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INTERNALLY GENERATED FACTORS AFFECTING EXPANSION OF ALUMINUM FABRICATION OPERATIONS IN THE PACIFIC NORTHWEST

by

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(Stanley Vance)

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PREFACE

This thesis is basically an analysis of the industrial market for aluminum in the Pacific Northwest. As such it does not include many of the variables that would have to be examined in order to determine the profitability of expansion of aluminum fabricating facilities in the region. The rather important factor of transportation costs is touched on lightly, and the other factors, such as labor costs and local taxation have not been discussed at all. The prime purpose of the study was not to make a thorough analysis of the Northwest economy, but, instead, to examine and analyze the principal uses of aluminum in the two state area in hope of being able to establish the locally generated need for a greater supply of raw materials for aluminum product manufacturers.

It was necessary to set some geographic limitation on the market in question and, since the bulk of the heavy industry in the Pacific Northwest is located in the states of Oregon and Washington, with the majority being in the latter, it was decided that these two states would comprise the area under study. Further limitations were necessary in order to adequately define the demand for aluminum. If all industrial consumers were considered, a considerable amount of double counting would result, so a "consumer of aluminum" has been defined as any firm manufacturing a finished product from aluminum which is, at the time of completion, ready for its final use. Thus, the definition includes the manufacturer of cast aluminum parts, but omits a contractor who places already finished aluminum windows into a new dwelling.

One hundred fifty firms are included in the population of aluminum products manufacturers in the Pacific Northwest. This population does not propose to be all inclusive, but it is felt that well over three-fourths of the firms and nine-tenths of the working force in this area are represented. The U. S. Census of Manufacturers: 1958 shows ninety-three firms in Washington and thirty-five in Oregon consuming aluminum in various shapes and forms. Investigation by the author found eighty-five Washington and sixty-five Oregon firms manufacturing aluminum products, so it would seem that the Washington population is somewhat understated. However, one can be quite sure that all firms employing more than twenty-five workers have been included. One possible reason for the elimination of some firms from the study is the fact that the analysis was confined to three Standard Industrial Classifications as established by the U. S. Department of Commerce. The classifications are:

S. I. C. 33 "Primary Metals"

S. I. C. 34 "Fabricated Metal Products"

S. I. C. 37 "Transportation Equipment"

By so doing, all of the major aluminum consuming firms in the two state area have been included and double counting has been minimized.

CHAPTER I

INTRODUCTION

The Problem

The Pacific Northwest has always been regarded as a center of lumber and wood production and, due to an abundance of fertile soil, an agricultural region. Possible as a result of these two means of livelihood, the region has not expanded economically as fast as it might have. Oregon, in particular, has not expanded its economic base to any great degree at all. During the decade 1950-1959 this state ranked ninth among the eleven western states in its rate of increase in non-agricultural employment and tenth in the rate of growth in manufacturing employment.[1] Washington, too, has suffered somewhat by a heavy dependence on a few industries. Although Seattle has become a center of aircraft manufacture, Washington has remained extremely dependent on its two major resource-oriented industries, lumber and agriculture. The existence of the Boeing Company in Seattle has removed that city from dependence on these two industries, but it has also made the community overly dependent on Federal government defense grants. Table I, which shows the value added by manufacturing, illustrates the dependence of the economies of the two states on very few industries. Value added by manufacturing, as illustrated here, is derived by:

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[1]James N. Tattersall, "Performance of the Oregon Economy," Proceedings of the Thirty-Fifth Annual Conference of the Western Economic Association. (Stanford, Calif., 1960), p. 72.

"...subtracting the cost of materials, supplies, containers, fuel, purchased electricity, and contract work from the value of shipments for products manufactured plus receipts for services rendered. The result of this calculation is then adjusted by the addition of value added by merchandising operations (that is, the difference between the sales value and cost of merchandise sold without further manufacture, processing, or assembly) plus the net change in finished goods and work-in-process inventories between the beginning and end of the year."[2]

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[2]U. S. Bureau of the Census, Annual Survey of Manufacturers: 1961. Statistics for States, Standard Metropolitan Areas and Large Industrial Counties: Part 9, Pacific. (Washington, D. C., 1963), p. 2.

Table I

Value Added By Manufacturing
In Washington and Oregon, 1961
($1,000)

Industry				
Food and Kindred Products	300,632	219,165	519,797	13.5
Textile Mill Products	4,850		4,850	0.1
Apparel and Related Products	24,039		24,039	0.6
Lumber and Wood Products	278,002	580,650	858,652	22.4
Furniture and Fixtures	19,791	12,604	32,395	0.8
Paper and Allied Products	291,011	119,413	410,424	10.7
Printing and Publishing	87,965		87,965	2.3
Chemicals and Allied Products	216,856	27,788	244,374	6.4
Petroleum and Coal Products	48,676	5,537	54,213	1.4
Stone, Clay, and Glass		32,891	32,891	0.9
Primary Metals	152,291	75,770	228,061	5.9
Fabricated Metal Products	73,278	49,393	122,671	3.2
Transportation Equipment	806,040	44,420	850,460	22.2
All Others	168,665	196,541	565,476	9.6
Totals	2,472,096	1,364,172	3,836,268	100.0

Source: U. S. Bureau of the Census, Annual Survey of Manufacturers: 1961. Statistics for States, Standard Metropolitan Areas and Large Industrial Counties: Part 9, Pacific. (Washington, D. C., 1963).

Note from this table that four industries, Food and Kindred Products, Lumber and Wood Products, Paper and Allied Products, and Transportation Equipment contribute nearly seventy per cent of the total value added in these two states. Note also that three of the top four industries are resource oriented. That is, they exist primarily as a result of the resourses of the region. The fourth, Transportation Equipment, is ninety-five per cent in Washington, and it should be added that nearly all of this Washington portion is contributed by a single firm. Obviously, this is not a sound economic situation. Heavy reliance on a few industries causes very sharp response to any cyclical fluctuations within any of these industries. Furthermore, firms working with food and forest products tend to be quite seasonal with the bulk of their work coming in the summer months. Such conditions do not lend themselves to economic growth, and it has been suggested that if this region is to maintain its relative income position, it must experience either a renewed expansion in these traditional areas or a greatly accelerated increase in other, less resource-oriented, manufacturing industries.[3]

One possible area of growth is in an industry which already contributes a substantial amount to the economy in the Pacific Northwest. This is the aluminum industry which grew so fast in this region during the 1940's and 1950's. The heavy demand for aluminum during World War II and the Korean Conflict made the inexpensive power of the Columbia River Basin quite attractive to the producers of primary aluminum.

3James N. Tattersall, The Importance of International Trade to Oregon. (Eugene, Oregon, 1961), p. 32.

The Aluminum Industry in the Pacific Northwest

In 1939 no aluminum was produced in the Pacific Northwest, but with the coming of World War II five reduction plants were constructed in the region in order to satisfy the increased wartime demand. Oregon and Washington were selected as sites for these plants because the Columbia River Basin was one of the few regions in the nation with an excess of electric power. Following the War the government owned plants were sold to private producers, and all but one were retained in production. In addition, three more plants were built by various producers during the 1950's; the last being the Harvey Aluminum Company operation in The Dalles, Oregon.[1] The proportional contribution of the Northwest to the nation's total aluminum production reached its peak in 1949 when fifty-two per cent of this total was produced here. Since then, this percentage has decreased, and there has even been some drop in the total amount of aluminum produced in the region.[2]

In 1962 five producers smelted 573,000 tons of primary aluminum in six mills located in Oregon, Washington, and Montana. This tonnage represents an increase over the preceding year, but the industry in the Pacific Northwest was still operating at well below its maximum capacity. Production in the Northwest was 27.05 per cent of the nation's total, so it is easily seen that in 13 years since the peak of 52 per cent, the region's contribution to the aluminum industry has diminished greatly.[3]

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[1]Carlton Green, The Impact of the Aluminum Industry on the Economy of the Pacific Northwest. (Vancouver, Wash., 1954), p. 8.

[2]D. Robert Papera, The Aluminum Industry. (San Francisco, 1958), p. 18

[3]U. S. Department of the Interior, Bonneville Power Administration News. Portland, Oregon, 1963), p. 2.

The current trend in the aluminum industry is to locate reduction plants in the Ohio River Valley where a power cost of four mills per kilowatt hour and a very short haul to the major markets compare quite favorably with the two mill power rate in the Northwest but a very long haul to market. Recent aluminum plant construction in this eastern region has taken place in Evansville, Indiana, Ravenswood, West Virginia, and Clarington, Ohio.[1]

There is still a production cost advantage in the Northwest, however, when one calculates the cost of producing one pound of primary aluminum ingot without considering its transportation from the plant. The following is one writer's estimate of this cost:[2]

	Pacific Northwest	Ohio River Valley
Electric Power	1.7	3.2
Salaries	3.2	3.6
Transportation of Raw Materials	1.2	.8
Totals (cents per pound)	6.1	7.6

Thus, there is still a distinct production cost advantage favoring aluminum production in the Pacific Northwest. This advantage disappears, however, because of the long distances over which the product must be carried in order to put it to any use. This cost problem is shown by an extrusion plant located near the geographic center of the United States. Ingot is shipped to this operation from three reduction plants. The cost of shipping ingot from the closest plant, located in Indiana, is

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[1]Richard A. Smith, "The Boiling Ohio," Fortune. June, 1956, p. 111.

[2]Frank B. Fulkerson, Trends and Outlook in the Pacific Northwest Aluminum Industry. (Washington, D. C., 1962), p. 17.

$.0031 per pound, while the rate from a Washington reduction plant is $.0125. In addition, the company must pay an average of $.0017 per pound for shipping the extrusions to market. Thus, a considerable saving results from a location close to a plant's major customers.[1] It would be surprising, then, to see any new aluminum reduction facilities built in this region.

Aluminum ingot must be transformed into usable shapes before it can be used as a manufacturing raw material. This work is done at the major producers' fabrication plants which are highly specialized operations generally producing aluminum sheet, extrusions, or rods of various thicknesses in large custom orders. At the present time only two of these plants exist in the Northwest; an extrusion plant in Vancouver, Washington, and a sheet plant near Spokane, Washington.

Fabrication mills traditionally have been located near major consuming markets for several reasons. For one, the primary ingots can be transported at lower freight rates since they can be shipped in bulk quantities. For another, these ingots require no packing which would increase the shipping costs, while still another reason states that it is less difficult to damage ingot en route. Finally, producers claim that it is easier to give customers technical service if the fabrication plants are located nearer large industrial centers.[2]

The important determinants of a region's competitive ability are its resource base, its population as it affects the regional market and the regional labor force, and the structure of transportation

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[1]Personal correspondence with a confidential source of information.

[2]Green, op. cit., p. 35.

costs.[1] The first of these factors, the resource base, has characteristics both favorable and unfavorable to the expansion of large aluminum operations. On the favorable side is the fact that a price advantage for electric power still exists in this region, but this is offset because the lack of bauxite deposits of sufficient quality to warrant mining necessitates the transporting of raw materials into the region. The regional labor force has long been exposed to aluminum production, and the industry currently employs over seven thousand workers in the production of aluminum. These personnel form an excellent nucleus for expansion. The structure of transportation costs has been shown to be quite unfavorable to the Northwest, so any expansion of primary aluminum operations will have to come from the indogenous local market factors. The problem is now more apparent. With respect to the Pacific Northwest's need for a more diverse economy, it would seem much easier to expand existing industries than to try to attract new ones, but in spite of the aluminum industry's vast investment in this area, its relative contribution to the total national production has been steadily decreasing. This study, then, is based on the hypothesis that large scale operations by major aluminum producers can, and should, be expanded in a manner which will be profitable to all parties concerned. Since this expansion cannot take place unless it is more profitable to produce aluminum here than elsewhere, and since transportation costs remove the advantage from the Northwest, it becomes the purpose of this thesis to examine the demand for aluminum in Oregon and Washington in order to determine whether

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[1] William Wolman, The Development of Manufacturing Industry in the State of Washington. (Pullman, Wash., 1958), p. 11.

this demand is sufficient to warrant expansion of either the reduction or fabrication operations of the major aluminum producers.

The Method of Study

At the present time there are three major areas of aluminum product manufacturing in the Pacific Northwest. These are general foundries which produce a variety of products for industry and the individual, building materials, primarily aluminum windows and other products made from aluminum extrusions, and transportation equipment, especially aircraft and missiles and truck bodies and chassis. Two other areas which do not presently appear as important in terms of their economic contributions will also be examined because of their adaptability to the wants and needs of the people of the Northwest. These are irrigation equipment and mobile homes.

All of the major areas of aluminum usage will be examined in terms of their current operations. This examination will include the employment generated by the industry, the value added by its production and its current aluminum usage. Accordingly, the study is based upon one major assumption: the existence of a consistency in the ratios of the operations in each area to the entire manufacturing economy in Oregon and Washington between the years 1958 and 1962. By this it is meant that an area of manufacturing which employed a certain percentage of all workers in 1961 employed the same percentage throughout the period.

