth

Aircraft and missile production foretells a rapidly growing market for light metal castings. Missiles appear to have special promise for future growth in the six state area. Production nationally increased from \$718 million in 1955 to \$3,444 million in 1959 (estimated)--an increase of almost five times in only four years. Missiles are rapidly replacing aircraft in many military applications.

Air Force officials have reported that by 1962 missile procurement would be up 500 per cent over 1956, and would exceed the dollar amount spent for aircraft. In 1955, missiles accounted for eight per cent of total military aircraft and missile expenditures, but in 1959, missiles were 33 per cent of the total.

FIGURE 3
 LOCATION OF AIRCRAFT AND MISSILE MANUFACTURING AND TEST
 FACILITIES IN THE SIX STATE AREA



The military is the major consumer for aircraft and missiles. In 1957, the last year when both civilian and military production figures are available, military production amounted to over 85 per cent of the total. Therefore, the light metal foundries serving the aircraft industry must be prepared to do business with the military services and to work under government contract.

Factors Affecting Consumption

The future growth of aircraft and missiles production should see a corresponding increase in the castings market. In fact, the castings market may well increase at an even more rapid rate for at least two reasons: (1) New alloys of aluminum allow production of castings with tensile strength of 38,000 psi ultimate, 20,000 psi yield, and elongation of three per cent. These castings can be used in many instances in the place of cast iron or steel. (2) The intricate shapes and parts of some missiles can be made most effectively by casting. Often several parts which must be welded or bolted together can be replaced by a single casting. Castings of thin section with stiffening ribs molded in are being used as control surfaces.

Castings are less subject to vibration and to buckling under stress than welded assemblies and are free of strains usually encountered in welded pieces.

With these technical factors joining with the economy of casting production a sizable increase in the market for aircraft and missile castings can be expected.

Estimates of Consumption in the Six State Area

The analysis of aluminum castings consumption by industry made from the 1954 Census data has indicated that the aircraft industry was the major consumer in the area at that time. The missile producers and producers of missile system components were not in existence when the 1954 survey was made and thus were not included as important consumers for the 1957 analysis.

The questionnaire survey revealed some of the missile manufacturers. These and all others known to be in the aircraft or missile industry in the six state area are listed in Appendix B.

The firms on this list have been contacted by questionnaire or personal interview, or an estimate was made of their consumption based on information obtained from trade sources.

The dollar value amounts estimated to be consumed have been tabulated in a manner calculated not to reveal any one company's consumption. Table 7 presents the totals of the estimates for the six state area for aircraft and for missiles manufacturers by type of metal cast. Table 8 gives the totals for the six state area by casting method used and by type of metal cast.

The surprising total of \$9 million worth of castings consumed by the missiles and missile component manufacturers as compared to about \$1 million consumed by the aircraft manufacturers certainly points up the growing importance of the missile industry--which was not even included as a consumer in the 1954 Census figures.

It is only fair to say, however, that the two major consumers of castings for missiles production take about 80 per cent of the noted consumption. However, this may point up the fact that the other missile producers in the main are not as far advanced in getting into production. This will mean that as these newer plants move into full production that their consumption will skyrocket. The missile industry in the area already exceeds the aircraft industry in number of workers employed. Additional production and test facilities are being contemplated.

With the missiles industry clearly pointed out as a major consumer along with the aircraft industry in the area, it will be profitable for anyone considering location of a new casting facility to serve these industries to consider location in Georgia as the center of the missile market.

Quality Control Requirements

Abstracts from a specification list of one aircraft manufacturer are given in Appendix C. These particular specifications apply to aluminum alloy castings. Since other metals must meet similar specifications, those for aluminum serve to give an idea of the requirements. It must be stated that the manufacturers contacted stressed almost without exception that quality was the main requirement in aircraft and missile castings. The belief was expressed that it would be difficult for anyone not already in the business to produce castings for aircraft and missile industries. Requirements are so much more demanding than for standard commercial castings that aircraft and missile castings are felt by many people in the industry to be in an entirely separate category.

