THE CANADIAN PRIMARY ALUMINUM INDUSTRY

by

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PREFACE

The present thesis is an attempt to analyse the factors and trends which helped to bring about what the aluminum industry is now, and which may in some measure contribute to the further development of that part of the economy.

The industry chosen for this study is a complex and interesting entity. It is also of considerable significance within the framework of Canadian economic progress in recent years. The aluminum industry today, in Canada as well as in other major producing countries, is an industrial giant. It has attained this stature only since World War II. Thus when focusing attention on present trends within the industry, it is only natural to find that much of this attention has been expended on developments since World War II.

In so doing one difficulty was encountered with which the reader should be acquainted at the outset. This difficulty is a scarcity of supporting material covering the more recent post-war period.

Even prior to the war, statistical coverage has not been as good for aluminum as it has been for other industries. For example, Dominion Bureau of Statistics data on Non-Ferrous Metal Mining and Smelting are broken down usefully only where subsections cover more than one firm. Otherwise the Dominion Bureau of Statistics would be releasing data on one particular company. The Aluminum Company of Canada is a case in point since until this year it was the only producer of primary ingot in this country. Fortunately this particular lack of data could for the most part be compensated by statistics from a variety of sources, including those published by the company. The remaining gaps were an impediment only in one chapter which presents a statistical snapshot of the industry by means of input-output tables. Though still illustrative, this chapter is not a cornerstone of the present analysis.

There is yet another, more deep-seated and less tangible reason for the dearth of supporting material. The identity of "firm" and "industry", in Canada until this year, in the United States until 1940, has in the past drawn more attention to the respective companies' activities than they had reason to find desirable. Anti-trust lawyers, the press, and other sectors of the general public have from time to time attacked the allegedly restrictive practices of the primary producers. As a result, a company receiving such attention may tend to discourage publicity other than its own. This is understandable enough, but for the independent researcher it poses a problem. Rumor has it, for instance, that Professor D.H. Wallace had to go over the draft of his book on the aluminum industry[1] with a team of lawyers before publication lest the Aluminum Company of America would take legal action against him.

There is no fear that the study presented here might encounter pitfalls similar to the ones Professor Wallace is supposed to have had to guard against. It is not within its scope to take to task past actions in the way Professor Wallace has done. Nevertheless nothing but published material was used.

For the period prior to World War II Professor Wallace's book contains a wealth of information. So does evidence presented in anti-trust actions against the Aluminum Company of America. However, since the present study is concerned mostly with the post-war era, there was occasion to use such material only sparingly. Good source material

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[1] D.H. Wallace: Market Control in the Aluminum industry. Harvard University Press, Cambridge, Mass., 1936.

covering the more recent post-war period is scarce. The reader may notice therefore that in the later part of this thesis rather heavy reliance may have been placed on a small, though excellent group of references. Here also newspaper and business magazine items had to be used more extensively than would have been desirable under more favorable circumstances.[2]

To comply with the regulations of the Faculty of Graduate Studies, here is a statement of my claim to contribution to knowledge:

First, the traditional frame of reference employed in the evaluation of the market behavior of the firm has been examined. Evaluations of market behavior based on static concepts no longer seem adequate. Without leaving the outer boundaries of neo-classical theory, an attempt has been made to create a more proper place for dynamics in our thinking by tempering traditional attitudes with a good deal of pragmatism.

Second, an analysis has been made of the main motivating factors which are likely to influence the extent and direction of further development within the Canadian industry. Since about 85 per cent of all Canadian primary production is exported, this analysis hinges mostly on an examination of the Canadian producer's foreign markets and the company's position vis-a-vis producers outside Canada.

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[2] F.A. Bond reviews in the American Economic Review 1956, volume 46, p. 727, a book by O. Main: The Canadian Nickel Industry. The reviewer deplores the fact that Dr. Main has placed such heavy reliance on newspaper items. When reading this before writing my own study there seemed nothing remarkable in this statement. I now suspect that Dr. Main probably had no alternative other than not writing his book at all.

In preparing the present thesis I have received valuable guidance and assistance from Dr. E.F. Beach, my thesis supervisor. I am also indebted for many valuable suggestions and comments to Dr. D.E. Foohey, Aluminium Securities Ltd., Montreal, Messrs. D.C. Campbell, Aluminium Secretariat Ltd., Montreal, A.M. Coll and A.C. Kilbank, Department of Trade and Commerce, Ottawa, S.W. Clarkson, Atomic Energy of Canada Ltd., Ottawa, and to my wife. The contribution of my wife was a threefold one. First, she brought to my attention most of the technical references pertaining to the technology of aluminum production and to atomic energy. Second, she checked the statements dealing with the technical problems of aluminum production, most of which occur in chapter nine. Third, she checked each draft of the whole thesis for good style and suggested a number of improvements in expression.

I am also indebted to Mr. A.A. Snow of the U.S. Department of Commerce in Washington, D.C., for his willingness to read the final draft of my thesis. Unfortunately, I was not yet in possession of his comments when this thesis was handed in.

Special thanks are due to the highly competent staff of the Commerce Library. Familiar with the nature of my project, they brought to my attention numerous references which otherwise might have escaped me.

Financial assistance in the form of a pre-doctoral fellowship granted by the Canadian Social Science Research Council is also gratefully acknowledged.

INTRODUCTION

The contents of what follows might perhaps best be described as an industry study. However, a reader familiar with other studies of this type may be unable to recognize a familiar, well established pattern.

The main objective of this thesis has been to determine the nature of the motivating forces which may influence the extent and direction of further development. Temptation has been resisted whenever possible to become involved unduly in historical events, no matter how interesting they may have been. In treating the past a selective approach has been chosen so as not to lose sight of the subject at hand. Although somewhat teleological, such treatment of the past has nevertheless been broad enough to include a historical summary for the purpose of providing sufficient background information.

In writing on the aluminum industry it is perhaps as important to state what has not been done as it is to state what has been done. It has not been the main objective to contribute further to the already sizeable literature on market behavior and market control. This policy requires justification since the main purpose of other industry studies has been just that. In fact, one of the most outstanding works in this field[1] has the aluminum industry as its subject. Also, anti-trust actions against the Aluminum Company of America, with the Canadian producer as the implicit or explicit codefendant, has fixed the aluminum industry indelibly in the minds of many people as a classical example of

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[1] D.H. Wallace: op. cit.

industrial monopoly or oligopoly.[2]

Under these circumstances it would not have been feasible to proceed with the original objective and to ignore the widely held views on the aluminum industry. As a result much space is devoted to traditional concepts which may stand in need of some revision in the light of more recent experience. There is some skepticism as to the practical value of the theories of Robinson and Chamberlin in as much as they rely so heavily on the expedient of comparative statics. In a time of dramatically rapid economic change such an approach holds little attraction, and some admittedly pragmatic modifications need to be made before proceeding with the original objective at hand.

Part I (chapters 1 - 4) serves the purpose primarily of acquainting the reader with the subject. Chapter 1 describes the physical properties of the metal which have, along with its price developments, contributed so heavily towards its impressive success. Chapter 2 unravels the sometimes confusing ties between the United States and the Canadian producer. Although nothing is introduced here which is entirely new, so much popular misconception appears to exist on this point that it is rather important to clarify these relations at an early stage. The next two chapters serve the purpose of describing the place which the industry has in the Canadian economy. Unlike in the

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[2] Purely as a technical aside, the Canadian producer has until this year remained the only producer of primary ingot in this country and consequently is a monopolist in Canada. However, 85 per cent of his output is being sold abroad where he sells in competition with a few other producers. Thus for most practical purposes the market form in the aluminum industry is more properly described as being oligopolistic. To most economists and lawyers, of course, the threat posed by either monopoly or oligopoly is basically the same. Consequently the term monopoly is often used where oligopoly would be the more proper appellation.

United States, primary reduction facilities in Canada have been concentrated mostly in one, and more recently, in two distinct regions. As a result, the purely regional impact on employment etc. has been rather pronounced (chapter 3). When considering the industry's place in the Canadian economy as a whole, its close association with Canada's foreign trade stands out: Almost all of its raw materials have to be imported and most of the end product exported. This situation, and the inter-industry transactions within Canada, are summarized in chapter 4.

Part II (chapters 5 - 7) serves the purpose of clarifying the "weltanschauung" underlying this thesis regarding the complex of market forms. Observations are confined mostly to what clearly applies to the industry under study. Chapter 6 follows logically, dealing with cash generation and pricing. Here the danger of getting lost in the underbrush of market theory is particularly great. A clear cut oligopoly situation with price leadership as the firmly entrenched mode of doing business is a very tempting subject indeed. So as not to stray too far, the analysis is restricted to what pertains to the subject at hand. Chapter 6 re-appraises the Canadian participation in pre-war aluminum cartels. In the light of the views expressed in the preceding two chapters, it should not be surprising that the interpretation given here differs somewhat from that of Professor Wallace. An attempt has been made to look at past actions not only with the eyes of the economist but also with those of the historian. A historian would be more likely to evaluate a past event in relation to the environment then prevailing than would an economist.

Part III (chapters 8 - 12) deals with the Canadian producer's market position. Before the war, Canadian metal went to numerous market areas, and proportions varied considerably over time. Since the war, however, all but a negligible portion of Canadian exports of metal go to two markets only: the United States and the United Kingdom. This is established in chapter 8. All subsequent chapters of part III examine the Canadian producer's prospects in the United States since dependence on that market may increase markedly over time.

Part IV (chapters 13 - 15) represents an attempt to give a quantitative meaning to the term "further increases in demand", and to show how the augmentation of productive facilities is expected to supply this additional demand. Naturally, this discussion is carried on largely in terms of the role the Canadian producer may come to play in the world supply situation.

Part V (Concluding Remarks) draws together the threads of the whole thesis. Here some general reflections on the aluminum industry's contribution to economic progress in Canada are also presented.

PART I

CHAPTER ONE

DEVELOPMENT OF DEMAND

In 1888 the Pittsburgh Reduction Company produced the first bars of electrolytic aluminum in North America. Aluminum in its pure form had been known since 1825 when it was first isolated by means of a chemical process. Chemical separation, however, was expensive and it was not until the advent of the electrolytic reduction process that the metal was launched commercially.[1] By making possible the production of aluminum on a large scale at low cost, the electrolytic reduction process initiated the rather phenomenal ascendency of a new industry.

Prior to 1888, only a few hundred pounds of aluminum had been produced annually by the old chemical method. During the following twelve years production grew to 400,000 pounds per annum and reached 16,000,000 pounds or 8,000 tons[2] by the turn of the century. As Table I indicates, the twentieth century then saw an even greater increase in world production to the point where in 1956 it may have passed the 3,000,000 ton mark.

Hidden behind these statistics is the rather interesting story of a few industrial "innovators" who created for the metal the prominence which it holds today.

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1 The electrolytic process was developed in France by Paul L.T. Heroult and in the United States by Charles Martin Hall. The two men had worked completely independently of each other, and yet their processes are essentially the same.