Sources of Information

Data on employment were obtained from the most recent directory of manufacturers in Oregon and Washington. Since both states published such a volume in 1961, all employment figures are relevant for that year.

Employment figures for any years prior to 1961 are estimates based upon the assumption of continuity stated above. Value added data were gathered from the U. S. Bureau of the Census' Annual Survey of Manufacturers: 1961, which is the most recent publication giving such data in sufficient quantity to be useful. Value added figures have been discounted by the percentage of employment applicable in order to show an approximation of the amount of value added by aluminum consuming industries. Data on usage of aluminum was obtained through a questionnaire prepared and distributed by the author. From the sample given by replies to this letter, estimates of total aluminum usage in each area were made. Usage data applies to the year 1962, and projections were made on 1961 employments, so it is possible that a certain amount of discrepency arises as a result. Attempts have been made, however, to correct any discrepencies by applying knowledge of current conditions within the various industries that the writer acquired during the course of the study.

CHAPTER II

CURRENT CHARACTERISTICS OF THE NORTHWEST ALUMINUM INDUSTRY

Employment

At this point in the analysis the "aluminum industry" consists of all firms that produce the metal or use it as a raw material. In 1961 such a group of firms employed 13,091 persons.[1] These workers represent 3.7 per cent of the 357,256 workers employed by all manufacturing organizations in the region in that year.[2] This estimate has been adjusted somewhat and does not include all workers by aluminum consuming companies. The employment data for all manufacture of airplanes, missiles, and parts have been excluded because of the large number of workers employed by a single firm in this area. The Boeing Company puts nearly sixty thousand people to work every year, and inclusion of this firm would cause a severe divergence from realism in trying to analyze aluminum consumption in the Northwest. Aircraft manufacturers will be dealt

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[1] This estimate is based on employment figures given in: State of Oregon Department of Planning and Development, 1961 Directory of Manufacturer's and Buyer's Guide. (Portland, Oregon, 1961), and Washington State Department of Planning and Development, 1961 Directory of Washington State Manufacturers. (Olympia, Washington, 1961), various pages in each.

[2] U. S. Bureau of the Census, Survey of Manufacturers: 1961. op. cit., pp. 14, 17.

with separately in a subsequent section. Of the total workers, 3944 are employed by firms in Oregon, while 9147 work for Washington companies.

The total also includes all employees of the eight plants in the two states which are operated by three major producers of aluminum. These operations, which employ 7030 persons, or more than half of all aluminum workers, are concerned with the production rather than the consumption of the metal. There are 1350 aluminum workers employed at two plants in Oregon, while the remaining 5680 work at six plants in Washington. Two of the Washington operations are fabrication rather than reduction plants, and these are responsible for 2640 of the workers. It is apparent, then, that relatively few workers are employed by firms using aluminum as a raw material.

By dividing the data given in the state directories by the Census Bureau data for the respective Standard Industrial Classification (S.I.C.) percentage of total employment applicable to aluminum producers and consumers can be approximated. Percentages relevant to this study are:

S.I.C. 33
Primary Metals: 56%
This classification includes all employees of the major aluminum producers and all workers in general foundries.

S.I.C. 34
Fabricated Metal Products: 24%
This classification includes manufacturers of building materials, irrigation equipment, sheet metal foundries and miscellaneous products.

S.I.C. 37
Transportation Equipment: 13%
This classification includes manufacturers of trucks and trailers and mobile homes, but it does not include manufacturers of aircraft and missiles.

Table II shows employment variations in these industries over the four year period 1958-1961 and is based on the assumption that the ratio of employees in each classification who are employed by aluminum-consuming

firms is constant over the four years. This assumption appears valid, for calculation of employment in the primary metal field from Bureau of the Census data for 1958 gives a rather rough estimate of fifty-eight per cent of all primary metals workers in non ferrous production.[1] Elimination of any non ferrous metals production other than aluminum should lead to a percentage very close to the 56 per cent derived above. This, it would seem safe to say that this percentage has remained constant over the four year period.

If consistency can be assumed in the percentage of all operations using aluminum within a larger classification, it can be concluded from Table II that employment in aluminum operations is fairly constant over the entire period, but has a tendency to fluctuate from year to year. This situation seems to be true for employment in all durable goods manufacturing areas. In both Oregon and Washington employment in durable goods industries showed a market increase from 1958 to 1959 followed by a significant decrease the following year, leaving the 1960 total slightly higher than that of 1958. This fluctuation occurred during a period when the national total of employees in this type of work was increasing steadily.[2] The consistency of employment is also borne out by the fact that the State of Oregon Department of Employment calculations show no net increase in fabricated metal products employment from 1956 to 1960, while employment in primary metals increased by over twenty per cent.[3] Much of

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[1]U. S. Bureau of the Census, U. S. Census of Manufacturers: 1958. "Washington", Area Report MC58 (3)-46, p. 8; and "Oregon", Area Report MC58 (3)-36, p. 7.

[2]Donald A. Watson, Changes in Oregon Employment, 1947-1960. (Eugene, Oregon, 1962), p. 19.

[3]Ibid., p. 19.

Table II

Employment in Aluminum Production and Aluminum Product Manufacturing in Oregon and Washington 1958-1961

S.I.C. 33 Primary Metals	Oregon	Washington	Total	% Using Aluminum	Est. Employment
1961	4968	8848	13,816	56	7706
1960	4943	9782	14,725	56	8246
1959	4609	9900	14,534	56	8125
1958	4214	10,320	14,534	56	8139
S.I.C. 34 Fabricated Metal Products	**Oregon**	**Washington**	**Total**	**% Using Aluminum**	**Est. Employment**
1961	4561	7129	11,690	24	2820
1960	4831	6811	11,642	24	2794
1959	5393	7228	12,621	24	3029
1958	5002	6661	11,663	24	2799
S.I.C. 37 Transportation Equipment	**Oregon**	**Washington**	**Total**	**% Using Aluminum**	**Est. Employment**
1961	4790	15,847	20,637	13	2655
1960	4123	10,613	14,736	13	1916
1959	4202	16,089	20,291	13	2638
1958	3849	13,843	17,692	13	2300

*These figures were derived by subtracting the employment at Boeing from the total in S.I.C. 37 for the entire state of Washington. Boeing employments in Washington as given for each respective year in Moody's Industrial Manual were: 1961 -- 59,677; 1960 -- 59,677; 1959 -- 59,018; 1958 -- 59,750.

Sources: U.S. Bureau of the Census, Survey of Manufacturers: 1961. Statistics for States, Standard Metropolitan Statistical Areas, and Large Industrial Counties; Part 9 Pacific. (Washington, D.C., 1963).

State of Oregon Department of Planning and Development, 1961 Directory of Manufacturers and Buyer's Guide. (Portland, 1961).

Washington State Department of Commerce and Economic Planning, 1961 Directory of Washington State Manufacturers. (Olympia, 1961).

this increase can be explained by the opening of the Harvey Aluminum, Inc. primary aluminum plant in 1958. This event caused an increase of six hundred workers, all of whom would be included for all four years in Table II. Thus, although state and Federal sources tend to conflict, they seem to be comparable on a relative basis.

The data in Table II is meaningless for the purposes of this study without a further breakdown in the employment within the larger classifications. By grouping the data given in the state directories by the type of product manufactured and applying these groups to the totals in Table II, a percentage breakdown of workers employed in the production of the various products and types of operations. Table III shows this data.

Table III can be somewhat misleading because of the assumption upon which all of the above calculations have been based. While total employment might remain fairly constant, it would seem more likely that in Standard Industrial Classification 34 certain trends of increasing and decreasing employment have developed during the period. For instance, the substantial increase in the use of aluminum in building materials would make a lower percentage than 65.4 more realistic in the earlier years with a steady increase over the period. There is no way in which this writer can correctly make this adjustment, but the totals given should be considered with this factor in mind.

These tables show employment in aluminum production and consumption to be fairly static over the four uear period. It would seem likely that this is more or less true, for the totals in each of the large classifications fluctuate in exactly the same manner shown in the results. Any significant increases in employment in the "aluminum industry" should become apparent by increases in the total. These increases would, however,

Table III

Employment in Aluminum Producing
and Consuming Industries in
Oregon and Washington
1958-1961

Industry	% Within S.I.C.	1961	1960	1959	1958
S.I.C. 33					
Primary Metals	100.0	7706	8246	8125	8139
Primary Aluminum Reduction and Fabrication	92.9	7160	7661	7548	7561
General Foundries	7.1	546	585	577	579
S.I.C. 34					
Fabricated Metal Prods.	100.0	2820	2794	3029	2799
Building Materials	65.4	1844	1827	1981	1831
General Sheet Work	21.2	599	592	642	593
Irrigation Equipment	10.2	287	295	309	285
Miscellaneous Fabrication	3.2	90	80	97	90
S.I.C. 37					
Transportation Equipment	100.0	2695	1916	2638	2300
Trucks and Trailers	89.5	2411	1715	2361	2059
Mobile Homes	10.5	284	201	277	241
Total (all three classes)		13,221	12,956	13,792	13,239

Source: Table II

be diminished by the use of a constant percentage. At any rate, the fact that the calculations were based on 1961 data causes any distortions of reality to be made in the earlier years with the percentages shown being indicative of the present situation.

Value Added

The concept of value added provides a very efficient and realistic yardstick which can be used to measure the relative contribution of an industry to the economic activity of a region. A comprehensive definition of value added was given on page 2, and this can be condensed into the difference between the value of a firm's output and the value of the productive materials that went into the manufacture of this output. Thus, it is a function of all factors of production, which can be used in comparison with the value added by other firms or industries, as a means whereby the efficiency and importance of any economic activity can be judged. Value can be defined as "the power of a good to command other goods in exchange". As such, the value added to a productive resource would consist of the sum of the various utilities created by the production and marketing processes.[1]

In the production of aluminum, value is added in each stage of transformation of bauxite into finished aluminum products. Bauxite, the best aluminum-containing substance, is usually taken from the ground by strip mining and transported to ore refining plants where it is transformed into powdered alumina. Alumina is then transported to reduction plants where aluminum ingot is manufactured by the application of an electrolytic

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[1]Stanley Vance, Industrial Administration. (New York, 1955), p. 8.

process. Usable forms are produced by two principal methods. Castings, which comprise fifteen to twenty per cent of all aluminum shipments, are created by pouring molten metal into dies or molds and allowing it to harden. Wrought forms are manufactured by changing the shape of the ingot by mechanical means. Of the wrought shapes the most important in terms of both volume and utility is rolled aluminum sheet, which is made by heating and rolling the ingot into sheets of the desired thickness. Thicknesses of less than one eighth inch are generally made by a cold rolling process. Extruded shapes, which are manufactured by forcing heated metal through dies are constantly increasing in importance due, in part, to the innumerable shapes which can be created. Additional wrought forms are created by forging or hammering or pressing the metal into the desired shape and size.[1] Thus, each stage of the production of aluminum puts the metal into a different form utility. As the metal is brought closer to its point of ultimate use, place utilities are created.

The aluminum industry in the Pacific Northwest is made up of all of the stages of production from reduction to final consumption. By far the most important is the reduction of the primary metal -- this region is still being responsible for the production of nearly thirty per cent of the nation's aluminum ingot. Wrought products are produced in large amounts at the Aluminum Company of America extrusion mill in Vancouver, Washington, and the Kaiser Aluminum sheet mill in Trentwood, Washington. Castings are produced by many independent firms of varying sizes throughout the Northwest for consumption both within the region and elsewhere in

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[1]D. Robert Papera, The Aluminum Industry. (San Francisco, 1958), pp. 2-3.

the nation. These wrought products and castings are then used as raw materials by the many manufacturers of aluminum products throughout the Northwest. In terms of value added, each of these products will be very different due to the differences in the types of productive process, the form of aluminum raw materials, and the scale of plant operation. All business operations dealing with a product add some value by virtue of the fact that utilities are created, so it is possible to compare firms by the amount of value they add.

The value added by aluminum producing and consuming manufacturers of the Pacific Northwest can be derived in much the same manner as their numbers of employees. In the case of transportation equipment manufacturers, an adjustment must once again be made for the Boeing Company, and, since this firm's value added by manufacture is not as readily available as its employment, the net value added in this Standard Industrial Classification was obtained by computing the ratio of aircraft manufacturing employment to all transportation equipment employment in the state of Washington and assuming that this ratio (an average for the four years 1958-1961 was used) was indicative of the portion of value added by the manufacture of transportation equipment contributed by the aircraft industry.