Table 7

ESTIMATED CONSUMPTION OF LIGHT METAL CASTINGS BY
AIRCRAFT AND MISSILES INDUSTRIES, SIX STATE AREA, 1958

	<u>Aircraft</u>	<u>Missiles</u>	<u>Total</u>
Aluminum	\$855,000	\$4,998,500	\$ 5,853,500
Magnesium and Zinc	127,200	4,250,000	4,377,200
Total	\$982,200	\$9,248,500	\$10,230,700

Table 8

ESTIMATED CONSUMPTION OF LIGHT METAL CASTINGS BY AIRCRAFT AND
MISSILE INDUSTRIES, BY METHOD OF CASTING, 1958

	<u>Aluminum</u>	<u>Magnesium and Zinc</u>	<u>Total</u>
Sand	\$3,415,000	\$2,100,000	\$ 5,515,500
Permanent Mold	1,115,000	1,920,000	3,035,000
Die Casting	856,000	257,200	1,113,200
Other	467,000	100,000	567,000
Total	\$5,853,500	\$4,370,000	\$10,230,700

Special Equipment Required

It can be seen that to meet the specifications outlined and satisfy all production requirements, a sizable investment in quality control equipment and procedure would be necessary. An estimate of \$100,000 has been calculated for the cost of quality control equipment. Purchase of some of the equipment might be postponed by contracting for some of the services until the company's sales volume was large enough to justify ownership of the equipment.

Some of the necessary quality control services are available on contract in the area. Others might develop once a substantial need is established. Some may have to be installed in the casting plant.

Contract Facilities Available

Heat treating facilities are available in Atlanta, Birmingham, and Chattanooga. Certification by the Air Force may have to be obtained, but there should be no trouble in doing this once the need is established. X-ray analysis must ordinarily be contracted, as the consumer may require inspection by a third party. Two possible contractors are available now in Atlanta. Chemical analysis is also available in Atlanta.

Zygló inspection techniques as well as pattern service would probably be set up in the producer's casting plant.

Comments of Consumers of Aircraft and Missile Castings

Several companies engaged in aircraft and missile production have made comments pertinent to the situation that will be of interest to prospective producers. The essence of some of these are listed. Most consumers were very interested in having production foundries close by for convenience. Some of their comments are given below:

Missile Manufacturers:

1. Our castings consumption is dependent on defense projects. We would like to have additional aluminum and magnesium precision casting facilities in the Southeast. Facilities close to us would increase consumption and we would have better control of any changes.

2. We would obtain better delivery from casting facilities close to us.

3. Missile castings require as high quality as aircraft castings. It takes special know-how to supply them. Reliability of performance is the big need in missiles, for it is a one-shot proposition. We would like to see additional suppliers in the area and would do business with a qualified supplier but cannot guarantee any specific amount of business.

Aircraft Manufacturers:

1. Would like steel investment castings and aluminum sand castings in Marietta or Atlanta. Must have suppliers that know how to turn out aircraft quality castings. These castings require more know-how than usual commercial castings and would call for more quality control and inspection equipment as well as the engineering and knowledge usually gained from experience in the field.

2. Our castings requirements vary radically. We would want a qualified source of supply. We would prefer Birmingham.

3. All of our requirements are supplied by our main plant in the West.

4. We have adequate suppliers in Atlanta for our requirements. (Aircraft and missile subassembly manufacturer.)

Present Sources of Supply

The major portion of aircraft and missile castings consumed in the six state area now comes from outside the area. There are some suppliers of a small amount in the Atlanta and Chattanooga areas, however. The major suppliers are in California, New Jersey and the industrial Midwest, Missouri and Illinois.

When the supplying company was mentioned, it quite often was a large producer of castings and one that would not be too dependent on the demand from any one customer. Several suppliers are specialists in the aircraft and missile castings field and have this as their major if not their entire market. There is a genuine fondness for the producer who can turn out the necessary quality. More than one consumer suggested that a present supplier might be the one to establish a new branch in Georgia. In any event, the estimated dollar volume and the strong interest consumers have in seeing a plant established certainly offer an excellent opportunity for a quality producer in Georgia.

Appendix A

ALUMINUM CASTINGS PRODUCTION CORRELATED WITH
TOTAL MANUFACTURING WAGES AND SALARIES
(U. S. TOTAL)

Year	Y	X
	Aluminum Castings (1,000,000 lbs.)	Manufacturing Wages and Salaries (\$1,000,000)
1957	751.7	\$ 80,630
1956	794.6	77,697
1955	820.8	72,132
1954	623.1	65,948
1953	658.0	69,773
1952	519.0	62,918
1951	515.1	58,232
1950	543.1	49,393
1949	302.5	43,860
1948	424.5	46,459
1947	442.0	42,500
1946	388.7	36,476