2 Throughout this thesis, unless otherwise indicated, the term <u>ton</u> refers to a short ton of 2,000 lbs.

TABLE I

Free World Production of Primary Aluminum

Year	Tons
1905	15,400
1910	47,300
1915	85,800
1920	140,800
1925	201,300
1930	292,600
1931	242,000
1932	167,000
1933	151,800
1934	171,600
1935	256,300
1936	361,900
1937	489,500
1938	585,200
1939	695,200
1940	789,800
1941	1,052,600
1942	1,460,800
1943	2,059,200
1944	1,775,400
1945	862,400
1946	749,100
1947	1,049,400
1948	1,226,500
1949	1,237,500
1950	1,421,200
1951	1,723,700
1952	1,951,400
1953	2,351,200
1954	2,646,400
1955	2,852,000
1956	3,000,000 (Estimate)*

* Author's estimate. Source: Brief submitted to the Royal Commission on Canada's Economic Prospects (Gordon Commission) by the Aluminum Company of Canada. Montreal, February 1956, p. 15.

In spite of its spectacular success later on, aluminum production was at first beset by innumerable difficulties. The industry had succeeded easily enough in capturing the existing small market which had hitherto been supplied by chemically produced aluminum. But there was little prospect for expansion in this market, and other uses could at first not be found. Fortunately another application presented itself in which aluminum could be used in ingot form without further processing. This was the discovery that the addition of minute quantities of aluminum to steel manufacture would reduce impurities in the latter.[3] Thus of the aluminum production in North America in the eighteen-nineties, the greater part found its way into the steel industry.

Clearly, there was little or no room for expansion in this direction alone. The quantity of aluminum used per ton of steel was not only small but technologically fixed. Therefore, if the makers of aluminum wanted to increase the scope of their activity, they had to look for other applications. These were found over the years in two directions:

1) Applications where the use of other materials would not be feasible.

2) Applications where aluminum would replace other materials.

Aviation is of course the most outstanding example of the first group, but with the exception of the war years, it did not account for an unduly large share of output. By far the most significant advances were made with applications falling into the second category.

In replacing other materials such as non-ferrous metals, certain types of steel, plastic, wood, etc., aluminum either originally had, or was given through metallurgical advances, the following features to recommend itself:

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[3] D.H. Wallace: <u>ibid.</u>, p. 10.

1) Since its inception aluminum has been the lightest of the large volume commercial metals. For example, its specific gravity is less than one third of copper, as can be seen from Table II. Another way of expressing low specific gravity is to say that the weight of a given volume of aluminum is only about one third of an equal volume of copper. Since metals are often used to cover a given area, or make an article of a specified size, the end product weighs less when aluminum is used.[4]

2) In spite of its light weight, aluminum was for many years at a disadvantage whenever great tensile strength was required. Aluminum in its pure form has a tensile strength of only 7,000 pounds per square inch (p.s.i.).[5] Early aluminum, with its numerous impurities, had probably much less. But metallurgical advances have considerably improved the competitive position of the metal in this regard. Through alloying, and/or heat treatment, its tensile strength can today be increased to about 90,000 p.s.i., which is greater than that of certain types of steel.[6]

3) Another factor which has furthered the wider acceptance of aluminum is its corrosion resistance. Upon contact with air, a protective surface layer of aluminum oxide is instantly formed. One of the problems besetting the industry in its early stages was the fact that this corrosion resistance was largely lost when aluminum was alloyed

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4 Ibid., p. 13.

5 Materials Survey: Aluminum. Aluminum and Magnesium Division, U.S. Department of Commerce, November 1956, p. VI-11.

6 Ibid., p. VI-11.

TABLE II

Specific Gravity of Major Non-Ferrous Metals

Metal	Specific Gravity
Aluminum	2.71
Zinc	7.14
Steel (cast or structural)	7.85
Copper	8.94
Lead	11.34

Source: Aluminium Panorama, published by Aluminium Ltd., Montreal, 1953, p. 13.

with other metals for greater strength. Modern metallurgy has found an answer to this problem: When alloyed with manganese or magnesium, aluminum loses none of its corrosion resistance and still retains the desired alloy properties.[7] For certain uses, where the natural process of surface protection through oxidation does not suffice, more elaborate methods have been devised recently. Aluminum sheet, for instance, can be given very hard protective surface films by means of an anodic oxidation process. Additionally, by adding pigments, these anodic surfaces can be given any color of the rainbow, thus enhancing the decorative value of the metal.

4) One of the first important applications which aluminum found was in the field of electrical conductors. On a volumetric basis, aluminum has only 60 per cent of the conductivity of copper, its chief competitor in this field. But since aluminum weighs only one third as much as copper, it follows that - roughly speaking - one pound of aluminum and two pounds of copper have the same conductivity.[8] This combination of light weight and conductivity has helped aluminum to continue its dominance in the electrical conductor field to the almost complete exclusion of other metals. This combination of the two factors in effect means that an aluminum wire or cable of a given conductivity has a somewhat larger diameter, but weighs only about half as much as its copper equivalent. It can be easily appreciated that this is of great importance with transmission cables and other electrical equipment where weight is an important consideration.

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7 Aluminium Panorama, op. cit., p. 14.

8 Aluminium Panorama, ibid., p. 14.

5) Aluminum has good thermal conductivity, a property in which it is exceeded only by silver, copper and gold. Without it, another of the earliest applications, cooking utensils, would not have been feasible. This thermal conductivity, however, occurs only where the metal is in direct contact with the source of heat. Where heat is transmitted through waves, aluminum reflects rather than absorbs it. This has led to an extensive application in the building industry where aluminum is used as roofing sheet and foil insulation.

Such versatility of the metal goes a long way towards explaining its wide acceptance today. But the metallurgical properties gain wider acceptance of the metal if considered in conjunction with a reduction in cost and sales price.

When aluminum was first marketed on a small scale in the eighteen-fifties, it sold for $545 per pound. Because of improvements in the chemical method of separation, the price soon dropped to $17 per pound. By 1888, when the Hall-Heroult discovery was made, the price stood at $8 per pound. At this point the chemical method had been refined to such perfection that there was little hope of bringing down the price still further.[9]

Electrolytic reduction had the immediate effect of bringing down the price to $2.00 per pound. Continuous technical improvements soon made possible substantial further reductions in price. By 1900 aluminum sold for 33¢ per pound at which level the price remained until 1905.

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[9] Aluminium Panorama, ibid., p. 10.

Subsequently, the price for aluminum underwent frequent wide fluctuations. We shall deal with these later developments in greater detail in another chapter. For the present purpose it suffices to mention that on the whole, the long-term price trend has been downward.

As mentioned before, in the majority of industrial applications non-ferrous metals compete on the basis of volume, or area covered. It would thus not be very meaningful to compare metal prices per pound. Graph I therefore shows prices per cubic foot of four of the major non-ferrous metals. While this gives a more realistic reflection of relative prices than prices per pound, Graph I indicates an advantage of aluminum over copper greater than it actually is. Since the latter two metals do not compete so much on a volume basis, but more often on the basis of conductivity, the apparent wide margin over copper is misleading. Graph II, which shows copper and aluminum prices per quantity of equal conductivity, reveals that until World War II the two metals had been priced quite closely together. But what even Graph II does not show is of course the weight factor and it is this which gives aluminum the deciding edge over copper in the conductor field.

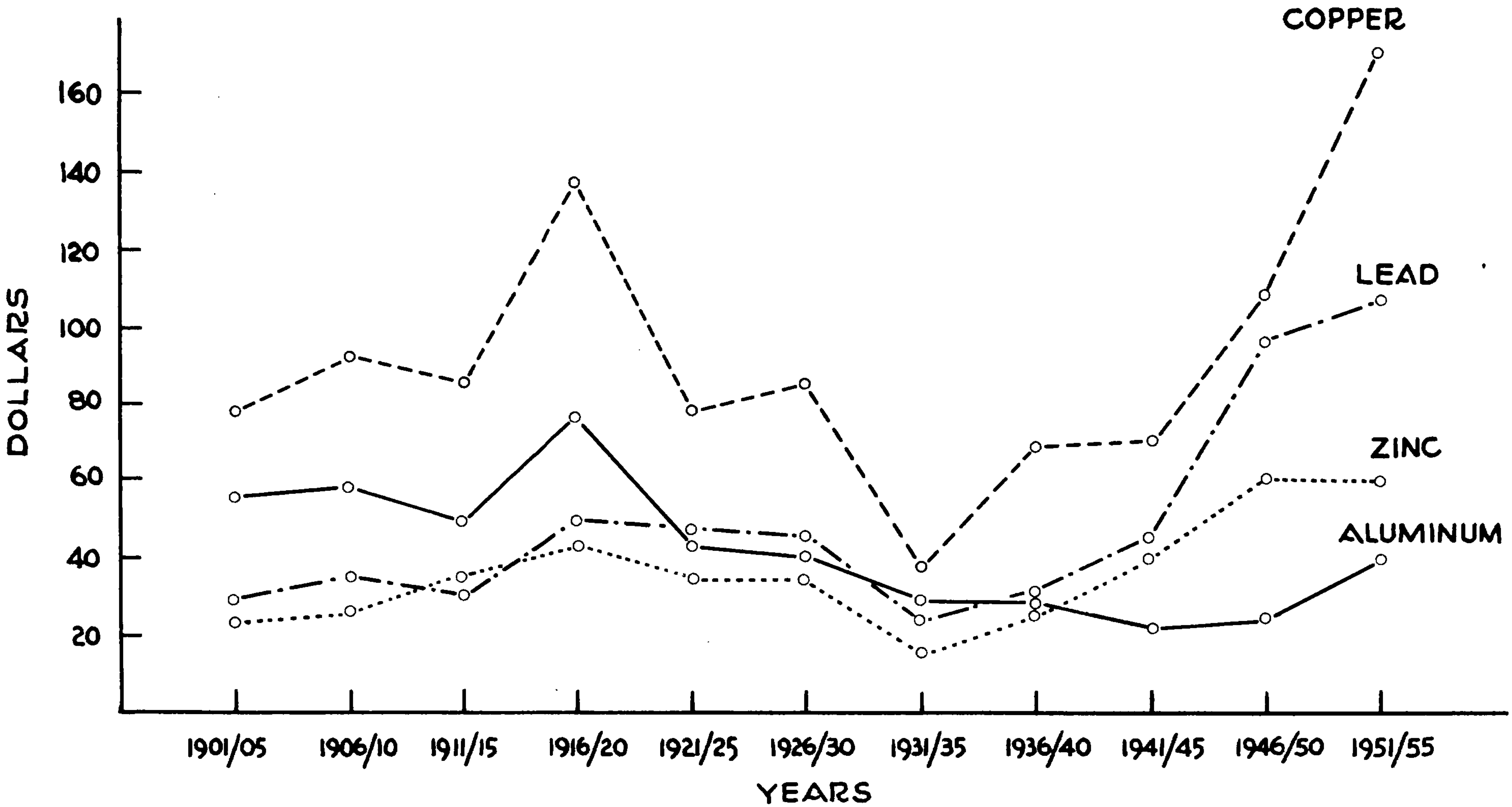
Competition between aluminum and copper is perhaps the most widely publicized success which aluminum has had in replacing another material, partly at least because in terms of volume it has gained more ground against copper than against any other non-ferrous metal. But aluminum has made substantial inroads on a large array of other materials as well. During the first two decades of electrolytic reduction, applications of aluminum numbered less than half a dozen. Today, in competition not only with other non-ferrous metals, but also wood, plastic,

GRAPH I

Comparative Metal Prices per Cubic Foot

Source: Metal Statistics 1956.
Published by American Metal Market, N.Y.