It should be noted that Table IV is based on the assumption that the percentage of the total value added in each classification by aluminum production and manufacture is the same as that for the respective number of employees. This is, that the value added per employee is constant throughout an entire classification. This assumption may not be true due to factors mentioned above, but it is entirely possible that the average throughout a classification is such that it is indicative of

the actual value added when broken down by products. That is to say that the averages of value added for the various firms will be distributed in such a manner that an assumption of consistency among the values added per employee will yield a fairly realistic result. Table IV, then, shows value added by manufacture of aluminum and aluminum products in Oregon and Washington under the same assumptions that were used in Table II. The transportation equipment section has been adjusted to include value added by the Boeing Company. Thus, the percentage of employees working for aluminum consuming firms is 78 per cent rather than the 13 per cent used in Table II.

Table IV shows that over the four year period 1958-1961 the aluminum industry and its dependents contributed $1,197,296,000 to the economy of the Pacific Northwest in terms of its value added by manufacture. On an annual basis, this total averages out to slightly less than $300,000,000. When this contribution by aluminum and its users is compared with other industries in the region, its magnitude is not so impressive. In 1961, all three classes of aluminum production and manufacture contributed $311,586,000, while the largest industry in the area, S.I.C. 34 ("Lumber and Wood Products"), contributed $858,652,000 to the industrial activity in Oregon and Washington.[1] Thus, aluminum is responsible for less than one half as much as the largest industry in the area, and in order to contribute this much it is necessary to include major portions of three industries.

A composite comparison of industrial activity in terms of percentages of total value added in the Pacific Northwest is shown in Table V.

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[1]U. S. Bureau of the Census, Survey of Manufacturers: 1961. (op. cit.), pp. 10, 11.

Table IV

Value Added by Aluminum Producers and Consumers
In Oregon and Washington 1958-1961
($1000's)

S.I.C. 33	Washington	Oregon	Total	% Using Aluminum	Estimated Value Added
1961	152,921	75,770	228,691	56	128,067
1960	157,176	79,928	237,104	56	132,778
1959	184,291	74,680	258,971	56	145,024
1958	172,040	65,784	237,824	56	133,181
S.I.C. 34	Washington	Oregon	Total	% Using Aluminum	Estimated Value Added
1961	73,278	49,293	122,571	24	29,417
1960	70,609	50,380	120,989	24	29,037
1959	66,624	52,715	119,339	24	28,641
1958	65,122	46,659	111,781	24	26,827
S.I.C. 37	Washington	Oregon	Total	% Using Aluminum	Estimated Value Added
1961	153,147	44,420	197,567	78	154,102
1960	125,757	43,410	169,167	78	131,950
1959	131,978	39,909	171,887	78	134,072
1958	125,380	33,851	159,231	78	124,200

*Washington figures have been adjusted in order to eliminate aircraft and missile manufacturers.

Sources: U. S. Bureau of the Census, Survey of Manufacturers: 1961. (Washington, 1963).

Table II

In this case the years 1947 and 1954 are shown in addition to the four year period 1958-1961. The two earlier years were added in order to make a comparison over the entire post World War II period. The year 1947 represents the first full year following demobilization of was industries, and 1954 represents the first full year following the Korean conflict. The data for these two years are not strictly comparable with the more recent figures because they have not been adjusted for merchandising operations. Total value added by all industry in the two states for each year was as follows: (in thousands of dollars)

1947	1,549,053
1954	2,586,516
1958	3,388,856
1959	3,784,911
1960	3,630,937
1961	3,836,268

It is conclusive from Table V and from the preceding discussion of the relative position of the aluminum industry in the total employment in the Pacific Northwest that these firms do not make a large contribution to the region's economy. The largest segment of the industry, primary aluminum production, contributes only slightly more than three per cent of the total value added at present, and this portion declined steadily throughout the four year period 1958-1961. At the same time, aluminum consumers appear to be remaining fairly static, so it appears that the aluminum industry is just barely holding its own in the Northwest economy. Of course, the inclusion of aircraft manufacturing in the industry would improve the situation immensely, but it is not felt that future gains are likely in that area.

Table V

Percentage Distribution of Value
Added by Industries In
Oregon and Washington
1947, 1954, 1958-1961

Industry	1947	1954	1958	1959	1960	1961
Lumber and Wood Products	41.5	34.5	25.1	27.0	23.5	22.4
Transportation Equipment	4.9*	0.6#	19.5	18.4	18.5	21.9
Aluminum Users*	----	----	15.2	14.3	14.4	17.1
Food and Kindred Products	16.6	14.0	14.7	13.3	13.9	13.5
Paper and Allied Products	11.1	11.0	10.5	10.7	11.5	10.7
Chemicals and Allied Prods.	1.8	5.2	5.7	6.6	6.0	6.4
Apparel and Related Prods.	----	0.7*	5.3*	6.1*	6.4*	6.3*
Primary Metals	4.1*	6.2*	7.0	6.8	6.5	5.6
Aluminum	----	----	3.9	3.7	3.5	3.1
Fabricated Metal Products	1.7*	3.1	3.3	3.2	3.3	3.2
Aluminum	----	0.7	0.8	0.8	0.8	0.8
Petroleum and Coal Prods.	----	----	1.1	1.1	1.6	1.4
Stone, Clay, and Glass	1.5	1.4	0.7#	0.8#	0.9#	0.9#
Furniture and Fixtures	1.8	----	1.0	1.1	0.9	0.8
Textile Mill Products	----	----	0.1*	0.1*	0.1*	0.1*
Others	19.6	10.7	3.9	2.8	4.6	4.5
	100.0	100.0	100.0	100.0	100.0	100.0

*Washington only
#Oregon only

Sources: U. S. Bureau of the Census, Annual Survey of Manufacturers: (op. cit.), 1956 and 1961.

CHAPTER III

CURRENT OPERATIONS

Primary Aluminum Production

At the present time there are seven aluminum reduction plants using power supplied by the Bonneville Power Administration. Six of these plants are located in Oregon and Washington, while the seventh, which is operated by the Anaconda Aluminum Company, is in Butte, Montana. In addition, two large fabrication plants are operated by the Aluminum Company of America and the Kaiser Aluminum and Chemical Corporation in the state of Washington. All of these operations employ a total of 7160 workers, 4520 of whom are in the reduction phase.

In 1962, the total economic contribution of these nine plants amounted to $136,489,800 which represented a ten per cent increase over the previous year. This contribution is in the form of total expenditures in the Northwest (which, in this case, includes Idaho and western Montana) and can be segmented as follows:

Salaries and wages	$ 54,221,800
Freight (rail and truck)	27,669,000
Electric power purchased	21,154,900
Northwest purchases of materials, supplies and services	27,606,700
State and local taxes	5,807,800
	$136,489,800

This total contribution, which is quite a substantial sum, is a better indication of the importance of this industry to the economy of the region than an estimate of value added, for it represents money actually spent in the Northwest by these firms.[1] Value added by the portion of the industry in Oregon and Washington in 1961 was less than $120,000,000.[2] In this same year $124,346,900 were spent on the factors listed on the previous page.[3] Since the former figure represents the factors to which value was added, these two calculations are actually two different things and are not comparable. Both, however, show the absolute magnitude of aluminum production operations in the Pacific Northwest.

Aluminum Reduction

The 573,000 tons of aluminum ingot produced by the seven reduction plants in 1962 represented 27.05 per cent of the national aluminum production.[4] With 679,000 tons of productive capacity located in the area this figure for total production indicates that the Northwest industry was operating at slightly more than 84 per cent of its capacity. This scale of operation was not far below the national average for the same year.[5] That the Northwest portion of the industry was operating at close

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[1]U. S. Department of the Interior, op. cit., p. 2

[2]This estimate was compiled by taking 92.9 per cent (the portion of employment attributable to primary production) of the total value added in S.I.C. 33 in Oregon and Washington.

[3]Ibid., p. 1

[4]U. S. Department of the Interior, op. cit., p. 1.

[5]"Aluminum Sees Sales at New High," Business Week. June 29, 1963, p. 98.

to the national average is shown by the fact that these plants make up 27.3 per cent of the nation's aluminum reduction capacity. Thus, if 27.05 per cent of the 1962 production came from Oregon and Washington this portion of the industry had to have been operating very close to the national trend.

Aluminum reduction facilities in the region are quite large, ranging in size from 65,000 tons per year to 176,000 tons per year, and each of the three largest producers has more than one-fifth of its total capacity in Oregon and Washington. Of course, most of these plants were part of the wartime building program, but all have been modernized to keep pace with current production techniques, and two of them, the Alcoa plant in Wenatchee, Washington, and the Harvey Aluminum, Inc., operation in the Dalles, Oregon, were constructed after World War II. Table VI gives a comprehensive picture of the reduction operations using Bonneville power.

This table provides all the necessary information on the structure of the aluminum industry in the Pacific Northwest. One other plant exists, but is not presently operative. This is the Kaiser Aluminum and Chemical Company plant in Tacoma, Washington. It is a rather small plant with a productive capacity of 41,000 tons and is presently being held as a reserve facility.[1]

Aluminum Fabrication

The term "aluminum fabrication" can mean many things to many people, for this phrase is used to describe all phases of aluminum product manufacturing following the initial reduction of the material. For the

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[1]Kaiser Aluminum and Chemical Corporation, A Profile for the Sixties. (Oakland, Calif., 1960), p. 6.

Table VI

Aluminum Reduction Facilities
Using Power from
The Bonneville Power Administration

Company (Total Capacity)	Location	Capacity	%U. S. Capacity	%Company Capacity
Alcoa (853,250)	Vancouver	97,500		
	Wenatchee	108,500		
Total for Company		206,000	8.3	24.1
Reynolds (701,000)	Longview	60,500		
	Troutdale	91,500		
Total for Company		152,000	6.1	21.7
Kaiser (609,500)	Mead	176,000	7.1	28.9
Harvey	The Dalles	80,000	3.2	100.0
Anaconda	Butte	65,000	2.6	100.0
(Total U. S. Capacity, 1962: 2,488,750 tons)		679,000		

Sources: Reynolds Metals Company, Background Data on Reynolds Metals Company. (Richmond, Va., 1963), p. 28.

D. Robert Papera, The Aluminum Industry. (San Francisco, 1958), p. 19.

purposes of this study, however, aluminum fabrication refers to the process of making aluminum ingot into usable shapes and forms, especially the manufacture of wrought forms.

Collected data on all five companies listed in Table VI show that in 1962, 238,990 tons of aluminum were processed beyond the ingot stage in the Pacific Northwest.[1] This conversion took place at the two big fabrication plants operated in Washington and Oregon. These two plants produce the two most widely used forms of fabricated aluminum. The Kaiser Aluminum and Chemical Corporation operated a large sheet mill ten miles from the reduction plant in Mead, Washington. Both Kaiser plants were built by the government during World War II, and the distance between them is explained by the fear of enemy bombings at the time. Actually located in Trentwood, Washington, the sheet and plate operation was the largest of its type in the nation when it was built. It was operated by the Aluminum Company of America during the War, but in 1946 it was leased to Kaiser, who subsequently bought it. The plant produces principally sheet and plate for industrial use, especially food containers, and also sells extrusion slugs to manufacturers of seamless cans. Its capacity is 396,000,000 pounds, or 198,000,000 tons per year, and the operation employs 1990 persons.[2]

The other fabrication plant in the Northwest, the Aluminum Company of America extrusion and wire plant in Vancouver, Washington, is primarily Northwest oriented. Extrusions are generally manufactured in job lots to customer specifications, although standard shapes are constant-

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[1]U. S. Department of the Interior, op. cit., p. 2.

[2]Kaiser Aluminum and Chemical Corporation, op. cit., p. 4.

ly increasing in number. Rod, wire, and cable are also manufactured here and sold throughout the West and to Asian customers. These products are enjoying increasing demand as more aluminum is used for the transmission of electricity. Extrusions are sold to manufacturers of building materials, trucks, and aircraft throughout the entire West.[1] Rated capacity of the plant is 65,000 tons, but a breakdown into weight measures of extrusions and other products produced is not available. There are 650 persons employed in this operation.

In conclusion, it should be noted that much less than half of the aluminum produced in the portion of the Pacific Northwest is processed beyond the ingot stage in this region. The primary reason for this fact is the cost-saving transportation situation already pointed out. While an advantage does exist making it less expensive to reduce aluminum in the Northwest, it is still less expansive to fabricate the metal at locations nearer to the major markets. An executive at the Kaiser Trentwood mill states that the principal disadvantage of his plant's location is its distance from major markets. At the same time, Alcoa personnel claim that the extrusion plant's location is somewhat advantageous as long as the bulk of its production is shipped to western customers and East Asian ports. The latter company, however, is quite reluctant to expand fabrication operations in the region because of a fear that sufficient demand will not materialize.[2]

Aluminum Product Manufacturing

The collective data analyzed in the previous chapter gives a picture

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[1]Fulkerson, Trends and Outlook in the Pacific Northwest Aluminum Industry. op. cit., p. 6.