Source: Facts For Industry
Survey of Current Business

Regression Equation: $Y_c = -37.32 + 0.0102S$

Standard Error of the Estimate: 64.00

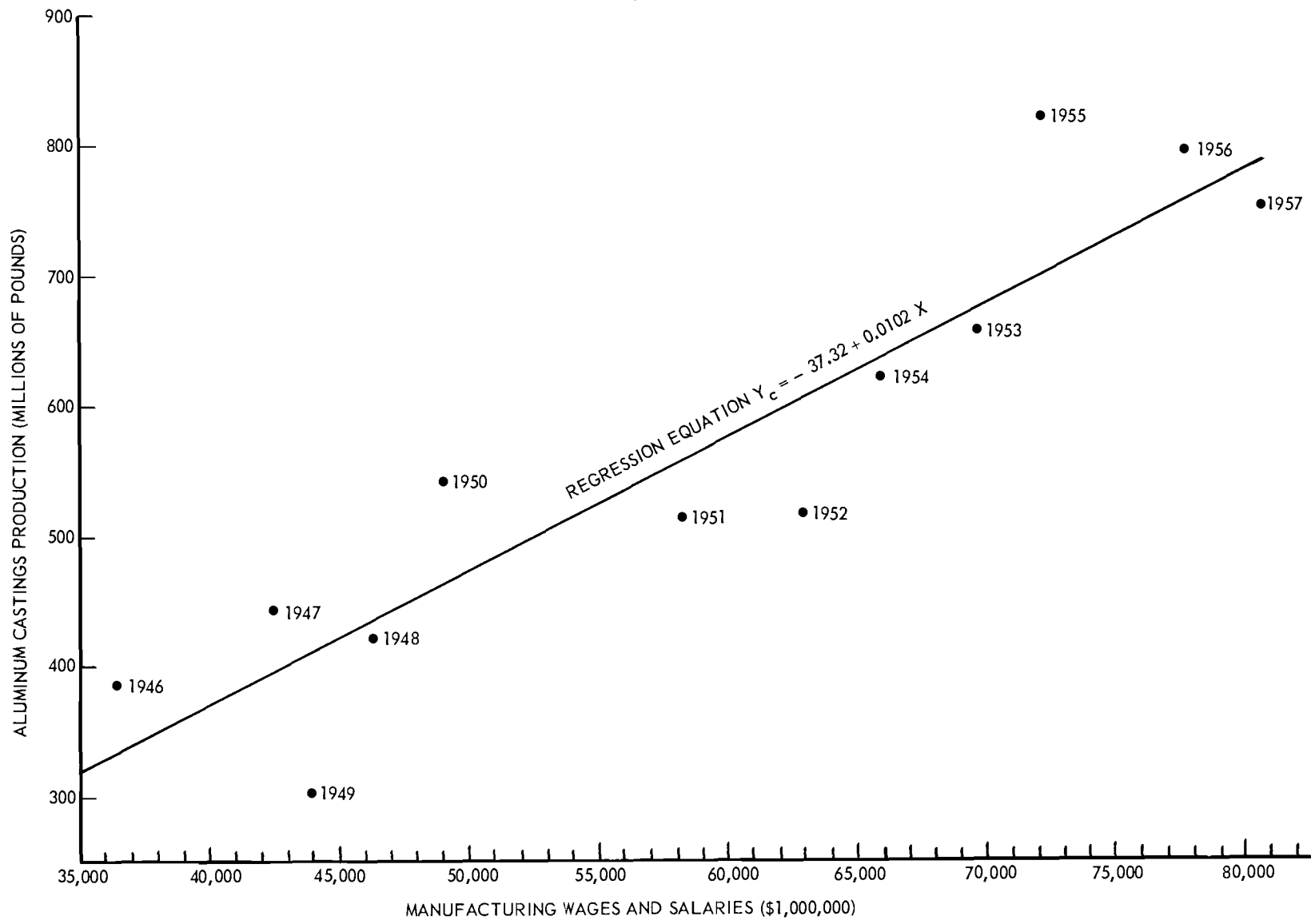
Coefficient of Correlation: 0.9156

It is assumed that Production equals Consumption.

With a constant term only 58 per cent of the standard error, the constant term could be zero after allowing for random fluctuations. Therefore the estimating equation reduces to $Y_c = 0.0102S$.

Other correlations between castings and manufacturing wages and salaries by individual industries or groups of industries do not have as high a correlation. The correlation with the wages and salaries of only those industries which are major users of castings (automobile, other transportation, machinery except electrical, and electric machinery) has a coefficient of correlation of only 0.9038 after correcting for the number of degrees of freedom. Therefore the correlation of castings consumed with total manufacturing wages has the highest correlation.