Note: Conversions from price per pound to price per volume by author on basis of specific gravity.


COPPER
LEAD
ZINC
ALUMINUM
160
140
120
100
80
60
40
20
DOLLARS
1901/05
1906/10
1911/15
1916/20
1921/25
1926/30
1931/35
1936/40
1941/45
1946/50
1951/55
YEARS

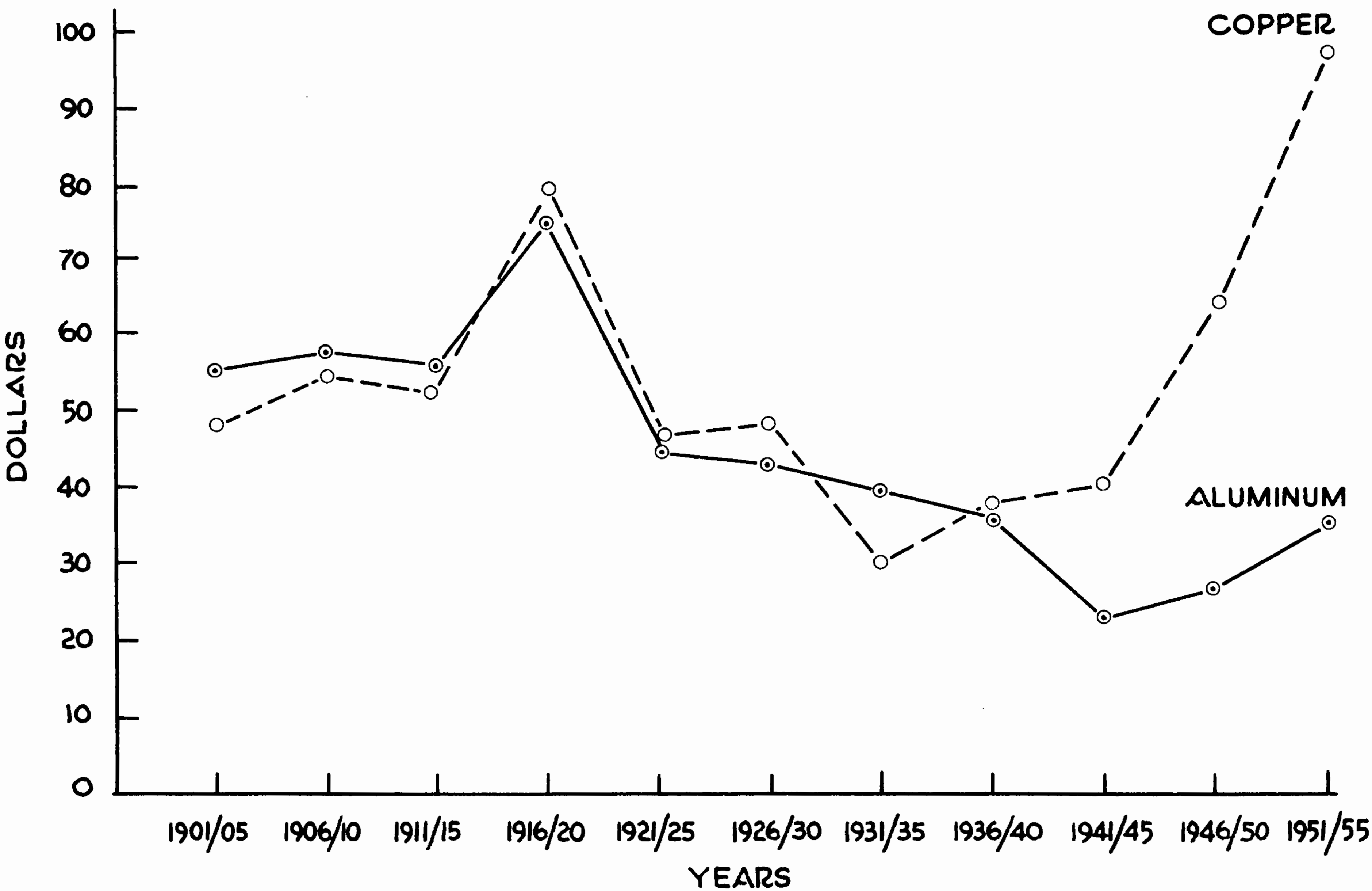
GRAPH II

Comparative Prices of Copper and Aluminum

For Volume of Equal Conductivity

Source: Metal Statistics 1956
Published by American Metal Market, N.Y.

Note: Conversions from price per pound to price per volume of equal conductivity by author.


COPPER
ALUMINUM
DOLLARS
100
90
80
70
60
50
40
30
20
10
0
1901/05
1906/10
1911/15
1916/20
1921/25
1926/30
1931/35
1936/40
1941/45
1946/50
1951/55
YEARS

glass, and various types of steel, applications number about four thousand. The exact figure is difficult to assess because of constant changes. New uses for the metal are being developed almost daily, whereas in other applications, it may in turn be replaced by other materials. On balance, new applications have so far outweighed the instances of lost ground. Otherwise the rapid expansion of aluminum output would not have been possible. But, by the same token, if the recent rate of growth is to be sustained in the future, the search for new applications has to be continued and perhaps intensified.

In this search for still further applications, one of the most promising fields of endeavor is competition with steel or, more correctly, certain steel alloys. The great bulk of steel production goes towards uses where on technological grounds the application of aluminum would not be practicable, no matter how low its price. But the reverse is not true. Although applications do exist where steel would not be feasible (e.g. aviation), the volume of aluminum going to uses where it competes with steel has been estimated to be as high as 50 per cent.[10] Thus competition with steel is an important aspect. But the steel market is of particular interest to the aluminum producer for another reason. Of the thousands of different end uses for aluminum by far the largest numerical part are uses which by themselves account for only a small fraction of total aluminum output. While such large numbers of small applications tend to give the aggregate demand for aluminum a highly welcome degree of stability, the temptation is nevertheless

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[10] United Nations: Competition between Steel and Aluminum, Geneva, 1954, p. 65.

great to search for outlets which would absorb large blocks of output. It is in this respect that the steel market holds great promise. To give an idea of the advantages that can be gained here, in 1952 total world production of aluminum amounted to as little as one percent of steel production. Had it been possible that year to take away only one per cent of the market for steel, aluminum demand would have been doubled. While this is of course a somewhat hypothetical exercise, some of the most important future advances of aluminum will in all likelihood be made in competition with steel.

By way of example, let us look at the railroads. Most North American lines have had difficulties now for some time in keeping their passenger operations out of the red. Bus companies and airlines are absorbing an ever-increasing share of this business. Here lighter and faster trains may eventually provide the only solution, a solution which would easily dwarf any other single application of aluminum.

Another major area of competition with steel, and one of some historical interest, is the automobile industry. In the nineteen-twenties the automobile manufacturers - with the exception of Ford who used none - made extensive use of aluminum. At one time consumption per unit was as high as 200 pounds, and the total demand of the auto industry for aluminum absorbed more than 50 per cent of the output in North America. Subsequently it lost out almost entirely to steel. In the twenties this was at least in part due to improvements in the quality of steel sheets,[11] but in part it was due to a high price policy. We shall therefore revert to this case in a later chapter.

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[11] Wallace, op. cit., p. 254.

As late as 1947, average aluminum consumption was only about 61 pounds per car whereas today the figure stands at about 40 pounds per car. Automobile manufacturers even use 200 pounds per car in some lines. To get an idea of the tonnages involved, let us calculate the effect on aluminum demand if the average consumption were to rise to 80 pounds per car - a reasonable assumption. For a North American production rate of, say, 7.5 million cars per annum, an additional 150,000 tons of aluminum would be used. This is the equivalent of the whole present output of Kitimat.

We have given a general outline of aluminum and its place in present day industrial life. Let us now turn to the corporate instruments in North America which have both stimulated and benefited from the developments outlined above.

CHAPTER TWO

CORPORATE PARENTAGE OF INDUSTRY IN CANADA

In 1956 the Aluminum Company of Canada could claim to represent an essentially Canadian industry, an industry independent from that in the United States.[1] Its inception in this country, however, is entirely an outgrowth of the aluminum industry in the United States.

Upon discovery of the Hall-Heroult process, several companies started to use the new technique. In Europe, four companies entered the field[2] whereas in America only one producer became established. The Pittsburgh Reduction Company, later the Aluminum Company of America, was formed in 1888 for the purpose of exploiting Hall's patent commercially. Although others attempted to embark upon the production of primary aluminum in North America, they were unsuccessful. Through a fortuitous combination of patent litigation, luck and shrewdness, Aluminum Company of America remained the only primary producer of aluminum in the United States until 1940.[3]

During its first few years of operation, the Pittsburgh Reduction Company encountered rather formidable difficulties. Working with an untried process, the quality of the product was of necessity

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1 Aluminum Company of Canada: Brief presented to the Royal Commission on Canada's Economic Prospects, Montreal, February 1956, p. 1.

2 See below, chapter seven.

3 For a more detailed description of the early beginnings of the industry in North America see Wallace, op. cit. In the present context, treatment of the early history of the industry in the United States is confined to the extent that it shows the spreading of the industry into Canada.

rather haphazard, and even the makers had only sketchy notions about the metallurgical characteristics of their product. Aluminum was often applied to uses for which it was not suitable with consequent disappointing results and damage to its reputation. All these shortcomings tended to aggravate the rather formidable marketing problem which the makers encountered at the time. This handicap, together with general inertia and ignorance, were overcome only gradually by means of an indefatigable publicity campaign waged by Alcoa.

During the first few years, aluminum had one ready-made market, the steel industry, where the metal could be used in ingot form without further processing.[4] For most other applications which the Aluminum Company of America tried to develop, the metal had to be rolled or drawn. The Company was unsuccessful in getting outside rolling mills and wire fabricators interested in the use of aluminum and was thus forced to enter the fabricating field itself.[5] A plant was built at New Kensington and soon the most important application was kitchen utensils. Before the turn of the century, they accounted for between one third and one half of total ingot production.[6]

Success achieved in breaking into the utensil field would, of course, have been impossible without the metal being suitable for that purpose. However, suitability alone meant little at that time. It was largely the company's policy of vigorous door-to-door selling

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[4] See above, chapter one.

[5] Wallace, ch. 1.

[6] Wallace, ibid., p. 11.

that led to the general acceptance of the new utensils.