[2]Information in this paragraph was obtained through personal correspondence and interview.

of the overall situation in the Pacific Northwest, but it is relatively meaningless without some knowledge of the size and scale of individual operations. The industries which will be discussed have been listed above as general foundries, building materials, irrigation equipment, trucks and trailers, and mobile homes. Aircraft and missile manufacturing was not considered in the grouped data in Chapter Two, but this industry will be discussed along with the others. It is not intended that these industries comprise all of the users of aluminum in the Northwest, but it is felt that these are the segments of the economy where growth in the near future is most likely. Among other users manufacturers of ships and boats are most predominant, but aluminum consumption in this area fluctuates so greatly that it is nearly impossible to discuss its use. There is very little use of aluminum in the local manufacture of machinery and appliances. Most of the machinery produced in the Northwest is oriented to the lumber industry where the extra strength of steel is necessary. Although aluminum is being used in the manufacture of cans and other containers, very little of this type of production is carried on in Oregon and Washington.[1] Thus, the industries listed initially are the only ones in the region that use aluminum in sufficient quantities and with sufficient regularity to be considered as sources of possible increased demand.

The appendix describes the principal tools used to analyze each of the consuming industries. All of these tools have to do with the frequency distribution, for it is in this manner that such groups of data can best be examined. The distributions of firms' employments within the

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[1] Fulkerson, Frank B., Aluminum Fabrication in the Pacific Northwest: An Economic Survey. (Washington, D. C., 1962), pp. 27-28.

various segments of the entire industry vary considerably. Sixty-five aluminum consuming firms in Oregon employ a total of 2594 workers. The average employment, then, is 40, but the median (the midpoint of all observations arrayed in order) is only 12.5. The mean being greater than the median, the distribution is obviously skewed to the right. Another proof of such skewness is the fact that the standard deviation is 64.5. This deviation, being larger than the mean implies that in order for the distribution to be normal, a large number of firms would have to have less than one employee, a situation which is impossible. The coefficient of skewness, then, is .444 which indicates that the mean is greater than the median by somewhat more than four tenths of one standard deviation.

The sixty-five observations contained in the distribution for Oregon range from one to four hundred, and the two modes (most often cited values) are three and seven. This information implies that the cause of the large degree of skewness is a few values at the high end of the curve. It should be noted that only five aluminum product manufacturers in Oregon employ more than one hundred persons. Elimination of an equal number of values from each end of the distribution would remove this heavy influence on the mean from the larger observations, but the median would remain constant. Examination of the middle ninety per cent of the data brings the distribution closer to typifying the actual situation of Oregon by decreasing the average size of each operation. By using fifty-nine rather than sixty-five values, the mean becomes thirty and the standard deviation twenty-four. However, due to the substantial decrease in the standard deviation the coefficient of skewness increases from .444 to .750 in spite of the much smaller absolute difference between the median and the mean.

Eighty-three aluminum consumers in Washington are distributed in much the same manner as the Oregon manufacturers. They employ 3467 workers with an average employment of 42 and a median of 15. The large standard deviation of 107 skews the distribution by a coefficient of .252. Of course, inclusion of aircraft manufacturers would add another 60,000 employees to the total, but because all but about two hundred of these are employed by a single firm, the standard deviation would increase to such an extent as to become meaningless. Examination of the middle 75 values in the distribution just described decreases the mean to 24 and the standard deviation causes an increase in the coefficient of skewness to .600.

The entire industry, including both Oregon and Washington aluminum consuming firms, consists of a total of 148 firms which employ 6061 workers. The average, then, is forty-one, the median is fifteen, and the standard deviation is 90.5, so the distribution is positively skewed by .287. The middle ninety per cent of these firms have an average employment of twenty-seven, but the standard deviation is only 41.2, so the coefficient of skewness is again increased to .291.

The above discussion should point out that the typical aluminum product manufacturer in the Pacific Northwest is rather small, but a few fairly large firms cause the average employment to increase. It is perhaps an error to refer to the firms employing more than one hundred persons as being "atypical", for these fourteen firms use the bulk of the aluminum consumed by local industry, and it is on firms such as these that future increase in aluminum usage depends.

General Foundries. General foundries in the Pacific Northwest manufacture aluminum castings by any of several processes. The continuous casting process converts molten aluminum into semi-finished product in one operation and is applicable to many different products. Sand casting is so called because the molds in this type of production are made from hard packed sand. Most custom producers use this type of mold because it is easily made and its materials can be used repeatedly. For castings made in larger quantities, permanent dies are used. These forms can be made to very close tolerances and are necessary for precision work.[1]

The aluminum castings industry, if it can be so called, is not an independent industry at all, for most of its operatives manufacture parts for producers of larger, more complex products. The industry is characterized by many small, independent foundries which have surprisingly large distribution areas, caused primarily by the specialized nature of the castings produced in most foundries. For instance, a relatively large foundry in Spokane, Washington, employs between twenty and thirty workers and has a productive capacity of 100,000 pounds of aluminum per month. This firm supplies most of the truck and trailer manufacturers in the Northwest with both custom die work and permanent mold castings. Although eighty-five per cent of its output goes to Spokane, Portland, and Seattle, this firm ships about ten per cent of its products to Chicago and another five per cent throughout the eleven western states. Another foundry in Eugene, Oregon, uses 180,000 pounds of aluminum ingot annually to make parts for manufacturers of aluminum irrigation couplers, sixty-five per cent of which are shipped out of the Pacific Northwest.

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[1]Stanley Vance, Industrial Structure and Policy. (Englewood Cliffs, N. J., 1961), pp. 122-123.

Foundries are generally of three types. First are the general custom foundries which supply local customers and typically employ less than ten persons. This type of operation does a variety of custom work, but its total annual consumption of aluminum is quite low, usually less than 100,000 pounds per year. Second are the previously described producers of specialized products on a contract basis. These operations are somewhat larger and might average fifteen employees. Their aluminum usage is also much greater, varying between 100,000 and 1,000,000 pounds per year. Finally, are the manufacturers of cast aluminum consumer products. These firms are usually quite specialized and are more inclined to mass production and assembly line techniques. The demand for the output of the first two types is derived from the demand for the products of their customers, while the third is faced with direct end consumer contact.

The 546 employees of manufacturers of aluminum castings in 1961 represent seven per cent of the total employment among producers of primary aluminum in the Pacific Northwest. The reason for this small percentage is that most of the workers in this classification work for the major producers at the previously discussed reduction and fabrication plants. Three hundred-one foundry employees work for fifteen firms in Oregon. This indicates that the average employment in a foundry is Oregon is 20 persons, but the median is only 10. A standard deviation of 23.5 gives the Oregon portion of this industry a coefficient of skewness of .426. In Washington the average number of employees in seventeen foundries is fourteen, while the median is fifteen. A small standard deviation of 10.7 skews this seemingly normal distribution by .093. The entire distribution for both states has a coefficient of skewness of .383 with a

mean of seventeen, a median of ten and a standard deviation of 18.3.

In 1958, 775,000 pounds of aluminum castings were consumed by Oregon manufacturers and 2,278,000 pounds were used by firms in Washington. Of the Washington consumption, 1,344,000 pounds were used by producers of fabricated metal products, and the remainder was purchased by manufacturers of transportation equipment and machinery.[1] Only forty firms in both states used these castings, and ten of these purchased more than $50,000 worth of the shapes.[2] These figures on consumption do not necessarily reflect the production in the area, for, as was pointed out above, a substantial portion of local producers ship their products great distances. Five respondents to the writer's questionnaire manufactured a total of 2,330,000 pounds of aluminum castings in 1962, so it appears likely that the region is a net exporter of aluminum castings. A projection based on the usage per man among the replying firms would estimate the total consumption of aluminum ingot by non-ferrous foundries to be 6,245,000 pounds.

The proximity of foundries in the Northwest to the suppliers of their raw materials would indicate substantial room for growth in this type of work. Since most of the products are quite small and shipped in bulk, the freight expenses to regions of greater industrial activity would not be much more than the cost of shipping the ingot to a producer in the larger market area the same distance from the reduction plant. Thus, it would seem that this might attract more casting firms. Other

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[1] U. S. Bureau of the Census, U. S. Census of Manufacturers: 1958. Consumption of Selected Metal Mill Shapes and Forms; Special Report MC58 (S)-5, (Washington, 1961), p. 112.

[2] Ibid., p. 118.

industry which might locate in the Northwest would also create an expanded market for cast aluminum products and would therefore tend to create more operations of this sort.

Building materials. The uses of aluminum in construction have been increasing rapidly since World War II, and as a result this continual leader in the consumption of aluminum uses more of the metal every year. In 1962, 23.5 per cent of all domestic primary aluminum production went into the manufacture of building materials. This total amounted to 1,350,000,000 pounds of which one-fifth was consumed by residential construction.[1] Use of aluminum in new homes which runs the gamut from insulation to mail boxes has increased by sixty per cent since 1958.[2] In fact the use of aluminum in the typical one family dwelling increased in 1962 from 235 to 245 pounds, thus showing how the popularity of the metal is constantly growing.[3]

The aluminum building materials industry is characterized by many small firms principally serving local markets. Only six companies making products of this type have annual sales of more than fifteen million dollars. Most of the larger producers are located in the Ohio River Valley where easy access to raw materials, inexpensive power, and nearness to the major population centers make this area desirable. The largest concentration of window manufacturers is in Florida where the climate is most adaptable to well ventilated houses.[4] Since 1958 the large increase

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[1]"Aluminum Sees Sales at New High," op. cit., p. 98.

[2]Steven S. Anreder, "Proving Their Mettle," Barron's. xlii: 24, June 11, 1962, p. 3.

[3]Reynolds Metals Company, op. cit., p. 23.

[4]Anreder, op. cit., p. 3.

in demand for aluminum building products has caused the number of producers to increase at a rapid pace, and even the largest firms have felt the impact of the added competition. Many of the marginal firms were unable to compete in such a market, and the result has been a drastic turnover of producers and low prices for the survivors due to excessive price competition.[1] Another destabilizing factor has been the entrance into the market of the major aluminum producers. Alcoa, Reynolds, and Kaiser all produce aluminum siding and other construction products at the same time that they sell aluminum to smaller operators for the same purpose. Despite these disturbances within the industry, experts predict a continuing rise in the use of aluminum in construction. As this increase takes place, however, it is felt that the industry will continue to be somewhat disturbed, for many small producers must meet the demand that exceeds the capacities of the larger organizations.

In the Pacific Northwest, building products manufacturers constitute the most rapidly growing use of aluminum. The industry in this region is characterized by many of the same factors as the national industry. Many small companies operate without much equipment, while a few larger firms have invested quite heavily in order to reduce production costs. The latter group of firms of the fabricates its own metal in order to be able to buy less expensive shapes from the primary producers. These firms obviously have some cost advantages, but the heavier investments cause an increase in their fixed costs and makes them somewhat less versatile.[2]

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[1] Ibid., p. 15.

[2] Fulkerson, Aluminum Fabrication in the Pacific Northwest: An Economic Survey. op. cit., p. 19.

Among the individual firms in this field, window manufacturers are by far the most numerous. Twenty-two companies in Oregon and Washington make aluminum windows of all sizes. The largest of these by far is a Seattle firm which employs 350 persons and uses 7,000,000 pounds of aluminum annually. This producer purchases the metal in ingots and uses its own extrusion press to turn out window frames. Windows, including glass, average twenty pounds in weight. The company, which sells ninety per cent of its output in the states of Oregon, Washington, and California, also makes pre-fabricated service stations averaging 8,000 pounds each.[1]

A more typical window manufacturer is located in Salem, Oregon, and markets its products in the Willamette Valley and Puget Sound areas. This firm purchases 300,000 pounds of extrusions each year in order to produce 20,000 windows. It is interesting to note that both of the firms discussed are able to consume aluminum at the same rate per man, 20,000 pounds. This factor is not constant among all producers of aluminum windows, however. A Portland manufacturer, making windows of approximately the same size purchases only 56,000 pounds each year and employs twenty persons for an average of 2800 pounds per man. Still another window maker, this one in Spokane, uses 50,000 pounds annually and has eighteen workers. This manufacturer also makes awnings and doors, so it is impossible to extimate its per capita consumption in this single area.

The estimate of total usage by window manufacturers was based on an annual consumption rate of 15,000 pounds per employee, for those

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[1] Ibid., p. 20.

firms making windows only are able to be quite productive due to the facility with which the product is fabricated. Thus, twenty-two firms employing 903 workers should use 13,545,000 pounds of aluminum, most of which is then placed in construction projects in the Northwest.

Another interesting and rapidly growing use of aluminum in the construction field is the manufacture of pre-fabricated buildings. Several small firms, ranging in size from two to thirty-five employees and employing a total of eighty-eight workers, produce various types of buildings which can be placed on the buyer's land with a minimum of effort. The lack of any large producers of this type of structure makes pre-fabrication a relatively minor consumer of aluminum. Total usage in 1962 was about 200,000 pounds, but many of the manufacturers of doors, commercial building facades, and architectural extrusions have also produced pre-fabricated buildings, so part of the 5,000,000 pounds of aluminum used in these areas should be applied to pre-fabrication.