FIGURE 4
ALUMINUM CASTINGS PRODUCTION CORRELATED WITH TOTAL MANUFACTURING
WAGES AND SALARIES



Appendix B

LIST OF AIRCRAFT, MISSILE, AND COMPONENT MANUFACTURERS IN THE SIX STATE AREA

Alabama

Chrysler Products, Huntsville, research and development, about 50 employees.

Hayes Aircraft Corporation, 50th Street at Municipal Airport Area, Harry T. Rowland, President. Aircraft armament, repairs and modification. Over 8,000 employees.

Redstone Arsenal, Huntsville, 2,500 - 5,000 employees. Research and development on rockets and guided missiles, including research on propellants, manufacture and storage of ammunition, storage of strategic materials, storage of machine tools, directs--nationally, research and development, procurements and field service missions in rocket and guided missile fields.

Florida

Boca Raton Tool and Gage, P. O. Box 402, C. W. Hubbard, Owner, Instrument housing, aircraft, 6 employees, Boca Raton.

Fairchild Aircraft Division (St. Augustine Branch Plant), St. Augustine, 800 employees, P. O. Drawer 58, O. A. Berthiaume, Assistant General Manager, Modification and overhaul of B-26 bombers.

Florida Flight Engineering Corporation, 4051 N. W. 26th Street, Miami 42, 10 employees, H. D. Coonley, President. Jet aircraft, plastic products.

Helicopters International, Inc., St. Petersburg, 20 employees. Overhaul and rebuilding of helicopters.

The Martin Company, Orlando, Florida, 7,000 plus employees, 500 Elwell; P. O. Box 2831, Ed G. Uhl, Vice President. Missiles and electronics, La-crosse guided missiles for U. S. Government.

Minneapolis-Honeywell Regulator Company, St. Petersburg, Aeronautical Division, Florida Plant, 600 employees, 13550 U. S. Highway 19, M. P. Fedders, Vice President. Inertial guidance, engineering, design and development systems and components; manufacturing and testing of prototype systems and components.

Piper Aircraft Corporation, Vero Beach, Development Center, 30 employees. Designed construction, testing and development ready for production of new models of small commercial airplanes.

Monocoupe Aircraft of Florida, Inc., 50 employees, P. O. Box 1328, R. G. Sessler, President. Aircraft. Melbourne (near Cape Canaveral).

Pratt and Whitney Aircraft Division of United Aircraft Corporation, 2,000 employees, Plant N. W. of West Palm Beach, P. O. Box 2691, Charles T. Roelke, General Manager. Research and Development, aircraft engines.

Sperry-Rand Corporation, Microwave Electronics Division, Oldsmar (near Tampa), 150 employees, plant: Route 584; Mail: P. O. Box 1828 Clearwater, Eugene J. Venaglia, Manager. Aircraft and missile guidance systems, electronic instrumentation.

Turbin Products, P. O. Box 1187, Boca Raton, O. A. Johnson, Plant Manager, 75 employees. Parts, aircraft.

Univair of Florida, Inc., Deland, 600 employees. Aircraft conversion (Military).

U. S. Air Force Proving Grounds Center, Elgin AFB, Pensacola.

U. S. Air Force Air Missile Test Center, Cape Canaveral.

Winder Aircraft Corporation, P. O. Box 2397, Lakeland, K. B. Bush, Manager. Guided missile boosters, metallic rectifiers, test panels and radar reflectors. 150 employees.

Georgia

Aid Corporation, Clayton, Georgia, 65 employees, Missile and aircraft sub-assemblies.

Lockheed Aircraft, Marietta, aircraft, 15,000 employees.

Rohr Aircraft Corporation, Winder, 50 employees. Aircraft engines.

North Carolina

Douglas Aircraft Company, Inc., Charlotte Division, 1820 Statesville Avenue, Charlotte, Sheldon P. Smith, Manager, SIC 3729, 1001-1500 employees. Missiles.

Mills Manufacturing Corporation, P. O. Box 8068, Asheville, Ernest A. Mills, President, SIC 3729, 101-250 employees.

Western Electric Company, Inc., Lexington Road, Winston-Salem, SIC 3661, Winston-Salem, F. E. Henderson, Manager. Missile components and systems. There are six plants in the area. This is the home office for the group. Here is employee distribution:

<u>Number of Plants</u>	<u>Employees per Plant</u>
1	101-250
3	1,001-1,500
2	over 2,500

Tennessee

Aluminum Taper Milling Company, Inc., Tullahoma Division, Tullahoma, 125 employees. Main office: El Segundo, California, 1956. Aircraft parts. Armond S. Groves, Plant Manager, Corp. Charles F. Milton, P. A.