There was a considerable degree of contact in those early days between the company and the ultimate consumer, a factor of far-reaching consequences. Even today, when compared with the Canadian producer, the Aluminum Company of America's fabricating operations figure much more prominently in the overall activities than is the case with Aluminum Company of Canada. One of the reasons therefor can be found in the Aluminum Company of America's early reliance on contact with ultimate customers. The American industry had to establish itself by seeking out a potential customer and "selling" him the metal, whereas aluminum in Canada started out merely as a convenient production site for the supply of markets already developed by the Aluminum Company of America.

In its struggle to gain wider acceptance for its product, the Aluminum Company of America made seemingly little progress for a number of years. However, once the combination of selling effort and improvements in the technology of production and application had succeeded in breaking the ice, the Company began to show impressive results. Whereas production in 1890 amounted to only 29 tons, it reached 3,500 tons by 1900, 20,300 tons in 1910, and almost 70,000 tons still another decade later.

To support its rapidly increasing volume of output, the Aluminum Company of America soon started to acquire its own sources of raw materials and also constructed its own alumina and carbon plants. More crucial, from a cost point of view, however, was the procurement of sufficient quantities of cheap power.

Around 1890 the original Smallman Street plant in Pittsburgh was shut down and operations were moved to New Kensington where steam power from coal and natural gas were available. Although fuel cost seemed low at first, steam was then quite an inefficient source of energy and the company must have realized soon after moving to New Kensington that hydro-power would provide a sounder basis for further expansion.

In 1893, only three years after its move to New Kensington, the Aluminum Company of America contracted to buy hydro-power from the Niagara Falls Power Company at Niagara Falls, N.Y., for a new smelter to be built at the same site. This first power was to be delivered to the company's pots in the form of direct current, but three years later the company added to that purchased turbine power for the operation of its own generators.

The next expansion move took the company to Shawinigan Falls, Que., where it could utilize the hydro-potential of the St. Maurice River. This time the Aluminum Company of America built its own power plant and merely purchased from the Shawinigan Water and Power Company the hydraulic energy required to operate the company-owned turbines and generators. Simultaneously the Aluminum Company of America constructed a reduction plant with one line of 40 Hall-type pots. In 1902 the combined installations were incorporated as the Northern Aluminum Company, a fully owned subsidiary. In 1925 this company's name was changed to the one it bears today, Aluminum Company of Canada, Ltd.

Superficially, the construction of reduction and power facilities at Shawinigan Falls could be taken to be the beginning of the Canadian aluminum industry. In fact, the Shawinigan Falls works did not mark an important point of departure which inaugurated a Canadian industry in its own right. It was merely one phase in the development of the United States industry; the development of an industry in Canada had yet to develop a momentum of its own.

After having realized the need for sizeable blocks of hydro-power for further expansion, the Aluminum Company of America decided to henceforward develop and own outright its power facilities, rather than purchase power or provide it through such mixed arrangements as at Niagara Falls and Shawinigan Falls. As a result of this new policy, the Company acquired over the years extensive riparian rights with enough horsepower potential to support the phenomenal expansion in later decades, particularly in Canada. Had the Company continued to rely to any great extent on purchased power, the full extent of later expansion might have been rather more difficult to achieve. Since the Aluminum Company of Canada later came to own one of the largest power sites originally acquired by the Aluminum Company of America under this policy, the Canadian company reaped considerable benefits from this early policy of the American company.

The plant at Shawinigan Falls was built when purchased power was still the rule rather than the exception. Perhaps it can be said that this factor helped to keep the Shawinigan Falls works in the background when compared with later developments which bypassed it. In 1901, when the first Canadian ingot was poured, there was no indication of a trend of smelting operations shifting to Canada. On the contrary, the Aluminum Company of America's primary interest was focused on U.S.

smelter sites. Thus further plant sites were located in Massena, N.Y., the Tennessee Valley and later in North Carolina.

Throughout this time, Alcoa pursued a policy of horizontal as well as vertical integration, at first largely inside the United States but soon also abroad. Interest in bauxite mines in South America dated back to before World War I, and in the years thereafter the Aluminum Company of America acquired interests in or purchased outright power stations, smelting and fabricating companies, mostly in Continental Europe.

Although in the light of subsequent developments not all of the Aluminum Company of America's purchases appear to have been very useful, indications are that the Company tried to apply in foreign markets some of the lessons it had learned at home. It purchased power interests in Norway to secure ample sources of cheap power for local production and acquired fabricating companies to help absorb the smelter output and keep the metal moving. With the benefit of hindsight we can now say that such a transplantation of the American approach to Europe was a somewhat doubtful venture. The European market, with its maze of tariff barriers and vested interests, required an entirely different approach from the one practised in North America. In recognition of these circumstances, the Aluminum Company of America came to rely largely on its Canadian subsidiary to carry on the European market operations. As a Commonwealth firm, the Aluminum Company of Canada not only gained - or was at least expected to gain - some benefit from Empire preferential tariffs, but it was also free to enter into cartel agreements which the parent Company was not. This role carried the seeds of later independence from the parent company. We shall say more on this early role of the Aluminum Company of Canada in a later chapter.

By 1925 the Aluminum Company of America's consolidated production had reached 86,500 tons of which 16,500 originated in the Canadian smelter. Demand continued to grow rapidly, but production was beginning to reach such proportions that any major expansion of productive facilities would now require power resources of hitherto unheard-of dimensions.

For a second time the Aluminum Company of America turned to Canada, this time with more far-reaching consequences to the Canadian industry. In this venture the Company associated itself with Mr. J.B. Duke and Sir William Price who owned extensive power interests in the Saguenay region of the Province of Quebec.

These two men owned jointly the Duke-Price Power Company, later to be called Saguenay Power Company, which in turn owned and operated a large power house with 360,000 horsepower installed capacity, located at Isle Maligne where the Saguenay flows out of Lake St. John. Upon the death of Mr. Duke in 1926, the Aluminum Company of America increased its holdings in this power station, also called the Upper Development, to 53 per cent.

Another company, the Canadian Manufacturing and Development Company, owned by Mr. Duke alone, held the entire stock of the Chute-a-Caron Power Company (later the Alcoa Power Company). This latter company held the title to the so-called Lower Development, which consisted largely of two power sites, Chute-a-Caron and Shipshaw, both a few miles downstream from the Upper Development. It was estimated at that time that as much as one million horsepower might eventually be developed at the Lower Development. The Aluminum Company of America acquired the Chute-a-Caron Power Company by merging with its holding company, the Canadian Manufacturing and Development Company. In this merger, Mr. Duke acquired one ninth of the common stock of the new Aluminum Company of America. The exact value of the latter company's stock at the time is rather difficult to determine, but suffice it to say that by then Alcoa was a sizeable corporation. One ninth of its shares at the time of the merger have been estimated on the basis of book value alone as having been worth at least $17,000,000.[7]

The fact that the Aluminum Company of America was willing to pay such a price for riparian rights alone with no existing power facilities is quite indicative of the importance which the company attached to having such a large power site at its disposal.

Although the Lower Development was not to be developed for years, the Aluminum Company of America's Canadian subsidiary, the Aluminum Company of Canada, commenced construction of a new smelter at Arvida, a few miles south of Isle Maligne. This new smelter was to operate with power purchased from the Isle Maligne power house. The initial capacity of this new smelter was not only larger than the existing capacity at Shawinigan Falls, but was also suitable for considerable later expansion. In the first instance it made possible an increase in Canadian production of aluminum from 16,600 tons in 1925 to 40,000 tons in 1927.

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[7] C.C. Carr, Alcoa, An American Enterprise. New York and Toronto, Rinehart & Co., 1952, p. 103.

With the developments in the Saguenay district, the Aluminum Company of America's holdings outside the United States had become so large that it seemed advisable to unite its foreign holdings in a separate corporate structure. The output of the Canadian subsidiary had been used for some time in the company's foreign operations, and it seemed logical to locate this new corporate centre for the direction of non-United States operations in Canada. This would leave the Aluminum Company of America free to concentrate on the fast growing domestic market while the new company specialized in the foreign markets.

In 1928 Aluminium Limited was formed to take over most of the foreign properties of the American company.[8] The shares of the new company were distributed to the shareholders of record of the Aluminum Company of America, thus creating two separate corporations with 100 per cent common ownership.[9]

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[8] There were notable exceptions: 1) The Surinaamsche Bauxite Matchapii in Dutch Guiana, South America, on which the Aluminum Company of America had become dependent for its bauxite requirements, and 2) the Alcoa Power Company which held the rights to the Lower Development. The latter, however, passed into the hands of a subsidiary of the Aluminum Company of Canada in 1938 for a consideration of $20,000,000 in 30 year mortgage bonds plus certain contingent committments which were valued on books at the Alcoa Power Company at $11,900,000. The Alcoa Power Company itself was eventually liquidated in 1955.
Source: Moody's Industrial Manual, Moody's Investors Service, N.Y., 1956.

[9] Naturally, share ownership did not remain unchanged for long. Deaths, etc., resulted in a gradual decline in the percentage of common share ownership. Through court order in 1953 certain persons still owning stock in both the Aluminum Company of America and Aluminium Ltd., and that presumably was still a majority, were enjoined to divest themselves of their holdings in one of the two companies over a ten year period. Until then the voting rights of the shares thus to be disposed were vested with court appointed trustees.

Of the companies taken over by Aluminium Limited, the largest one was the Aluminum Company of Canada which then possessed two smelter sites, the original one at Shawinigan Falls and one at Arvida which had been completed two years previously.

Among the assets taken over outside North America were bauxite properties in South America (British Guiana), France, Greece, Italy and Yugoslavia.

In the smelting field Aluminium Limited obtained title to or a controlling interest in a number of companies, principally in Scandinavia, as well as a smelter in Italy and a hydro-electric station in France. In addition, several small fabricating companies were taken over in various European countries.

Nevertheless, Aluminium Limited was not well equipped to start its own operations. Its financial position was not strong and when the Great Depression struck the year after Aluminium Limited was formed, it all but eliminated the newly formed company. Whereas Canadian output in 1928 stood at 44,000 tons, under the impact of the depression it dropped to 17,100 tons in 1933.

Most industries throughout North America continued to suffer from the effects of the depression which was brought to an end ultimately only by the outbreak of World War II. Aluminium Limited, on the other hand, was able from about 1935 on to gradually increase its output again, mostly because of markets in the United Kingdom and in Japan. Two years later sales were moving so briskly that the company embarked upon a program to double the ingot capacity at the Arvida plant. As a result, ingot capacity stood at approximately 90,000 tons when World War II broke out.

But even this immediate pre-war capacity utilized only a small part of the total hydro-potential of the Saguenay district. However, much of the unused potential had been partially developed to the point where additional horsepower capacity could be brought in within a fairly short time.

Under the pressure of war-time demand, expansion took place in rapid succession. Additional pot lines were installed at Arvida and new reduction plants went up at Isle Maligne, Shawinigan Falls, La Tuque and Beauharnois, all in the Province of Quebec. In spite of all the available power potential, the increase of reduction capacity outstripped the increase in power capacity so that in 1943, in order to support a peak war-time production of almost 495,000 tons, as much as 30 per cent of the power required had to be regimented by government decree from other users.