In 1961, aluminum consumption per home was 235 pounds, and this figure increased by ten pounds in 1962. This being the case, the total aluminum consumption in residential construction in Oregon and Washington during these two years can be approximated by multiplying the number of houses built by these figures. Table VII accomplishes this, and, upon examination, it can be seen that in the past two years fifteen million pounds of aluminum were used in the construction of houses in the Pacific Northwest.

Table VII accounts for only single family new dwelling units, so it should be apparent that even in residential construction, aluminum usage is actually much higher than is shown here. Nearly all new apart-

Table VII

Aluminum Usage in New Home Construction
in Oregon and Washington
1961-1962

	1961		1962	
	New Homes	Aluminum	New Homes	Aluminum
Oregon	10,514	2,470,790	11,422	2,798,390
Washington	17,992	4,228,120	22,520	5,517,400
Totals	28,506	6,698,910	33,942	8,315,790

Sources: U. S. Bureau of the Census, Construction Reports--Building Permits, Housing Authorized in Individual Permit Issuing Places, 1962. (Washington, 1963).

Reynolds Metals Company, Background Data on Reynolds Metals Company. (Richmond, Va., 1963).

ment houses are being built with aluminum windows because of the ease in maintenance, and this fact alone will account for a great deal of consumption. In addition, commercial and other non-residential buildings are recognizing the advantages of metal windows in terms of lower maintenance costs and aesthetic beauty. In addition to window frames, aluminum is constantly finding new application in non-residential construction. Many commercial buildings are now being renovated with aluminum facades, and many others, noteably service stations, are made entirely from aluminum sheet. The great amount of aluminum used in construction today has made this the largest user of the metal in the Northwest. Total consumption of aluminum by manufacturers of building materials in Oregon and Washington is well in excess of 20,000,000 pounds.

A total of sixty firms make up the aluminum construction products industry in the Pacific Northwest. Of these companies, twenty-three are in Oregon and employ 661 workers, while thirty-seven Washington firms employ 1188 persons. The Oregon producers range in size from one to two hundred employees with the average employment being thirty. The median, however, is only eight, and the bi-model distribution has peaks at four and thirty. Only four firms employ more than fifty persons, and two of these have more than one hundred employees. Thus, the Oregon portion of the industry is made up of many small firms with a few larger ones causing their distribution to be quite skewed to the right. Much the same situation exists in Washington where the average employment is thirty-two, but the median is fifteen. The standard deviation of the distribution, which ranges from two to 350, is sixty, and this large measure of variation makes the coefficient of skewness somewhat smaller than the Oregon distribution. The

entire industry employs a total of 1849 persons for an average of thirty-one workers. The median of fifteen and the standard deviation of fifty-six cause the distribution to be positively skewed by a coefficient of .291.

Irrigation equipment. Prior to the 1950's very little equipment was needed for the irrigation of farmland. The primary reason for this was the type of irrigation then carried on by most farmers. Flood and furrow irrigation systems require little equipment other than a shovel and perhaps wood or canvas gates to control the flow of water, and these systems were used almost exclusively prior to the previous decade. Since then, an ever increasing amount of irrigation has been done by sprinkling the land rather than allowing the water to run over it. In 1948, about half a million acres were sprinkler-irrigated in the eighteen states west of the Mississippi River.[1] Since that year, the use of sprinklers increased to the extent that in 1959, 2,817,283 acres were irrigated wholly or in part by sprinklers.[2]

The increased use of sprinkler systems is largely due to their superior efficiency, while another reason is the innovation in the manufacture of sprinkler equipment which caused it to be made from aluminum rather than conventional steel. Aluminum irrigation pipe is made in lengths that can be easily carried by one man, coupler fittings that can be installed without wrenches enable changes to be made quite rapidly. Thus, due to the lightness of aluminum, one set of piping is capable of being used over a large area of farm land. The only drawback to the use

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[1]Douglas B. Carter, The Relation of Irrigation Efficiency to the Potential Development of Irrigated Agriculture in the Pacific Northwest. (University of Washington PhD. Thesis, 1957), p. 55.

[2]U. S. Bureau of the Census, U. S. Census of Agriculture: 1959. Vol. III, Irrigation of Agricultural Lands, (Washington, 1962), p. 42.

of sprinkler systems is the additional cost that is experienced by the farmer in the purchase of the necessary equipment.[1]

The truck and vegetable farms in the Willamette Valley in Oregon and the Puget Sound area in Washington are highly adaptable to this type of irrigation as are the vegetable farms in the eastern parts of these states. As a result, the Pacific Northwest has more than its proportional share of the sprinkler irrigated land in the West. Table VIII shows this fact quite clearly and brings to a focus the amount of this type of farming that is currently being done.

The bottom portion of this table shows that as the degree of sprinkler irrigation increases, the ratio of farms in Oregon and Washington to all farms of the same class in the eighteen state area also increases. The same ratio of total acres also increases, but at a lesser rate. This would lead to a conclusion, which is verified by the table, that the average size of an irrigated farm is smaller in the Northwest than in the West as a whole. However, the relative number of farmers switching to sprinkler irrigation systems is greater in the two state area than in the eighteen state area.

The demand for irrigation equipment should continue to grow as more and more land is irrigated. Not only will the increase in irrigable land bring on more demand for sprinklers, but the indirect effect of a greater need for water conservation will cause many farmers who are now devoted to flood and furrow systems to switch to the more efficient sprinklers. Since sprinkler irrigation systems are almost entirely

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[1] The Aluminum Association, Expanding Markets for Aluminum. (New York, 1962), p. 32.

Table VIII

Sprinkler Irrigation
In Oregon and Washington
1959

	Total Irrigated		Sprinkler Irrig.		Sprinkler Irrig. Only	
	Farms	Acres	Farms	Acres	Farms	Acres
Oregon	17,724	1,384,284	8,954	283,506	7,747	234,031
Washington	19,292	1,006,969	10,481	342,665	7,991	251,603
Totals	37,016	2,391,253	19,435	626,171	15,538	485,634
Totals for Eighteen Western States						
	267,431	31,222,967	54,957	2,817,283	41,103	1,959,259
% Total in Oreg and Wash.	14.2	7.7	15.4	22.3	37.8	24.8
Avg. acres Farm 18 states		116.8		51.3		47.7
Avg. acres farm Oreg. and Wash.		64.6		32.2		31.4

aluminum, any increase in its use would be a boon to the local aluminum industry. Aluminum couplers and pipe are easily shipped in bulk quantities, so it would make little difference whether or not the manufacturing were located near the center of consumption. Thus, the availability of primary aluminum in the Northwest and the existence of an already substantial market should make the region attractive to future manufacturers of irrigation equipment.

There is already a sizeable irrigation equipment industry located in Spokane, Washington, and throughout the Willamette Valley in Oregon. In addition to these seven, many of the non-ferrous foundries previously classified as "general foundries" make irrigation couplers on order and add to the potential output of the area. At least three foundries in Portland, employing a total of sixty persons, have been known to cast irrigation couplers, so it can be seen that the actual contribution of the irrigation equipment industry to the economy of the Northwest is difficult to state.[1]

Many of the producers also manufacture other products in an attempt to steady the fluctuating demand for these goods. Among these is a Eugene, Oregon firm that has gone quite heavily into defense subcontracting. Another firm in Spokane, the only Northwest manufacturer of aluminum irrigation tubing, makes a large amount of construction siding. Other manufacturers of irrigation equipment also make industrial couplers, job-order castings and parts for mobile homes.

The market areas for manufacturers of aluminum irrigation equipment extend far beyond the Pacific Northwest. Most truck farming regions west

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[1] Fulkerson, Aluminum Fabrication in the Pacific Northwest: An Economic Survey. op. cit., p. 25.

of the Mississippi River are potential markets for producers in Oregon and Washington. In fact, three of four reporting firms consider the Northwest to be minor market areas. Table IX shows more clearly that local manufacturers destribute their products into other regions where sprinkler irrigation is possible.

Aluminum usage by manufacturers of irrigation equipment is quite difficult to estimate for several reasons. For one thing, in spite of a distinct similarity in their products, the manufacturers of aluminum couplers vary considerably in their production techniques. In addition, nearly all of these firms make some other product in order to smooth out the inherently unsteady demand. Three producers of couplers replying to the questionnaire used 755,000 pounds, so it was estimated that all five coupler manufacturers could not have used more than 1,400,000 pounds. By applying the ratios of the various forms to the total and adjusting this by the writer's knowledge of the individual firms, this estimate can be divided into 630,000 pounds of aluminum ingot, 390,000 pounds of castings, and 380,000 pounds of sheet metal. In addition, one firm in the region produces aluminum irrigation tubing and siding. This firm used 8,000,000 pounds of aluminum sheet in 1962, but it did not supply sufficient information to make any allocation between the irrigation equipment and the building materials produced.

Six of the seven manufacturers of irrigation equipment located in Oregon and Washington employ 287 persons (the seventh would not report its employment). The average, then, is forty-eight workers per firm, and the median of 47.5 shows that this distribution of firms is nearly symetrical. This statement can be very misleading, for the seasonality of demand forces many of these firms to vary their employments considerably.

Table IX

Distribution Pattern of Four Major Producers of Irrigation Equipment in Oregon and Washington

Firm	Location	Product Distribution	Usage (lbs.)	Employ.
1	Eugene, Oregon	Entire United States 65 % east of Mississippi River	300,000	85
2	Spokane, Washington	Western States 50% Midwest 40% Southeast 10%	8,000,000	50
3	Eugene, Oregon	California, Texas Midwest, less than 10% Pacific Northwest	280,000	45
4	Corvallis, Oregon	Western Oregon 35% Pacific Northwest 30% California 10% Midwest 15% East of Mississippi 10%	175,000	12

Source: Personal correspondence and interview.

It can be said, however, that the Northwest irrigation equipment industry consists of seven relatively small firms, all of which also produce some other type of product.

The future of this industry appears fairly bright as more and more farmers convert to sprinkler systems, and the proximity to a large source of raw materials causes optimism for expansion in this area in Oregon and Washington.

Trucks and trailers. The specialized nature of the product makes the truck industry much different from the automobile industry. Since trucks are usually purchased with a particular use in mind, mass production techniques are difficult to apply to their manufacture. Over the past fifty years, however, a few types of trucks have become widely used due to their adaptability to several different functions. Half of all trucks in the United States today are of three types: panel, pick-up, and platform. These three types are generally assembled in their entirety by the manufacturer and have little specialized equipment.[1]

Most larger trucks lose standardized characteristics shortly after they leave the factory as they are adapted to the uses for which they are purchased. Often, these vehicles are purchased from the manufacturer without a body and are then taken to a custom body producer who builds a body to meet the buyer's specifications. In addition, many trucks consist of a tractor only, and trailers are fitted by specialized manufacturers. Such conditions have served to make the truck industry one of relatively small, independent producers of a small volume of equipment.

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[1] Vance, Industrial Structure and Policy. op. cit., p. 191.

Since World War II the American Association of State Highway Officials has been working toward some degree of consistency in truck size limitations in the various states, and the indirect effect of these efforts has been the standardization of the large freight truck. In 1963 all states but one had raised their load limits to over 70,000 pounds, and the highest among these is the 73,280 pounds approved by Congress as the maximum weight on Federal highways and legal in sixteen states. The A.A.S.H.O. is still working for standardization of load limits and liberalization of sizes and expects continued success.[1]

Another trend in the truck industry has been the consolidation of many producers. Typical of this movement is a firm in Portland, Oregon, that entered into a sales and service contract with one of the major heavy truck producers. This agreement has served to place the local firm under nearly complete dominance of the larger organization.[2]

In the Pacific Northwest the truck industry is characterized by several medium sized firms. Most of the important producers employ more than seventy-five persons and have converted to aluminum from the heavier steel, so this industry is one of the most important markets for the metal in the region. Aluminum, which is well suited for truck bodies and trailers because of its strength and lightness, has become so popular in the manufacture of these products that seventy-five per cent of all highway trailer vans are now produced from it.[3] Northwest producers are

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[1] "How Big Should a Truck Get?" Business Week. Aug. 31, 1963, p. 93.

[2] "White Motor: 'A' for Agility," Forbes. Dec. 1, 1961, p. 19.

[3] Reynolds Metals Company, op. cit., p. 23.

no exception to this trend. Seven manufacturers of truck bodies and trailers used over ten million pounds of aluminum in 1962.

Three distinctly different types of products are produced by the seven largest truck and trailer manufacturers. These are truck bodies, chassis and trailers. For the purpose of analysis, bodies and chassis have been grouped together because most of the body manufacturers also produce or modify chassis, while only one firm makes both bodies and trailers. Table X shows the production characteristics of these seven firms.