Arnold Engineering Development Center (U. S. Air Force), Tullahoma. Testing of structures.

Avco Manufacturing Corporation--Corsley Division, Nashville Plant, Vultee Building, Nashville, 2800 employees. Main office: Cincinnati, Ohio, 1939. Home appliance, aircraft and missile parts. Bernard Clark, Manager, Corp.

Bryce, Inc. Erin, 85 employees, 1956. Precision parts. Ken Cross, Manager, Corp.

Flexonics Corporation, Memphis, 300 employees, 2021 South Latham Street, 1952, Bellows, flexible tubing and aircraft component parts. C. H. Levey, Manager, Corp.

Raytheon, Bristol, Missiles.

R. E. Bell, Manufacturing Company, Memphis, 140 Hernando Street, 30 employees, 1942. Centrifugal and diaphragm pumps, aircraft hardware. R. E. Bell, Sr., Prop.

Sperry Farragut Corporation, Bristol (Division of Sperry-Rand Corporation), 1952, 1,000 employees. Precision military equipment, Charles S. Rockwell, Manager, Corp. S. J. Nastro, P. A.

Tennessee Aircraft, Inc. Berry Field, Nashville, 1941, 90 employees. Precision sheet metal units for aircraft, guided missiles, and electronics. G. L. Riegel, Executive Vice President, Corp. W. C. Miesner, P. A.

Appendix C

ABSTRACTS OF SPECIFICATIONS FOR AIRCRAFT CASTINGS

Condition

Castings shall be furnished in the solution heat treated artificially aged condition. The heat treating facilities may be required to be certified by the air force.

Composition

<u>Element</u>	<u>Per Cent</u>
Silicon	6.5-7.5
Magnesium	0.2-0.4
Copper	0.2 max.
Iron	0.6 max.
Manganese	0.3 max.
Zinc	0.3 max.
Titanium	0.2 max.
Other elements	0.05 max.
Aluminum	Remainder

Chemical Analysis Specimens

When specified, shall be cast with and supplied with each lot of castings.

Tensile Strength

The test casting shall be chosen at random from a lot which have passed radiographic inspection. Failure of any specimen to meet tensile properties listed below shall be cause for rejection of entire lot represented.

Tensile Properties:

Casting Thickness Represented Inches	Tensile Strength (ULT) Minimum LBS/Sq.In.	Yield Strength at .2% Offset or at Extension Indicated E = 10,300,000 Minimum P.S.I.	Extension Under Load Inch Per Inch	Elongation in 2 Inches or 4D - 4W Minimum Per Cent
0 thru .124	36,000	24,000	.0043	5.0
.125 thru .249	34,500	23,000	.0042	4.5
.250 thru .499	33,000	22,000	.0041	4.0
.500 thru .749	31,500	21,000	.0040	3.5
.750 thru 1.000	30,000	20,000	.0039	3.0

Quality

Castings shall be uniform in quality and condition, sound, clean and free from foreign materials.

Castings shall not be repaired by plugging, welding, or other methods without written permission from the purchaser. Castings shall not be impregnated, chemically treated or coated to prevent leaking unless specified or allowed by written permission.

Radiographic Inspection

Laboratories performing X-ray inspection shall be certified in accordance with Government specification and purchaser's quality control department.

Penetrimeters shall be employed to determine the sensitivity obtained by the radiographic technique and the choice of the radiographic standard for dispersed effects.

All radiographic examinations shall be performed with a technique which will be capable of indicating the presence of defects having any dimension equal to 3 per cent of the section radiographed for magnesium and 2 per cent for other metals.

Appendix D - Questionnaire

LIGHT METAL CASTINGS

Principal Products _____

Number of Employees _____

1. What is your annual consumption of light metal castings in dollar values?

	<u>Aluminum</u>	<u>Magnesium</u>	<u>Zinc</u>
Sand Mold	\$ _____	\$ _____	\$ _____
Permanent Mold	_____	_____	_____
Die Casting	_____	_____	_____
Other	_____	_____	_____

2. What per cent of each of the above do you produce in your own company?

3. Will you list some of the specific castings you purchase in volume from other companies?

<u>Casting Description</u>	<u>Annual Dollar Purchases</u>	<u>Supplier Location</u>
_____	\$ _____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

4. What increase in use of castings do you now contemplate? _____

5. What additional casting facilities would you like to have in the Southeast?
(Indicate your preferred location)

6. How would additional casting facilities close to you affect your consumption?

Your name _____ Title _____