With the existence of such intense demand for power, the Lower Development was pushed to its maximum. Alcoa Power Corporation had already (in the nineteen-thirties) constructed a power house on the smaller of the two sites constituting the Lower Development, at Chute-a-Caron. Now a second power house was erected on the Shipshaw river. This giant Shipshaw project, with an installed capacity of 1,200,000 horsepower, was completed in a record eighteen months. A project of similar size would normally take two to three years to construct.

After the feverish activity of the war years the immediate post-war period must have appeared rather cold and sobering to the aluminum people. Military airplane production, which had used most of the war-time output, had shrunk to insignificance. Most of the war-time smelter facilities were either closed down or dismantled, and production fell to 191,000 tons in 1946.

If the Canadian industry experienced an atmosphere of gloom right after the war, it could not have lasted very long. Within three years, a vigorous civilian demand for the metal began to make itself felt. In addition, the Cold War necessitated the maintenance of a higher level of defense expenditure than had been hoped necessary upon the close of the war.

To meet this demand, the Aluminum Company of Canada began to rehabilitate some of its war-time smelter facilities. With Shipshaw now in operation, plant extensions in the Saguenay district could be supported to a large extent by company-generated power. Even the Shawinigan Falls plant could be operated at least in part on power imported from Shipshaw. Only Beauharnois had, and still has, to depend entirely on purchased power.

By about 1949 it seemed evident that the strong demand of the recent years was not temporary, but rather seemed to be the manifestation of a long term trend likely to continue for many years. In order to meet this expected demand of future years, a two-pronged expansion program was announced in 1951 which consisted of, first, the rounding out of power facilities in the Saguenay District through the construction of two stations on the Peribonka River (a third one is still under construction at present), and, second, the Kitimat-Kemano project in British Columbia.

Present-day integrated smelter facilities can be summarized as follows:[10]

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[10] Aluminium Ltd. Share Prospectus, January 1955. Aluminum Company of Canada Sinking Funds Debentures Prospectus, May 20, 1952.

Lake St. John - Saguenay District:

Saguenay Power Company, owned 93.57 per cent by Aluminium Ltd., originally built with an installed capacity of 350,000 horsepower, now has 540,000 horsepower installed. Approximately one third of its output is used by the Isle Maligne smelter, the rest is sold to other industrial users as well as to private consumers.

Facilities fully owned by the Aluminum Company of Canada:

Name	Installed Capacity	Year Completed
Chute-a-Caron (on Saguenay)	300,000	1931
Shipshaw (" ")	1,200,000	1944
Chute du Diable (on Peribonka)	270,000	1952
Chute a la Savanne (" ")	270,000	1953
Chute des Passes (" ")	1,000,000	under construction.

With the completion of the Chute des Passes power station, the following rated smelter capacities should be supported entirely by company-owned power:

Arvida	362,000 tons per annum
Isle Maligne	115,000 tons per annum
Shawinigan Falls	68,000 tons per annum.

Total Saguenay and St. Maurice Region 545,000 tons per annum.

Beauharnois, with a rated capacity of 37,000 tons per annum, is, as already mentioned, dependent entirely on purchased power.

British Columbia: Kemano Power Station of 750,000 horsepower installed supports a rated capacity at Kitimat of 180,000 tons per annum.

Grand Total for all Canada in 1956:

Rated Reduction Capacity: 762,000 tons
Horsepower Installed: 2,950,000 tons *

* Includes 30 per cent of installed capacity of Saguenay Power Company.

Fabricating:

The fact that smelting in Canada started out as a basis of supply of ingot for foreign markets seems to have had - at least in the early years - a retarding influence on the development of a fabricating branch of the aluminum industry in Canada. Unfortunately, the extent of fabricating activity in Canada prior to 1926 is difficult to determine because the Dominion Bureau of Statistics did not publish any data for the aluminum products industry prior to that year. Projecting backwards a trend which has been apparent since then, it would seem that in the early years the larger part of the aluminum consumed in Canada in semi-fabricated or fabricated form was imported from the United States. However, the Aluminum Company of Canada soon started to have its own fabricating facilities, and although the Aluminum Company of Canada's fabricating facilities have always been the largest in Canada, gradually more and more independent fabricators entered the field.

In 1926, for instance, the Dominion Bureau of Statistics reports 12 firms in Canada which together accounted for a value of output of $1.9 million. It is interesting to note in passing that about $1 million thereof, or more than 50 per cent, were cooking utensils - an indication of the prominence which this application has had in this country also.

Imports of fabricated and semi-fabricated products in 1926 amounted to 1.36 million, or over 70 per cent of domestic production, whereas exports of semi-fabricated and fabricated products were valued at $1.2 million. One explanation for both the high figures for exports and imports may be sought in the fact that Canada lacked sufficient rolling facilities. It thus had to rely to a large extent on United

States mills for its requirements of sheet and circles for both the domestic and the export market.

Twelve years later, in 1938, Dominion Bureau of Statistics lists 19 establishments, two of which were rolling mills and eight were still chiefly engaged in the manufacture of cooking utensils. Total output that year was valued at $6.9 million, whereas imports of fabricated and semi-fabricated products were $1.95 million, a drop to only 28 per cent of domestic production from over 70 per cent on 1926. Exports, on the other hand, declined even more sharply, to about half a million, mostly because of the effects of United States tariffs.

As regards consumption of aluminum in Canada as compared with that in the United States, it has followed largely the same pattern. It remained fairly constant over a considerable period of time, and just prior to World War II was even slightly lower than in 1926:

Per Capita Consumption of Aluminum in Pounds

Year	Canada	U.S.
1926	1.6	1.8
1938	1.25	1.4
1954	10.0	19.1

World War II and the strong post-war demand for aluminum has of course had profound impact on the fabricating industry in Canada. In 1955, Dominion Bureau of Statistics lists 93 firms which were primarily engaged in the fabrication of aluminum. In addition, aluminum was processed by an ever increasing number of other firms which are not included in the Dominion Bureau of Statistics data for the aluminum products industry since aluminum was not their primary product.

The 92 firms listed by Dominion Bureau of Statistics accounted for an output close to $80 million. Imports in 1955 were about $20 million and exports $11 million. These imports in 1955 were about 20 per cent of domestic sales and exports combined, as compared with 22 per cent in 1938 and 41 per cent in 1926. This would indicate that the very substantial increase in the consumption of fabricated and semi-fabricated products in Canada since the war has been met largely by an augmentation of Canadian facilities.

The relative significance of the aluminum fabricating business in the Canadian economy is somewhat difficult to assess accurately. One of its virtues is that fabricating lends itself to small scale production, thus providing scope for small companies, and with the exception of the large facilities maintained by the Aluminum Company of Canada, the majority of firms in this branch of industry are small. Furthermore, they are mostly located in major population and fabricating centres of the country and thus tend to lose their identity among a large number of other manufacturing concerns.

This presents a sharp contrast to the smelting branch of the industry. For one, aluminum smelting accounts for a much larger share of Gross National Product than does fabricating. For another, until a few years ago almost its entire production took place in one distinct and somewhat isolated region of the country, the Lake St. John - Saguenay area. Consequently, the impact which the aluminum industry has had on this part of the country has been both profound and permanent.

CHAPTER THREE

DEVELOPMENT OF ALUMINUM PRODUCTION IN CANADA: A REGIONAL VIEW

Achieving economic as well as political identity posed a problem which has confronted Canada ever since the American Revolution. Along much of its length, the Canadian-United States border arbitrarily cuts through regions which from a geographic point of view could be considered as units. Thus there has in the past often been a tendency for distant regions of Canada to become economically more closely associated with neighboring States than with other parts of Canada. Canadian economic history is to a large extent the story of a continuous government effort to bring about the development and strengthening of East-West ties of trade and communications. In so far as Western movement was substituted for the more natural tendencies towards North-South trade relations, this policy has been fairly successful.

Policies attempting to direct trends of development towards the North have not been equally successful because of the increasingly severe climate. It is true that mining has created numerous settlements far north, but these were either boom towns which eventually fell into oblivion, or they were isolated mining towns with little or no ancillary settlement around them.

Prior to the passing of the frontier, a region was normally first opened and explored by hunters and fur traders, but it was not claimed from the wilderness permanently until the first settlers had arrived. Only after they had cleared the land to provide enough produce for their families was permanent settlement possible. Eventually villages and townships grew and, together with them, commercial and industrial activities.

Even though industries may eventually have become the chief source of employment within a given region, agriculture was usually the initial and most important impetus to the development of a region. This pattern, at any rate, could be observed quite closely in the United States and in the southern fringes of Canada. Whereas in the United States the opening of new regions took place along a broad front moving gradually to the West, generally the process in Canada was forced into a more narrow channel. To the south there was the American border, and to the north a natural barrier erected by increasingly severe climate and poorer soil.

The wagon train opened up the Canadian West, but settlement in Upper Canada took place largely along the major rivers, and tended to branch out along its tributaries only if the latter flowed through fertile country. Thus, settlement at first entirely bypassed the fertile Lake St. John - Saguenay region, largely because the natural entry to the region, the lower Saguenay was - and still is - rather forbidding country.

Since aluminum later came to have such a great impact on this particular region, a brief historical sketch of its earlier period may be of interest.

The Saguenay region is formed by a depression in the Eastern rim of the Pre-Cambrian Canadian Shield, with both climatic and soil conditions being more favorable than those of the surrounding shield.[1] In addition, because it is a depression entirely surrounded by higher grounds, it serves as a drainage basis for much of the surrounding area, and is consequently rich in hydraulic resources. Although explored as early as 1672[2] a combination of factors combined to prevent the region from being settled. One such factor was the great remoteness from other settled areas, and another was the fur trade.

Once contact between the French and the native Indians of the region had been established, an extensive fur trade developed which proved so lucrative for a long time that it was very much in the interests of the fur traders to preserve the region in its pristine state and prevent settlement.[3] Even when the fur trade of the region came to grief because of scarcity of fur and competition from the English at Hudson Bay, the French kept the region closed to settlement in the hope that the fur trade would improve.[4] The same policy was later pursued by the English when the region fell under their control.

In 1838, when settlers finally did arrive, they had to enter under the guise of working a lumbering concession since outright settlement was still forbidden. Lumbering, however, proved to be more than

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[1] The writer owes his knowledge of the region almost entirely to an outstanding treatment by a geographer: Historical Geography of the Saguenay Valley by (Miss) C.M. Johnston. M.A. thesis, McGill University, Department of Geography, 1950. Whenever specific facts are quoted in the present chapter from this work, they are footnoted as such. It is not possible, however, to footnote the general understanding gained about the region from reading Miss Johnston's thesis.

[2] Ibid., p. 36.

[3] Ibid., p. 37.