The fourth column in this table shows a rather wide range in the productivity of labor. This difference is affected by the degree of standardization of each firm's products and the applicability of assembly line production techniques.

With 5103 truck bodies using 7,800,000 pounds of aluminum, the average per truck is 1333. This appears to be indicative of the true average, for the median average usage reported by the five firms is 1300 pounds. Consumption of aluminum per trailer, however, is affected somewhat by the greater volume of firm number three. The other two firms report their average usage to be 5000 and 3000 pounds, while the average for the 986 units produced by all three companies is 2407. It should be pointed out, firms six and seven make tank trailers which, by nature, should require more aluminum than the vans produced by the other firm.

Of the 10,174,000 pounds of aluminum used by all seven manufacturers about two thirds, or 6,650,000 pounds were sheet, and the remaining portion was divided between extrusions (2,725,000 pounds) and castings (793,000).

Table X

Output, Employment, and Aluminum Consumption of The Seven Largest Manufacturers of Trucks and Trailers in Oregon and Washington 1962

Firm	Employ.	Output 1962	Output per Employee	Aluminum Consumption (lbs)
Truck Bodies and Chassis				
1	900	1883	2.09	4,000,000
2	400	1928	4.82	2,750,000
3	125	1102	8.81	540,000
4	90	40	.44	60,000
5	75	150	2.00	450,000
Total	1590	5103		7,800,000
Trailers				
6	250	100	.40	500,000
3*	125	836	6.60	1,774,000
7	85	50	.56	100,000
Total	460	986		2,374,000

*Firm number three employs 250 workers and manufactures both bodies and trailers, so for the purpose of analysis the LaPlace Criterion of equal weights to unknowns was applied, and one-half of the working force was applied to the manufacture of each type of product.

Source: Personal Correspondence.

To further characterize the truck and trailer manufacturing industry of the Pacific Northwest, a number of smaller firms must be added. These are local operators in many cities that produce or service trucks for the transporters and farmers in their communities. They also include two small producers of aluminum boat and utility trailers, and all of these sixteen additional firms add a barely significant amount of value to that generated from the operations of the seven firms discussed previously. The "big seven" constitute only thirty per cent of the twenty-three firms classed as truck and trailer manufacturers, but they employ eighty-four per cent of the workers in this field. A reasonable estimate of their portion of aluminum consumption would be well over ninety per cent, so it can be concluded that all truck and trailer manufacturers used approximately 10,500,000 pounds of aluminum in 1962.

The distribution of sizes of firms in Oregon include eleven companies employing 962 persons. The mean in this case is 87, but the median is 30, so a standard deviation of 121 would create a coefficient of skewness of .471. The situation in Washington is quite similar, for twelve firms employ 1449 workers for an average of 121, but the median is only 37.5. This distribution has a range of from three to 900 and a standard deviation of 243.2, so the coefficient of skewness is a relatively small .343. The total for both states is 2411 workers which creates a mean employment of 104, and median of thirty-five, and a standard deviation of 172, so the distribution is positively skewed by a coefficient of .40.

At the present time the manufacture of trucks and trailers makes a significant contribution to the economy of the Pacific Northwest, and it appears to be increasing. In 1961, the seven large producers manufactured

2936 truck bodies and chassis and 924 trailers, so the 1962 production of 5103 bodies and chassis and 986 trailers represents increases of 73.8% and 6.7% respectively. Sales for 1963 should be even higher, for 1963 has been said to be the best sales year in the history of the truck industry.[1] This, however, is not necessarily a sign of continued prosperity -- for the truck industry has historically behaved in much the same manner as the machine tool industry. That is, that as business improves for the consumer of the industry's product, in this case the motor freight haulers, they will purchase more of the necessary equipment. This causes extra equipment to be on hand in poorer years, and, consequently, the replacement rate falls somewhat. Thus, the acceleration principle is in force in this industry and causes a very unstable demand.[2] The average life of a truck will vary, especially among the heavier models.

Over the five year period 1957-1961, commercially operated truck and trailer registrations in Oregon and Washington have shown a consistent upward trend at about the same rate as the national average.[3] New truck sales, therefore, have increased in this area each year by somewhat more than the net change in registrations, for such a figure fails to account for replacement sales. In addition, the four largest firms in the region consider their primary market to reach far beyond the Northwest, so any increase in the demand for heavy trucks or trailers will have considerable influence on the local industry. The truck and trailer manufacturing industry in the Pacific Northwest, then, is one of the principal

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[1] "Truck Sales Still Barreling Ahead," Business Week. April 6, 1963, p.32.

[2] Vance, Industrial Structure and Policy, Op. cit., p. 155.

[3] This is shown in compilations of data given in U. S. Bureau of Public Roads, Highway Statistics. Various years.

consumers of aluminum and, as these firms continue to expand this usage of the metal will also increase. Performance by these firms in recent years coupled by the bright outlook for the industry in general makes continued growth a distinct possibility.

Mobile homes, travel trailers, and pick-up coaches. At the present time there are nearly four hundred manufacturers of house trailers in the United States. Many of these are small, independent operators whose business is primarily done locally. Several large firms dominate the market for the larger mobile homes, however, as the top twenty-five firms enjoy sixty per cent of the total sales, and the top ten have forty per cent.[1] The local producers have a distinct advantage over their large competitors because it costs forty cents per mile to move a large trailer to its sales point.[2] Such a competitive situation generally has a disruptive effect upon the industry, and the result is often a decrease in operating margins and profits for all operators and bankruptcies of the less solvent firms. This was precisely the condition of the industry in 1961 -- partly due to the increased popularity of the pick-up coach. Easily substitutable for the travel trailer, the "camper" is more mobile, less expensive, and easier to care for. Shipments in the year 1961 totaled slightly more than 130,000 units which represented a ten per cent decrease over the previous year and the lowest year's total since 1955.[3]

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[1]Norris Willait, "Homes on Wheels," Barron's. February 29, 1960, p. 3.

[2]Jerrold Lanes, "Pre-fab, Mobile, and Shell," Barron's. March 29, 1963, p. 7.

[3]Norris Willait, "Trailer Blazers," Barron's. May 14, 1962, p. 11.

Mobile home and travel trailer manufacturing in Oregon and Washington is on a very small scale, and the nine firms in the two state area producing these vehicles could hardly be expected to make more than 1400 mobile homes and 4000 travel trailers. If the average mobile home is assumed to be sixty feet long, ten feet wide, and eight feet high, the total number of exterior square feet, including windows but excluding the bottom which is usually made of steel, would be 1720. Since aluminum is generally used as an exterior covering only, 1400 mobile homes would use 2,408,000 square feet of thin aluminum sheet which weighs .075 pounds per square foot. Thus, the entire consumption of aluminum is the manufacture of mobile homes in the Northwest is only 181,600 pounds.

The smaller travel trailers tell much the same story. Average dimensions being around twenty-five feet by eight feet by seven feet would give an outside area of 662 square feet. This would mean a total of only fifty pounds of aluminum in each trailer, and the entire annual production of 4000 units would consume only 200,000 pounds of aluminum sheet.

Mobile home and travel trailer production in the Pacific Northwest is characterized by several small firms producing the various types of trailers. In both Oregon and Washington the nine firms using aluminum in the manufacture of these items employ only 284 persons. Of this total 140 are employed by a McMinnville, Oregon branch of one of the industry's larger firms whose headquarters are in Richmond, Indiana. The mean employment of the nine firms, six of which are in Washington, is thirty one, but the median is only fifteen which demonstrates that the typical scale of operations is quite small. A standard deviation of 40.5 causes the skewness of the distribution to be .407.

In the past five years there has been a sharp increase in the use of pick-up coaches or "campers" as replacements for travel trailers. A camper is nothing more than a metal box which is placed in the load bed of a pick-up, thus removing certain maintenance and registration expenses that the owner of a travel trailer must incur. Campers generally come in two sizes; either eight or ten feet in length. The other dimensions will vary with the manufacturer, but on the average, pick-up coaches are about six and one-half feet high and seven feet wide. Some producers cover only the exposed portions (the parts not protected by the sides and bottom of the truck bed) with sheet metal, while others cover the entire box. If only the exposed portions are covered, about 225 square feet of aluminum would be used on the eight foot models and 250 on the large ones. It would appear, however, that because of differences in the manufacturers' designs, the average usage per unit would be closer to three hundred feet.

It is very difficult to pinpoint the number of producers of campers currently operating in the Pacific Northwest. Research by the writer into the four firms reporting in the 1961 Census of Oregon Manufacturers that they make pick-up coaches found that at least two of these were no longer in production. The same situation exists in Washington where of the five producers listed, one is no longer in business and another uses steel rather than aluminum. An estimate would at best be rough, but there are most likely seven manufacturers of campers in Oregon and Washington at the present time employing about seventy-five persons. It would also seem reasonable that these seven firms produce three thousand

campers each year.[1] Three thousand coaches using three hundred square feet of aluminum sheet each would mean that a total of 900,000 square feet of aluminum are used in this production. At .075 pounds per square foot, this would become 67,500 pounds of aluminum per year.

Thus, it appears that the mobile home industry in Oregon and Washington is not as important a user of aluminum as was originally anticipated. Estimates of the consumption of aluminum in each of the three catagories is as follows:

Mobile homes	180,600
Travel trailers	200,000
Pick-up coaches	67,500
Total	449,100

Due to the method of estimation, this figure is subject to considerable error, and it would seem best to increase the estimate somewhat due to distinct possibilities of under statement of usages per unit. The total aluminum consumption in these three types of manufacturing is estimated then, as approximately 500,000 pounds.

Future growth in this industry depends mostly on the new demand developed by more leisure time among the residents of regions accessible to outdoor vacation spots and the increased need for more mobile dwelling units. It is quite possible that the next ten years will see considerable growth in the use of campers, but mobile homes and travel trailers, currently experiencing an upheaval within the industry should

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[1] One of the larger manufacturers employs twenty workers and produces 1500 units per year. Productivity of labor in this case is seventy-five units, but this must be discounted to account for smaller scales of plant, so the reasonable estimate of units per man would be forty.

not grow so rapidly. At any rate, the comparatively small amounts of aluminum used in the manufacture of these products will continue to make this industry at best a minor consumer of aluminum for some time to come.

Aircraft and missiles. The aircraft and missile industry in the Pacific Northwest consists primarily of a single firm, the Boeing Company which is the largest single employer in Oregon and Washington. Boeing manufacturers military and commercial aircraft and guided missiles and parts. Other manufacturers in the two states include small plane and parts producers in Everett, Washington, and Sandy, Salem, and Portland, Oregon. These firms and the many service companies consume a negligible amount of aluminum, however, and their total employment is less than 500 workers. So it could be said that the aircraft industry in the Northwest is the Boeing Company.

In 1958, 90 per cent of Boeing's output was sold to the Federal Government, but this figure has decreased to 55 per cent in 1963 as a result of two factors. First, the firm has entered quite successfully the commercial jet airliner market with three planes: the 707, 720, and 727, and their modifications. In addition, the company is no longer producing the military bombers which were so profitable in the past. The final B-52's have been delivered and the B-47 has not been in production for some time. The company is still producing Minuteman and Dyna-Soar missiles, but the government contracts do not compare in value with those of the past decade.[1]

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[1]Leverett, Richard, "Boeing Counts Yearly Losses in 'Meaningless Figure'", The Oregonian. August 15, 1963, p. 15a.

In the commercial jet transport field Boeing was at an advantage in that its initial model, the 707, was actually a modification of the KC-135 military transport. The B-47 and B-52 also gave the firm valuable experience with large jet airplanes, and the Seattle based organization was able to introduce the first American jet transport in 1959. This competitive position was improved by the subsequent introduction of the 720 medium range airplane and the 727 short range jet.[1]

The shifts in the method of government contracting have not been helpful to Boeing. During World War II when the need for aircraft was at its peak, the Federal Government furnished all parts and materials to the fabricating contractors who operated on a "cost plus" basis. Following the war it was customary to let a contract to a single firm which would then develop and deliver the desired weapon system. Recently, however, the Defense Department has contracted groups of firms to jointly manufacture the product.[2] The Dyna-soar and Minuteman missile contracts were let in this manner. Boeing, as manager of the Minuteman project will receive fifteen per cent of the $25,000,000 to be spent on that system.[3]

Serious difficulties may lie ahead for the Boeing Company, and as a result the aircraft industry in the Pacific Northwest could suffer. Many of the aluminum foundries and other fabricators are sub-contractors to

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[1]"Boeing Soars Ahead of Douglas in the Jet Race," Business Week. February 11, 1961, p. 64.

[2]Murray L. Weidenbaum, "The U. S. Aircraft Industry," Financial Analyst's Journal. March-April, 1963, p. 51.

[3]"Head Winds for Boeing," Forbes. September 1, 1960, p. 14.