[4] Ibid., p. 37.

a subterfuge. It grew so rapidly over the years that at one stage it seriously impeded the development of agriculture. Lumbering in its hey-day had first call on the local labor force, and farming was carried out often on a part-time basis. And since lumbering took place during the winter and lasted well into spring sowing time, agriculture suffered.

Lumber from the region was exported largely to England in the form of square timber, and later also in increasing amounts to the United States in the form of sawn lumber.

Around 1850 the lumber boom broke when England reduced its preference rates on Canadian lumber and thus made Baltic lumber more competitive in the English market. At the same time the United States began to pursue a high tariff policy. Lumbering recovered once temporarily, when American tariffs were reduced again in the eighteen-seventies. This delayed the ultimate decline of lumbering, however, only for a short time. By then the forests of the region had been virtually depleted of white pine and cedar, the mainstay of the industry.

Settlement had first occurred at Ha Ha Bay, South-West of Chicoutimi, and at Chicoutimi. The latter became the first non-agricultural center in the region and continued to be the major population center in later years.

The total population of the region in 1839 was only 336. By 1860 it had increased to about 5,400. During the next two decades settlement began to spread towards Lake St. John and eventually around it. In 1870 population numbered 17,500, a figure which includes

Chicoutimi, then a town of 1,400 people.[5]

Although agricultural settlement increased throughout the lumbering era, it flourished especially when the lumbering industry began to decline and continued its growth even when new industries entered the region. During the eighteen-nineties, the first pulp mill of the region was constructed. Unlike their predecessor, the lumbering industry, the pulp mills had less retarding influence on agriculture. On the contrary, they created for the first time the nucleus of a non-agricultural labor force which provided the surrounding farmers with an ever-increasing market for their produce.

From the eighteen-nineties until the late nineteen-twenties, pulp production alone at first, and then pulp in conjunction with paper production constituted the major industrial activity of the region. During that time, population increased two and a half times, with the urban centers receiving about 60 per cent of the increase.

Pulp production had originally been started largely to supply the British market because the Lake St. John - Saguenay area was particularly suitable for this purpose. The extensive woodlands of the area no longer yielded sufficient trees suitable for lumbering, but there was a plentiful supply of smaller trees, chiefly spruce, balsam, and jack pine, which were quite suitable as raw material for pulp. These could be brought to the mills from the interior on the numerous waterways, and since tide water from the Gulf of St. Lawrence extended up the Saguenay as far as Ha Ha Bay and Chicoutimi, pulp could be loaded directly for shipment to overseas markets.

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5 Johnston, ibid., pp. 50, 62.

The story of the pulp mills of the region is a rather close parallel to that of lumbering. The chief export market at first was England, but Scandinavian competition made pulp production unprofitable almost as soon as it had reached sizeable proportions. As a consequence, companies operating pulp mills only underwent decline. But those that had foresightedly added paper production to their operations expanded still further because of a new market for the finished product in the United States.

By the end of World War I, U.S. forest reserves had become seriously depleted, and because of a provincial embargo on unprocessed wood products, the United States had to accept the location of processing industries at the source of raw materials.

The producers of pulp and paper had a twofold advantage in the Saguenay region. First, the numerous rivers made possible the transport of large volumes of logs to the mills. Second, because of the sharp drop in the elevation of the Lake St. John-Upper Saguenay basin to the tide waters of the Gulf of St. Lawrence, there was an abundance of hydraulic power potential. This the paper mills needed in large amounts.

The first hydraulic power station had been built at Chicoutimi as early as 1895, but the development of hydro-power did not really gain much momentum until after World War I when the paper producers came to rely increasingly on hydraulic power generated in their own stations. The paper mills built their own stations. Furthermore, they did a considerable amount of regulatory work to the drainage system of the region because paper production requires firm power. Hydro-electric energy cannot be stored. Thus a station of, say, 10,000 horsepower installed is of little use if it delivers only one third of its potential during six months of the year. Thus, to regulate the run-off, storage dams and reservoirs have to be built. The size of the stations built during the early phase of hydraulic electrification, from 1895 to 1920, varied considerably. The largest station was built at Kenogami on the Au Sable River with an installed capacity of 27,200 horsepower.

With new stations being built and further regulatory work becoming necessary, knowledge of the hydraulic system of the region increased. Engineers began to realize that the ultimate power potential was of hitherto unheard-of magnitude. Until about 1920, many small and medium-sized plants were built to satisfy the immediate and near future requirements of adjacent paper mills. Gradually, however, it was realized that in order to make future expansion feasible on a large scale, larger blocks of power should be developed. Impressed by the power potential, some entrepreneurs of the region were even beginning to think in terms far exceeding the present and probable future requirements of the paper mills.

By then, two of the largest known power sites were as yet untouched: the Grand Descharge, where the Saguenay flows out of Lake St. John north of Isle Maligne, later to be known as the Upper Development; and the Chute-a-Caron, the plant site, a few miles downstream, later to be known as the Lower Development.

Prior to World War I, both these sites had been acquired by men who wished to develop them with the intention to attract, if necessary, industrial customers other than the paper mills. These men lacked capital, however, and one of them succeeded in getting an influential American industrialist interested in the sites. In 1913 Mr. J.B. Duke, of tobacco fame, at the time interested in nitrogen production based on cheap hydro-power, bought the rights of the two sites from the original owners.

Duke's nitrogen project never materialized. His troubles were twofold: One, certain technical problems pertaining to the production process could not be solved, and two, in order to firm up power of a station to be built at Isle Maligne, the water level of Lake St. John would have to be raised, thereby flooding low lying farmland. There was a prolonged wrangle with the Provincial Government over this problem which delayed construction of a station for many years.

Construction was finally started at Isle Maligne in 1922, a venture into which Mr. Duke entered with Sir William Price, a grandson of William Price, the lumber king of an earlier era. The Isle Maligne station was completed in 1925, and its first customers were several paper mills as well as the Shawinigan Water and Power Company which was connected to Isle Maligne by a transmission line, 125 miles long.

In the following year, the production of aluminum at Arvida commenced, also based on Isle Maligne power, and a new era of industrial expansion had been inaugurated.

The broad outlines of what followed are indicated, at least in part, in the previous chapter. When the Great Depression struck, its effects were felt particularly strongly since both major industries depended so heavily on exports. Little progress was therefore made during the height of the depression. There was only one notable exception

- the construction of a new power house on the Chute-a-Caron site. It had been started at the height of the boom and was completed in spite of the depression.

As we mentioned in the previous chapter, recovery for the aluminum industry occurred on a moderate scale even before World War II. Naturally, this had favorable repercussions in the surrounding region. These developments were subsequently dwarfed by the effects of war-time expansion. Since the aluminum industry began to weigh more and more heavily in the overall economic picture of the region, war-time changes were of much greater magnitude than in the rest of the province.

In order to gauge the role which the aluminum producer has played in the Saguenay region, let us consider the following:

The Saguenay district was fortunate in that it had all the prerequisites for a balanced growth. The importance of agriculture has declined only relatively to the industrial sector. Without these features of balanced growth, a population increase higher than that for the rest of the province could not have been sustained over the decades.

Year	Province of Quebec Millions	Increase over Period Per Cent	Lake St. John, Chicoutimi County	Increase over Period Per Cent
1901	1.65	-	37,000	-
1911	2.01	22	50,500	36
1921	2.36	17	73,000	45
1931	2.87	22	106,000	45
1941	3.33	16	143,200	35
1951	4.06	22	198,000	38
1956	4.63	14	235,000	19

Source: Johnston, ibid., p. 102.
Dominion Bureau of Statistics,
Census of Canada, 1956 Population, Rural and Urban Distribution.

It is interesting to note that the rate of increase in the Saguenay region was the highest before aluminum had become a large scale industry. Very rapid expansion was possible until the agricultural and wood products potential had been fully utilized. Once these limits were approached, continued further expansion depended then on the settlement of another major industry in the region. The ascendancy of the aluminum industry in the region was slow at first, largely because of the depression. The war years and the surge in post-war demand for aluminum, however, have increased the region's dependence on the industry considerably.

It is difficult to assess the contribution which the aluminum producer makes to the region in the form of employment and income generation, but perhaps some rough estimate might serve to indicate the general magnitude.

The carrying on of smelting activities generates income streams which may be divided into permanent and non-permanent. Investment expenditures are the main example of the latter group. These have amounted to hundreds of millions of dollars since the outbreak of World War II. Much of this expenditure must have drained away directly through imports into the region of construction equipment and materials. During the war much of the labor force employed in construction had to be brought from outside the region. For instance, a large camp was established to house the men working on the Shipshaw II project. When the project was completed, the camp was dissolved and most of the men left the region. While they were there, their wages spent created more income there, but upon cessation of construction, this income stream dried up as the men moved away. A similar pattern is probably true today although a larger part of the labor force on construction projects is now drawn from the region itself.

The more important permanent income stream generated by the smelting activities results from wages and salaries paid in the region and materials and services purchased locally. Compared with the value of output, the number of men employed by the aluminum smelters is rather small. However, the existence of an industry within a certain region creates a number of jobs indirectly, and we should take these into account if we are to attempt an estimate of total employment caused by the presence of the industry.

In 1954 the Stanford Research Institute undertook a study of a region similar to the Saguenay, also with the objective of gauging the impact of an aluminum industry on the surrounding region.[6] The case studied was the Pacific North-West where the role of the aluminum smelters is similar to that in the Saguenay. As a measuring device, this study has attempted to express, on the basis of the per capita income of the region, the equivalent population that could be supported by the direct expenditures of the aluminum producers of the region. For the Pacific North-West, the population figure corresponding to all types of expenditures in the region is as high as five times the figure corresponding to the wage bill alone. Many of these expenditures, for instance industrial consumption of aluminum and purchase of power from third parties, do not apply in the Saguenay region. If we

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[6] Stanford Research Institute (Carleton Green), The Impact of the Aluminum Industry on the Pacific North West, Vancouver, Wash., 1954.

eliminate all expenditures from the Stanford study which would not apply in our case, we are still left with a figure indicating a population twice as large as that supported directly by the payment of wages and salaries.

If the two regions, the Pacific North-West and the Saguenay, are at all comparable in the present context, we may estimate the total number of people finding employment in the Saguenay region as a result of the aluminum industry having located there. Since the present direct employment is approximately 8,000, we may conclude that a total of 16,000 people find employment.

In the Saguenay region, the active labor force is about 29 per cent of the total population. Thus, 16,000 men employed correspond to a population of 55,000 which is close to one quarter of the total population of the region in 1956. This amply illustrates the preponderance which the aluminum industry has in the Saguenay district, particularly when we consider that the above population figure supported by the industry is less than one half of one percent for Canada as a whole.

CHAPTER FOUR

INTER- AND INTRA-INDUSTRY TRANSACTIONS

A STATISTICAL VIEW

The growth of the Canadian aluminum industry had been slow in gaining momentum, and the industry's integration into the economy has been a gradual one.

The first smelter at Shawinigan Falls was entirely supplied with alumina, cryolite and carbon from the parent company in the United States. Thus virtually the only income effects created in Canada - other than the ones incurred during construction - were wages and salaries paid for the smelter operations. Out-of-pocket cost of production of company-owned power is exceedingly low.

In contrast to Shawinigan Falls, Arvida soon obtained its own alumina facilities followed by a plant for the manufacture of carbon electrodes. Raw materials and fuel still had to be imported. Until a few years ago, cryolite, which is used in the electrolytic bath, had to be imported from Greenland, the only place where it is found in its pure form. It is now being replaced to an increasing extent by synthetic cryolite made in Canada from sulphur and fluospar. The latter material comes from Newfoundland; other raw materials, such as petroleum coke for the baking of carbon electrodes (anodes), and metallurgical coke for the pot lining (cathodes), are still imported today.

Although the processing of raw materials has been shifted to Canada to an increasing extent, most of the raw materials are not available in this country and must be imported. Nevertheless, the value added by Canadian operations has tended to increase.

When aluminum production first started in Canada, all raw materials were brought in from the United States in processed form, ready to be used in the smelting process. Practically the whole smelter output was re-exported. As operations grew in size, however, ramifications developed to an increasing extent. Raw materials were processed in Canada and some previously imported goods were made here. Furthermore, as fabricating establishments grew, a greater volume of the smelter output was absorbed by local industry. As the acceptance of the metal grew, an increasing number of end users became customers of the aluminum industry within the borders of Canada. Eventually, the Aluminum Company of Canada developed side lines such as the sale of calcined bauxite to chemical companies as abrasives. By the time the industry was a fully integrated concern, inter- and intra-industry transactions had become quite complex. A description of such transactions will be simplified by the use of a new method of statistical presentation, Input-Output analysis.

Such an analysis will permit us to gauge as accurately as possible the position of the Canadian aluminum industry within the framework of industrial and commercial activity. Although research in this field of Input-Output tables goes back to before World War II, practical applications of this technique have so far been limited, and some of the difficulties encountered with it have not yet been solved satisfactorily. These difficulties, however, crop up mainly in connection with intertemporal comparisons. For the purpose of taking a "snapshot", which we propose to do here, Input-Output tables are quite adequate.

For the present purpose, the year 1949 has been chosen for analysis because the Dominion Bureau of Statistics just recently published an Input-Output table for Canada for that year.[1] Thus it was possible to construct a table for the aluminum industry which can be considered to be the elaboration of one part of the D.B.S. table. In arriving at the various values, the same concepts have been used as in the D.B.S. table. At least two of those stand out and deserve special mention:

(1) Inputs are broken down into intermediate inputs, mostly raw materials, goods and services purchased from other industries, and primary inputs, such as labor, profits and depreciation. By listing wages and salaries separately in the latter category, rather than imputing this expense to the various stages of production, individual values are fundamentally different from accounting values. For example, an accounting Statement of Net Income may look as follows:

Sales (f.o.b. plant)	100
Cost of Goods Sold	65
Gross Op. Profit	35
Administrative, Selling and General Expense	15
Income before Tax	20
Tax @ 47%	9
Net Income After Tax	11
Depreciation absorbed:	10.

For the purpose of an Input-Output table, the same operation would be expressed as follows:

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[1] Dominion Bureau of Statistics. Research and Development Division: The Inter-Industry Flow of Goods and Services, Canada 1949. Ottawa, 1956.

Intermediate Inputs:	
Materials purchased from other industries:	40
Total Intermediate Inputs:	(40)
Primary Inputs:	
All labor, wages and administrative salaries:	30
Corporate profits before taxes:	20
Depreciation:	10
Total Primary Inputs:	(60)
Total Input:	100.

(2) The treatment of cost of transporting the output to the ultimate consumer. There are basically two methods open:

a) making the assumption that the purchaser buys a product f.o.b. plant from the industry which produces it, and then contracts separately with the transportation industry to deliver his purchase;

b) making the assumption that the consumer purchases a "package deal" from the supplying industry, which includes transportation to the purchaser's location. In this case, transportation would have to be shown as an input into the supplying industry.

This latter method is the one adopted by the D.B.S. study, and we have consequently adopted it also for our purposes. Thus, the above numerical example would have to be written as follows:

Intermediate Inputs:	
Materials purchased from other industries:	40
Services purchased from transport industry:	5
Total Intermediate Inputs:	(45)
Primary Inputs:	
All labor, wages and administrative salaries:	30
Corporate profits:	20
Depreciation:	10
Total Primary Inputs:	(60)
Total Input:	105.

Corporation taxes are not reflected in Input-Output tables so as to make the aggregate of results comparable to the Gross National Product concept of the National Accounts.

The output of an industry is subdivided according to the same pattern as applies to inputs. Sales to other industries are classified as "intermediate outputs". The personal expenditures (of the ultimate consumer) as well as government expenditures on the goods and services produced by a particular industry are classified as "final output". Also falling into the latter category are exports and changes in inventory:

Output Industry A

Industries X	Industries Y	Industries Z	Total Intermediate Output	Exports	Personal Expenditure	Govt. Expenditure	Gross Domestic Investment	Change in Inventories	Total Final Output	Total Output
20	20	15	(55)	10	20	5	10	5	(50)	105

Constructing an Input-Output table for the aluminum industry is rather difficult because data are not available in as great detail as would be desirable. Although we have so far loosely spoken of the aluminum "industry", this term is, as far as smelting operations are concerned, synonymous with one company.Since the Dominion Bureau of Statistics publishes its industrial data in such a way that no inference can be drawn as to the operations of any particular company, D.B.S. data on aluminum smelting are for practical purposes non-existant. We had to rely for information largely on annual reports and company prospectuses, therefore, for data on smelting.

To determine the input of aluminum smelting, we had to impute much of the data used, and the results should therefore not be regarded as actuals but rather as estimates. As estimates, however, our results are likely to be fairly reliable. All estimates lie within a well defined scope of possibility of error, and since this scope can be narrowed down appreciably, incorrect estimates are unlikely to be large enough to invalidate the final results.

To be specific, we know the total tonnage produced by aluminum smelting, and we also know its sales value. We know profits and depreciation, since they are published by the company. Thus we are left with the task of breaking down Cost of Goods Sold and Administrative, Selling and General Expense. In breaking down the former into raw materials and labor, we are aided by the fact that aluminum reduction requires technologically quite inflexible inputs, the quantities of which (per ton of final output) are known. The production of one ton of aluminum requires a fixed proportion of bauxite of a specific aluminum and silicon content, and a known market price for such bauxite exists. This market price is usually quoted for bauxite of a certain purity, should the ore be below the standard its price would be adjusted accordingly. Thus for our purposes it does not matter whether 4, 4½, or 5 tons of bauxite were used for one ton of ingot. The value of bauxite input per ton of output must have remained much the same.[2]

As regards power, again an unvarying amount is required to produce one pound of aluminum. Electric current used in the reduction cells is somewhat below ten kilowatt hours per pound (kwhrs/lb), but it is generally accepted to use the figure of 10 kwhrs/lb since this very closely approximates total power requirements, including such ancillary ones as heating, lighting etc. The quantity of power used can thus be estimated, but it is difficult to estimate the value of this amount of power.

Since aluminum production depends so heavily on power, the true out-of-pocket cost of power has traditionally been a closely guarded secret with the major producers throughout the world. Fortunately an estimate of the Aluminum Company of Canada's power cost during 1949 has been published.[3] This estimate appears to be reliable and was used in the present calculations.

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[2] This method assumes of course that the base price for bauxite remained unchanged during the period, or that an average for the year has been taken.

[3] Aluminum and the Four North American Producers. First Boston Corporation, New York, N.Y., 1951.

Bauxite and power make up the largest part of the total raw material input. A similar approach to that discussed above for bauxite was used to calculate the quantities and values of the other materials. These included the chemicals used in the alumina plant, and material used for the manufacture of electrodes.

After estimating the values of the physical inputs, we were left with a residual of Cost of Goods Sold, plus Administrative, Selling and General Expense. This residual had to be wages and salaries, as well as a number of smaller items which could not be linked to any particular phase of operations. To mention just a few: rent of head office space, office and shop supplies, normal repairs and maintenance charged to cost of production. Principal arbitrary assumption in the present estimate, and the greatest single possibility of error, lies in the split of the residual between wages and salaries on the one hand, and certain "unallocated" items on the other.

As regards the disposition of smelter output, by far the largest part was exported. The remainder was allocated, via the aluminum products industry, to the various domestic industries on the basis of percentages of ultimate end uses as estimated by the Aluminum Company.

One further possibility of inaccuracy should be mentioned, although it is a minor one: Of the various ancillary raw materials, some were wholly imported, some were made by the company or purchased within Canada, and some were both imported and procured domestically. For the latter group no data as to domestic or foreign origin were available, and their value has been split somewhat arbitrarily as between input "Imports" and input "Industry X". However, since the aggregate value of this group accounts for only a small percentage of the total, the split finally used, even if inaccurate, could not distort the overall results to any extent.

Finally, all information has been treated as if all inputs flowed through two industries: First, intermediate and primary inputs are introduced into the aluminum smelting division of the non-ferrous mining and smelting industry, the latter being a Dominion Bureau of Statistics classification used in their Input-Output table for Canada. Almost the entire output of the aluminum smelting division is treated as going to the aluminum products industry, a division of the "Non-Ferrous Metal Products, n.e.s."[4] industry (intermediate output), and to exports (final output). (Tables III and IV.) A further set of tables then shows the flow of ingots and other inputs through the non-ferrous metals industry to the ultimate consumer. To complete the picture, activities other than the main activity have been taken into account. Examples of such activities are sales of chemicals and sales of power to private consumers.

Only one further comment is required for Table III, that items 41 and 44 should be treated together. The split between them is nothing but an estimate of annual rent of head office space.

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[4] Not elsewhere shown.

TABLE III

Inputs - Ingot Stage

No.	Classification	Name of product	Values of each product	(4) Non-ferrous mining & smelting (Total)
4	Non-ferrous mining and smelting	Hydro-power		$4,200,000
6	Non-metals, mining and quarrying	Limestone, Cryolite, Fluospar	$ 700,000 2,450,000 157,000	3,307,000
34	Products of petrol and coal	Coal, Pot-lining materials	473,000 4,730,000	5,203,000
35	Chemicals and allied products	Soda ash, Sulphur	1,326,000 1,200,000	1,340,000
38	Transportation	From smelter to fabricating plant to border		2,260,000
41	Finance, Insurance, Real Estate	Rent, Sun Life Building		4,000,000
43	Imports	Limestone, Cryolite, Coal, Soda ash, Sulphur, Pot-lining mat'l, Bauxite, Petr. Coke, Pitch, Fuel Oil	71,000 805,000 473,000 1,325,000 126,000 530,000 7,410,000 3,540,000 2,370,000 2,210,000	18,860,000
44	Unallocated			3,000,000
45	Total Interim Input			42,170,000
46	Wages and Salaries			19,200,000
47	Corporation Profits			34,000,000
51	Depreciation			5,950,000
52	Total Primary Input			59,150,000
53	Total Input			101,320,000

In Table IV, the value of output going to the aluminum products industry under "Non-Ferrous Metal Products Industry" is as reported by Dominion Bureau of Statistics for 1949.[5] Total value of exports also correspond to the D.B.S. figures of exports from Canada for that year. The red inventory adjustment is more than a balancing item. The Aluminum Company of Canada shows a reduction in inventories in 1949 of $2,400,000. The larger part of this was taken to be a reduction in the finished goods inventory of the smelter section, since the volume of inventories of raw materials are normally held closely to what is required by good operational practices.