Boeing projects, so any cutbacks at the larger firm will have repercussions throughout the Northwest. The level of commercial transport manufacturing at the Seattle plant is not sufficient to support the current level of operations, so either new contracts must be obtained, or the firm will be forced to decrease its scale of operations.[1] Hope still exists that the firm will be granted the contract to manufacture the TFX jet fighter plane, but at present this is far from a reality.

An estimate of the use of aluminum by all aircraft manufacturers in the Pacific Northwest in 1960 was 13,100,000 pounds,[2] while another projection for 1962 states that 16,512,000 pounds were consumed.[3] The source of the latter estimate has at times been shown to be quite unreliable and differs from the statement by the Boeing Company that 13,500,000 pounds were used in 1962. If Boeing consumes thirteen million pounds, it seems most unlikely that the entire Northwest industry would use sixteen million. A more realistic estimate of aluminum consumption by all aircraft manufacturing operations in Oregon and Washington would be 14,000,000 pounds which assumes that firms other than Boeing use a half million pounds of the metal. The 1962 estimate is useful for an estimate of the breakdown of the shapes of aluminum used, so using the percentages shown by this source, the 14,000,000 pounds of aluminum used in 1962 by Northwest aircraft manufacturers is distributed as follows:

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[1] Ibid., p. 15.

[2] Fulkerson, Aluminum Fabrication in the Pacific Northwest: An Economic Survey. op. cit., p. 4.

[3] Confidential source.

Tube, bar extrusions (34%).....4,760,000

Sheet and plate (60%).....8,400,000

Castings (6%).....840,000

In 1960, thirty per cent of Boeing's total aluminum consumption was used for products other than jet aircraft, mainly missiles.[1] This fact is primarily due to the usage associated with the Bomarc missile, a project which has since been closed. As missiles become more important to Boeing, aluminum consumption should taper off due to the relatively minor position aluminum plays in missile fabrication. Aluminum does not withstand heat as well as magnesium and titanium alloys, so it is not used for missile skins to the degree that it is in airplanes. Since the immediate future of Boeing operations rests with the Minuteman missile, 950 of which have been ordered to date, it is unlikely that the firm will increase its aluminum consumption by any significant amount in the next few years.

William Allen, the president of the Boeing Company, has been quoted as saying, "Anybody who makes prophesies about the aircraft industry is plainly touched, and the further a fellow tries to look ahead, the crazier he, himself, is likely to look."[2] With this statement in mind it seems rather foolish to predict the future of the aircraft industry in the Northwest. At the present time Boeing has a sufficient backlog of orders to assure production of eight 727's and three to four 720B's per month

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[1] Fulkerson, Aluminum Fabrication in the Pacific Northwest: An Economic Survey. op. cit., p. 9.

[2] Charles J. V. Murphy, "The Plane Makers Under Stress." Fortune. July, 1960, p. 111.

through 1968.[1] Since each of these planes require about 35,000 pounds of aluminum, this assures the annual use of nearly 4,000,000 pounds of the metal through that year. Substantial amounts should also be used in the missile programs, but without a project to replace the heavy bombers, aluminum consumption by this firm will be cut somewhat. The TFX is still a possibility as is a supersonic transport, but beyond these two the only other possible course for Boeing is to reduce its labor force and cut back its operations. Such a situation would, of course, be quite harmful to the Northwest in general and the Seattle area in particular.

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[1] "Boeing Expects Full Production in Transport Division for Ten Years," Aviation Week and Space Technology. December 10, 1962, p. 40.

CHAPTER IV

CONCLUSIONS

Use of Aluminum

Manufacturers of aluminum products in Oregon and Washington used 65,030,000 pounds of aluminum in 1962. This estimate is the total of all figures stated in Chapter III with the addition of 4,600,000 pounds to account for consumption not discussed. The extra metal added to the estimate should be sufficient to show the usage in other industries. Of this, 2,400,000 pounds are allocated to ship and boat manufacturing. This is the same figure quoted in a 1960 estimate and has been used because no other is available. It is felt that the use of aluminum in ship building is such that any consistency in production should apply to aluminum consumption. There having been no significant increase in the construction of ships since 1960, this 2,400,000 is assumed to approach the actual use.

Another 1,000,000 pounds is allocated to the eleven firms in the Pacific Northwest engaged in general sheet metal work. Since no replies were received from members of this industry and since production techniques and products vary considerable, it was impossible to estimate the usage of aluminum by these firms. The U. S. Bureau of the Census figures show sheet metal foundries in Oregon and Washington using slightly less

than 800,000 pounds of sheet aluminum in 1958.[1]

Manufacturers of various types of machinery also consume a substantial amount of aluminum. This is nearly impossible to estimate, for aluminum is used here not as a principal material, but rather in a secondary capacity. Census Bureau data once again shows about one and two thirds million pounds of aluminum in 1958, so allowance for a definite increase would place this figure at 2,000,000 pounds in 1962.[2] In both machinery and sheet work an increase of twenty-five per cent over 1958 is shown as the assumed addition to aluminum consumption. It will be shown subsequently that this figure is actually in excess of the increase in total aluminum consumption in the Northwest in the same period.

Finally, another 200,000 pounds was added to the estimate to account for the small manufacturers of consumers durable products and miscellaneous production that is not otherwise included. Table XI shows total aluminum consumption in the Pacific Northwest as was estimated from data collected by this writer. This consumption compares quite favorably with a reliable estimate of 1960 usage and shows an annual increase of nearly five per cent over 1958. Table XII shows comparisons with other statements of aluminum consumption in Oregon and Washington and a comparison with the national percentages of total usage.

An adjustment of the data in Table XI will show that aluminum usage in the Pacific Northwest has increased by 17.1 per cent since 1958. The U. S. Census of Manufacturers: 1958 states that 43,758,000 pounds

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[1]U. S. Bureau of the Census, U. S. Census of Manufacturers: 1958, Consumption of Selected Metal Mill Shapes and Forms. op. cit., p. 99.

[2]Ibid., p. 99.

Table XI

Aluminum Consumption in
Oregon and Washington, 1962
(1000 lbs.)

Industry	Ingot, Billet	Extrusions, Tube, Rod	Sheet, Plate	Castings	Total	% Total
Foundries	6,245				6,245	9.6
Windows	6,650	6,220	625		13,545	20.8
Doors, thresholds		2,640	1,300		3,940	6.1
Architectural extrusions	245	755	100		1,100	1.7
Pre-fabs		64	80	56	200	0.3
(Total Building Materials).....					(18,785)	(38.5)
Irrigation equipment	630		8,380*	390	9,400	14.5
Sheet Work			1,000		1,000	1.5
Trucks		2,830	6,830	840	10,500	16.1
Mobile Homes			500		500	0.8
Aircraft		4,760	8,400	840	14,000	21.5
Ships and Boats					2,400	3.7
(Total Transportation Equipment).....					(27,400)	(42.1)
All Others					2,200	3.4
	13,770	17,269	27,265	2,126	65,030	100.0

*A substantial but unknown portion of this figure should be allocated to building materials.

of aluminum mill shapes and castings were consumed by manufacturers in Oregon and Washington in 1958.[1] This figure does not include consumption of ingot and extrusion billet, so in order to make any comparison the 13,770,000 pounds of these forms must be subtracted form the 1962 total. Such a calculation shows that in 1962, 51,260,000 pounds of mill shapes and castings were used. The increase then becomes 17.1 per cent. Thus, the assumed increases in sheet metal work and machinery, both of which were slightly less than twenty-five per cent, cannot be too unrealistic, but could easily be somewhat excessive.

A Bureau of Mines estimate of aluminum usage in 1960 for Oregon, Washington, and Idaho was 60,000,000 pounds.[2] Since very little manufacturing is carried on in Idaho, this estimate is quite comparable to the one shown in Table XI. The increase in consumption over the two year period was 11.7 per cent which indicates a more repid increase in the use of aluminum during the past two years than during the three prior to that. However, the method of calculation of the two estimates differs somewhat, and it is not unlikely that the 1960 figure is under stated. Table XII shows a comparison of the allocations of aluminum usage for the two estimates and the 1962 allocation for the entire nation.

Both of these estimates are at best minimal in their totals with certain portions possibly exceeding the real consumption. The 1960 estimate seems to overstate mobile home consumption even if it does include the

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[1] Ibid. pp. 99, 113.

[2] Fulkerson, Aluminum Fabrication in the Pacific Northwest: An Economic Survey. op. cit., p. 4.

Table XII

Aluminum Consumption in Oregon and Washington
And Its Allocation Among Principal Industries
1960 and 1962
(1000 lbs.)

Industry	1960 (1) Consump.	% Total	1962 Consump.	% Total	1962 (2) U.S. %
Transportation Equip.					
Aircraft	13,100	22	14,000	21.5	
Trucks	10,100	17	10,500	16.1	
Ships	2,400	4	2.400	3.7	
Mobile Homes	2,400*	4	500	0.8	
Other	2,000	3			
Total	30,000	50	29,400	42.1	23.4
Building Mats.	18,000	30	18,785	38.5	23.5
General Foundries	3,000	5	6,245	9.6	
Irrigation and all others	9,000	15	12,600	9.8	53.1
Totals	60,000	100.0	65,030	100.0	100.0

(1) Frank B. Fulkerson, Aluminum Fabrication in the Pacific Northwest; An Economic Survey. (Washington, 1962), p. 4.

(2) "Aluminum Sees Sales at New High," Business Week. June 29, 1963, p. 98.

*Included in this figure is a rather extensive mobile home industry in Idaho which explains the large discrepency in the two years.

Idaho manufacturers, while the 1962 estimate quite possibly has over stated consumption by sheet metal foundries and machinery manufacturers. These conditions must be known in order for either of the statements to be useful.

Conclusion

Each of the industries described in Chapter III has excellent prospects for future growth. However, the relative scale of operations for each is, at the present time, so low that a very large degree of expansion is necessary before the Pacific Northwest market for aluminum will be sufficient to support additional fabrication facilities in the region.

Industrial foundries, it was pointed out, derive their demand from demand for other goods. Many of the foundries in the region manufacture aircraft and missile parts for Boeing, so if production is curtailed by this large firm, aluminum consumption by manufacturers of castings should fall somewhat. It is felt, however, that this portion of the aluminum industry can and will develop more in the coming years due to the availability of raw materials in the region. Since most cast products are shipped in bulk, transportation costs should not present any great problems. Of course, most foundries are quite small in terms of the value they add to the economy, so it would take a great increase to make aluminum casting a major industry of the Northwest.

The manufacture of building materials from aluminum is growing constantly, and the Northwest should be no exception. As the population of the area expands, new dwellings must be built to house new inhabitants. In addition, schools and commercial buildings will add to the new con-

struction, and each building is a potential market for aluminum. The building materials industry is presently the second largest user of aluminum in the Northwest. However, the region remains a net importer of construction goods, so there is still considerable room for growth. The small investment necessary to start a business in this field should continue to attract new producers.

It is difficult to see manufacturers of irrigation equipment becoming a major part of the Northwest economy. While a continued expansion of the use of aluminum irrigation equipment is foreseen, the ability of a small firm to satisfy a large number of customers and the instability of demand for the products should serve to minimize the expansion in this area. The region is presently a net exporter of aluminum irrigation equipment, so it does not seem likely that a large degree of expsnsion will take place.

The truck and trailer industry should continue to play an important part in the economy of the Pacific Northwest. However, the substantial investment necessary to begin operations in this type of production should keep new firms from initiating large scale manufacture. Thus, the expansion should come through the firms already in existence as they continue to grow and increase their annual sales.

Mobile homes are somewhat of a problem. This industry was insufficiently analyzed to make any sort of prediction as to the immediate future. This industry is made up of many small, marginal producers, which should continue to be the case as demand for mobile homes, trailers and campers increases. However, it is impossible to say whether enough units will be manufactured in the region to satisfy the local demand,

and whether the region will continue to consume products made in California.

Aircraft was shown to be in a state of transition with a distinct possibility of a forced cutback in production. If this is the case, the aluminum industry in the Pacific Northwest will suffer greatly. At any rate, it seems very unlikely that any new firms will develop in this region in either Oregon or Washington. The center of the industry being in California and the climate of the Northwest not well suited to the requirements of the industry, it is doubtful that any large aircraft and missile manufacturers will choose to locate here.

Thus, the outlook for a continuing increase in aluminum consumption by Pacific Northwest industries is quite favorable, but it should be remembered that very little aluminum is actually being used. The 65,030,000 pounds of aluminum used as raw materials by Oregon and Washington manufacturers in 1962 represents only 1.2 per cent of the nearly six billion pounds produced in the year.[1]

To further illustrate the relative consumption of the region, all of the aluminum used in the Northwest in 1962 could have been reduced by one half of the annual capacity of the smallest reduction mill in the area.[2]

Table XIII shows comparative data on aluminum production and consumption in the two state area since the end of World War II. It is It is easily seen from this table and from the accompanying figure that the amount of aluminum consumed in Oregon and Washington does not begin

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[1] "Aluminum Sees Sales at New High," Business Week. June 29, 1963, p. 98.

[2] The Reynolds Metals Company operation in Longview, Washington, has an annual capacity of 60,500 tons, so the 32,515 tons used by Northwest manufacturers is only slightly more than 50% of the possible production of this mill.

to compare with the amount produced here. Although data are not strictly comparable,[1] considerable increase in the amount of aluminum used by manufacturers in the Pacific Northwest in the past seventeen years.

The data for aluminum fabrication (labeled "Processed Beyond the Ingot Stage") in Table XIII were determined by the combination of figures from several different sources. Figures for 1961 and 1962 were given in the April 11, 1963 release of the Bonneville Power Administration News, while the 1947 and 1954 figures came from the respective Censuses of Manufacturers. A spokesman representing the Northwest aluminum industry stated that in the eleven year period 1952-1962, 2,200,000 tons of aluminum were fabricated in the area.[2] The average annual increase between 1954 and 1961 was computed to be 9,800 tons, and this figure was used to compile the data shown in the table for the years 1955-1960. The remaining 314,300 tons were then equally allocated to 1952 and 1953.

The outlook is for continuing increases in the industrial use of this material, but since 1962 consumption was only 6.4 per cent of the

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[1]Figures for 1947 show only the consumption of mill shapes and forms and do not include ingot, extrusion billet and castings. Data for 1954 and 1958 neglect ingot and billet but include castings. In 1962, castings represented 3% of all aluminum consumed and ingot and extrusion billet represented 21%. Thus, in order to make the data given in Table XIII more comparable the 1947 figure was increased by 24%, and the 1954 and 1958 figures were increased by 21% Original data taken from the U. S. Bureau of the Census, Census of Manufacturers for the respective years were (in thousands of tons):

1947	5.6
1954	16.7
1958	26.5

[2]Personal Correspondence

Table XIII

Production and Consumption of Aluminum
in Oregon and Washington, 1946-1962
(1000 tons)

Year	Primary Production	Processed Beyond Ingot Stage	Consumption
1946	148.0		
1947	265.0	112.4	6.9
1948	295.0		
1949	311.4		
1950	343.0		
1951	364.1		
1952	350.0	157.1	
1953	480.8	157.2	
1954	512.0	171.5	20.2
1955	531.7	181.3	
1956	562.1	191.1	
1957	527.9	200.9	
1958	422.4	210.7	26.5
1959	473.8	220.5	
1960	470.6	230.3	30.0
1961	457.6	240.4	
1962	506.2	239.0	32.5

Sources:

Aluminum Company of America, Personal Correspondence.

Bonneville Power Administration, Personal Correspondence.

Frank B. Fulkerson, Aluminum Fabrication in the Pacific Northwest: An Economic Survey. (Washington, 1962), p. 4.

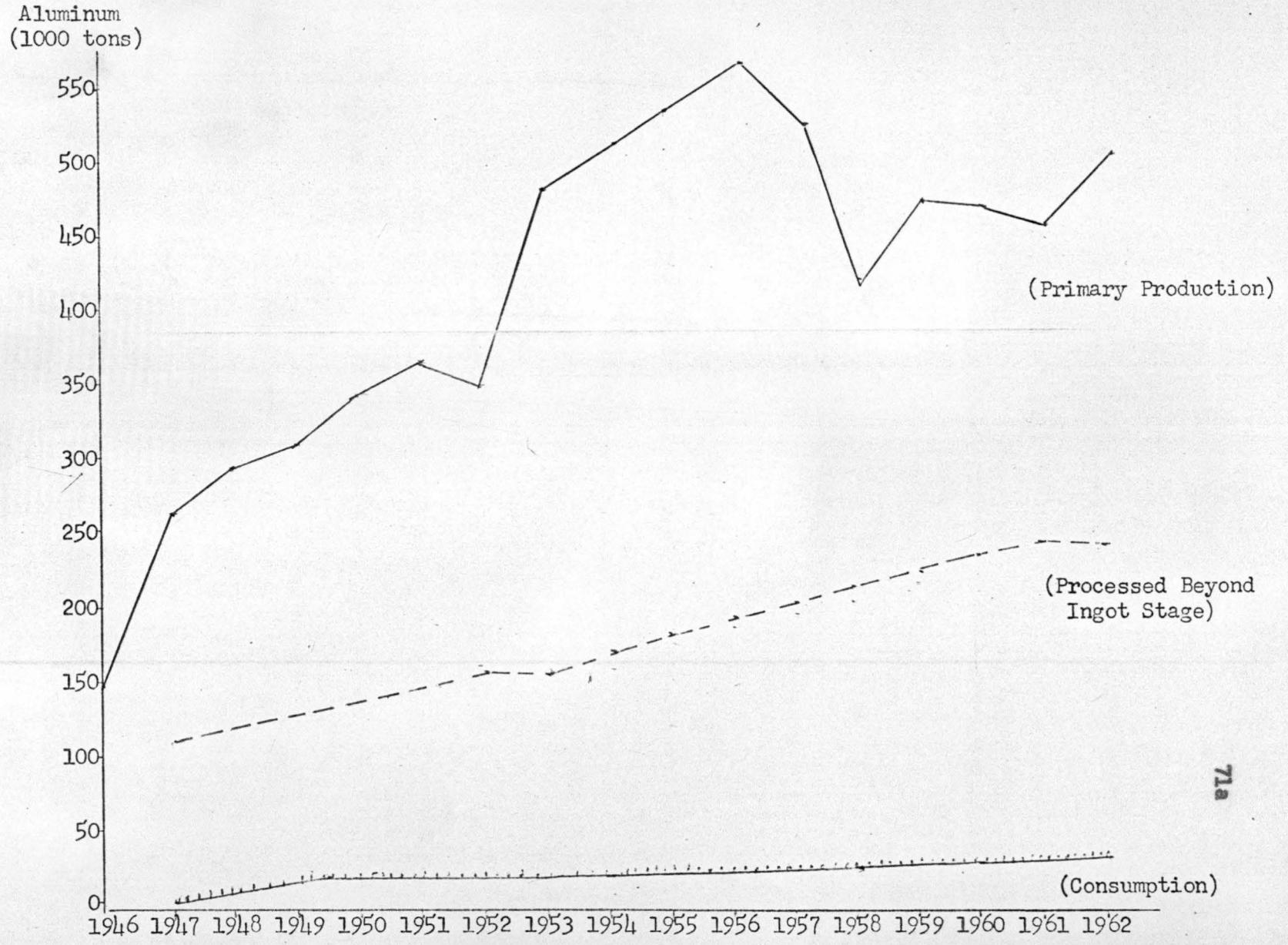
U. S. Bureau of the Census, Census of Manufacturers: 1947. (Washington, 1950), p. I--245.

U. S. Bureau of the Census, Census of Manufacturers: 1954. (Washington, 1957), p. 210--49.

U. S. Bureau of the Census, Census of Manufacturers: 1958. (Washington, 1961), p. 7--64, 7--65.

U. S. Department of the Interior, Bonneville Power News. April 11, 1963, p. 2.

ALUMINUM PRODUCTION AND CONSUMPTION IN OREGON AND WASHINGTON
1946-1962



aluminum produced in the Northwest and slightly more than 10 per cent of all aluminum processed beyond the ingot stage,[1] it appears the existing facilities should be more than sufficient to serve the local market for quite some time. The intervals for which the consumption figures in Table XIII are given show average increases as follows:

1947-1954	1,900 tons per year
1954-1958	1,600 tons per year
1958-1960	1,750 tons per year
1960-1962	1,250 tons per year

Due to the heterogeneity of the methods of data collection, it would not be statistically possible to calculate an average increase per year, but it does seem likely that an annual increase of 1,500 tons would not overstate the true condition. At this rate, it would take more than 130 years for aluminum consumption to catch up with the production of fabricated shapes.

Discussion in Chapter III stated that the average employment for industrial firms using aluminum as a raw material was forty-one. This fact, more than any other, appears to be the principal reason for consumption of the metal to lag so far behind its production. Expansion of industrial activity in the two state area and an increased scale of operations would provide the impetus that would make expansion of aluminum fabrication operations a necessity.

The only possible conclusion that this study can reach is that aluminum product manufacturing in Oregon and Washington is not sufficient

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[1]Only the figures in Table XI showing the totals for fabricated shapes and forms were used in this calculation.

to warrant more investment by major aluminum producers at the present time. Considerable growth in existing industries is necessary before new plants can be considered for this reason. The region is highly dependent on two major areas of aluminum fabrication, building materials and transportation equipment, for the bulk of the aluminum consumption. In 1962 these two industries consumed 80.6 per cent of all aluminum in the Northwest, while the national consumption by them was only 46.9 per cent. Thus, the Pacific Northwest is relatively undeveloped in areas of aluminum fabrication that use over fifty per cent of all aluminum produced in the United States.[1]

One possibility for expansion does remain, but it is out of the realm of this thesis. That is, to locate fabrication mills in the Northwest to serve the large California market. At least on major producer is considering such a step at the present time, but whether it will prove profitable is questionable. A move such as this would be in keeping with one of the current trends in the aluminum industry -- the construction of integrated production facilities. Already two complexes of reduction and fabrication operations exist in the two state area, the Trentwood--Mead operations of the Kaiser Aluminum and Chemical Corporation near Spokane, Washington and the Vancouver works of the Aluminum Company of America. In recent years Ravenswood, West Virginia, Alcoa, Tennessee, and Listerhill, Alabama have been the sites of expansion of more than one type of aluminum operation, so it seems entirely possible that the California demand might be served from fabrication plants located in conjunction with present reduction facilities. Whether the initial costs of installing a plant to serve the

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[1] Table XII.

California markets would offset the greater transportation costs that would be incurred, is not known, but it does remain a fact that any fabrication plant expansion will have to be generated by some force other than the existing market in the Pacific Northwest.

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APPENDIX

THE COEFFICIENT OF SKEWNESS

The principal tool of analysis used in this study is the frequency distribution. A frequency distribution is nothing more than a list of the values of some variate occurring in some collection of data. In this case the distribution is of numbers of workers employed by each member of a group of firms. Each firm is an observation and its value is its number of employees.

A frequency distribution can take practically any shape, but the most commonly known is the normal distribution in which all data is evenly dispersed around the arithmetic average (the mean), which is identical with the median (that value which is greater than half of the observations and less than the other half) and the mode (the value occurring most often in the distribution). When the distribution is not normal these three measures will differ from each other.

The standard deviation is another important characteristic of a distribution. This is the measure of the dispersion around the mean, and it can be proven that in the normal distribution sixty-eight per cent of the data will fall within one standard deviation to either side of the mean, ninety-five per cent will fall between two deviations and nearly one hundred per cent will fall within three standard deviations to either side of the mean.

Whenever the mean, median, and mode differ from each other the distribution is said to be "skewed". The mode will always occur at the peak (most common observation) of the distribution, so the skewness of the distribution must be measured by the difference between the mean and the median. When the mean is greater than the median, the distribution will be skewed to the right or "positively skewed" which means that the extreme observations are to the positive side of the mean. In a distribution skewed to the left (negatively skewed) the mean is less than the median, and the extreme values are to the negative side of the mean.[1]

Since most of the distributions shown in this study are very skewed, another tool has been used to show the degree of skewness in order that the actual characteristics of each distribution can be seen. The "coefficient of skewness" is calculated by dividing the difference between the median and the mode by the standard deviation. Thus, this number actually shows the number of standard deviations which separate the median and the mean. The coefficient will be positive if the distribution is positively skewed and negative if the distribution is negatively skewed. As the coefficient approaches one of either magnitude, the distribution will become more skewed.[2]

By measuring the difference between the mean and median in terms of the standard deviation of the distribution, the coefficient of skewness

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[1]For a more comprehensive explanation of these statistical tools and terms see Ernest Hurnow, Gerald J. Glasser, and Frederick R. Ottman, Statistics for Business Decisions. (Homewood, Ill., 1959), chapters two and three.

[2]Frederick A. Ekeblad, The Statistical Method in Business. (New York, 1962), p. 251.

acquires one inherent weakness. The degree of skewness is dependent on the size of the standard deviation and is only relative to this base. Because of this, two distributions with different standard deviations cannot be compared without some knowledge of the data within them and the dispersion of this data around the mean. However, this measure of a distribution's normality does meet certain other prerequisites which make it as useful as any other method of showing skewness. It is a pure number independent of the values in the distribution and has a value of zero when the distribution is symetrical. In addition, it makes use of a meaningful measure of scale (the standard deviation) so that skewness can be related to something.[1] Thus, since all distributions discussed in the text show the same thing, sizes of firms, it seems acceptable to use this method of computing the coefficient of skewness in spite of the fact that the standard deviations of the various distributions differ.

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[1] Ibid., p. 251.

TYPED BY

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