Inputs into the aluminum products industry were not difficult to establish since most of them, including salaries and wages, are published in the D.B.S. census of production for the industry and so is the value of the final output. The residue was then split between depreciation and corporate profits by assuming that the ratio of depreciation to profits is the same for the industry as it is for the Aluminum Company of Canada. Since the latter company accounts for about 85 per cent of the output of the aluminum products industry, this is a reasonable assumption.

Both Table V and Table VI have imports as an input item because a wide range of aluminum products in varying stages of processing were imported. Most of the finished goods (kitchenware, garden furniture, etc.) went directly to the consumer. Semi-finished goods, such as sheet and extrusions, went to various fabricating establishments for further processing.

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[5] Dominion Bureau of Statistics, Census of Production, Aluminum Products Industry, 1949.

TABLE IV

Output - Smelting Stage

No.	Classification	(31) Non-ferrous metal products	(44) Total Intermediate Output	(48) Inventories	(49) Exports	(50) Total Final Output	(51) Total Output
4	Metal Mining and Non-ferrous Mining and Smelting	17,900,000	17,900,000	1,480,000	84,900,000	83,420,000	101,320,000

TABLE V

Inputs - Non-Ferrous Metal Products

No.	Category	Names of Commodities	(31) Non-ferrous Metal Products
4	Non-ferrous mining and smelting	Ingot Copper, etc.	17,900,000 130,000
28	Iron and Steel products	Steel Core, etc.	140,000
34	Products of Petrol. and Coal	Fuel	500,000
36	Miscellaneous Manufacturing Industries	Plastic handles etc. Unallocated	1,000,000 300,000
38	Transportation	To consumers and to border	2,300,000
40	Electricity		500,000
43	Imports	Semi-fabs of aluminum	4,230,000
45	Total Intermediate Input		27,000,000
46	Wages and Salaries		13,900,000
47	Corporation Profits before Tax		9,100,000
51	Depreciation		3,100,000
52	Total Primary Input		26,100,000
53	Total Input		53,100,000

TABLE VI

Output - Non-Ferrous Metal Products

No.	Category	(1) Agriculture	(29) Transportation Equipment	(35) Chemical Products	(37) Construction	(43) Unallocated	(44) Total Intermediate Output	(45) Personal Expenditures
31	Non-ferrous Metal Products	1,940,000	10,100,000	2,400,000	21,400,000	3,060,000	38,900,000	5,930,000
43	Imports							3,770,000

No.	Category	(48) Change in Inventories	(49) Exports	(50) Total Final Output	(51) TOTAL OUTPUT
31	Non-ferrous Metal Products	930,000	9,200,000	14,200,000	53,100,000
43	Imports				3,770,000

Since the Dominion Bureau of Statistics on Input-Output transactions is drawn up on an establishment basis, the values for a particular industry include those items which are alien to the main product line, but made in the same plant. For instance, the services of a trucking fleet operated by a manufacturer of machinery, are included in the value produced by the machinery industry, rather than being imputed to the transportation industry.

Similarly, D.B.S. figures on the Non-Ferrous Metal, Mining and Smelting industry include the sale of such non-metal products as chemicals, etc. Furthermore, the aluminum smelters, or more exactly, their power stations, make available a fair amount of hydro-electricity to the residents of the region in which the stations are located.

Since the chemicals are sold almost entirely to the chemical industry, that part of the output is shown as going to the chemical industry. Power, however, is not sold direct to the consumers, but rather to a distributing company which retails the electricity to the ultimate consumer. Thus part of the output (power) of the smelting industry is shown as going to the Electricity industry, from which in turn it goes to the ultimate consumer. All this is reflected in Tables VII and VIII.

Then, superimposing all the above tables, we obtain Table IX which can be related directly to the Dominion Bureau of Statistics table for Canada for 1949.

TABLE VII

Input - Chemicals and Power

No.	Category	(4) Non-Ferrous Metal Mining and Smelting
43	Imports (Bauxite, Oil)	2,600,000
45	Intermediate Input	2,600,000
46	Wages and Salaries	1,700,000
47	Corporation Profits	2,600,000
51	Depreciation	300,000
52	Total Primary Input	4,600,000
53	Total Input	7,200,000

TABLE VIII

Output - Chemicals and Power

No.	Category	(35) Chemical Products	(40) Electricity	(44) Total Intermediate Output	(51) Total Output
4	Non-ferrous mining and smelting	6,100,000	1,100,000	7,200,000	7,200,000

Input-Output Canadian Aluminum Industry, All Stages

TABLE IX

Millions of $

No.	Classification	4 NON-FERROUS MIN. & SMELT. INCL. ALUMINUM	1; 29 AGRICULTURE & TRANSPORTATION EQUIPMENT	31 NON-FERROUS METAL PRODUCTS	35 CHEMICALS + ALLIED PRODUCTS	37 CONSTRUCTION	40 ELECTRICITY + OTHER UTIL.	43 UNALLOCATED	44 TOTAL INTERMED. OUTPUT	45 PERSONAL EXPENDITURE ON CONS. GOODS	48 CHANGE IN INVENTORIES	49 EXPORTS OF GOODS & SERVICES	50 TOTAL FINAL OUTPUT	51 TOTAL OUTPUT
4	Alum. Smelting			17.90	6.1		1.1		25.1		1.35	84.77	83.42	108.52
4	Non-ferrous min. & smelt. incl. own power	(1) 4.2		(2) .13					4.33					4.33
6	Non-metal min. quarrying, prospecting	3.307							3.307					3.307
28	Iron and Steel products			.14					.14					.14
31	Non-ferrous metal products	(3) 12.04			2.4	21.4		3.06	38.90	5.93	.93	9.20	14.20	53.10
34	Products of Petrol. and Coal	5.203		.50					5.703					5.703
35	Chemicals and allied products	1.34							1.34					1.34
36	Miscellaneous Manufacturing Industries			1.00					1.00					1.00
38	Transportation etc.	2.26		2.30					4.56					4.56
40	Electricity and other utilities			.50					.50					.50
41	Finance, Insurance & Real Estate	4.0							4.0					4.0
43	Imports of Goods & Services	21.46		4.23					25.69	3.77			3.77	29.46
44	Unallocated	3.0		.30					3.30					3.30
45	Total Intermediate Input	44.77	12.04	27.00	8.5	21.4	1.1	3.06	117.87	9.70	2.28	93.97	101.39	219.26
46	Salaries and Wages	20.9		13.9					34.8					34.8
47	Corporation Profits before Tax	36.6		9.1					45.7					45.7
51	Depreciation Allowances	6.25		3.1					9.35					9.35
52	Total Primary Input	63.75		26.1					89.85					89.85
53	TOTAL INPUT	108.52	12.04	53.10	8.5	21.4	1.1	3.06	207.72	9.70	2.28	93.97	101.39	309.11

(1) Power. (2) Copper. (3) Includes $1.94 agriculture.

TABLE X

Input per Dollar of Output

		4	1;29	31	35 37 40 43	44	45 48 49	50	51
No.	Classification	NON FERR. MIN + SMELT INCL. ALUM.		NON FERR. METAL PRODUCTS		TOTAL INTERM. OUTP.		TOTAL FINAL OUTPUT	TOTAL OUTPUT
4	Alum. Smelting			.33710					
4	Other N.F. metal mining & smelting incl. own power	.03870		.00245					
6	NON-METAL MIN.	.03047							
28	IRON + STEEL			.00263					
31	Non-ferrous (al) metal products								
34	PETR. + COAL	.04795		.00942					
35	CHEMICALS	.01234							
36	MISC. MANUF.			.01883					
38	TRANSPORT.	.02082		.04331					
40	ELECTR. UTIL.			.00942					
41	FIN. INS. REAL EST.	.03686							
43	IMPORTS	.19775		.07966					
44	UNALLOCATED	.02764		.00565					
45	Total Intermediate Input	.41255		.50847					
46	SALARIES WAGES	.19259		.26177					
47	CORP. PROF. BEF. T.	.33726		.17137					
51	DEPRECIATION	.05759		.05838					
52	Total Primary Input	.58745		.49153					
53	TOTAL INPUT	1.00000		1.00000					

TABLE XI

Output per Dollar of Input

No.	Classification	4	1; 29 AGRICULTURE	31 NONFERR. METAL PRODUCTS	35 CHEMICALS	37 CONSTRUCTION	40 ELECR. + OTHER UTIL.	43 UNALLOC.	44 TOTAL INTERMED OUTPUT	45 PERSONAL EXPEND. GOODS SERV	48 CHANGE IN INVENTOR.	49 EXPORTS OF GOODS, SERV.	50 TOTAL FINAL OUTPUT	51 TOTAL OUTPUT
4	Alum. Smelting			.16495	.05621	.	.01013		.23129		.01244	.78114	.76870	1.00000
4	Other N.F. Metal Min. & Smelting incl. own power													
6 28														
31	Non-ferrous (al) metal products		.22674		.04520	.40301		.05763	.73258	.11167	.01751	.17326	.26742	1.00000
34, 35, 36, 38, 40, 41, 43, 44.														
45	Total Intermediate Input													
46, 47, 51.														
52	Total Primary Input													
53	TOTAL INPUT													

PART II

CHAPTER FIVE

MONOPOLY, COMPETITION, AND THE ECONOMISTS' FRAME OF REFERENCE

In April of 1937 the United States Government brought to court an anti-trust action against the Aluminum Company of America *et al.*[1] The initial court action lasted for five years during which time some 40,000 pages of evidence were presented. Specifically, it was alleged that the Aluminum Company of America

1) had monopolized the markets for virgin aluminum and certain semi-fabricated products,
2) had entered into conspiracy with other companies abroad, including Aluminium Limited, for the purpose of fixing prices, restricting imports, etc., and
3) was guilty of "other misconduct", i.e. it charged extortionate prices and made exorbitant profits.[2]

The remedial action sought by the plaintiff was the dissolution of the Aluminum Company of America.

Judge Caffey, in giving the trial court's opinion in June 1942, found the defendants not guilty on all counts and ordered the Government's petition dismissed.

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[1] The "et al" included some 25 subsidiaries of the company as well as Aluminium Limited. It also comprised 37 directors, officers, and principal share-holders of the Aluminum Company of America.

[2] Federal Supplement, West Publishing Co., St. Paul, Minn., Vol. 44, 1942, p. 224.

The trial court's decision, however, was appealed. In March 1945 Judge Learned Hand handed down a judgment which differed in some important aspects from that of the lower court.

First, Judge Hand held that the Aluminum Company of America (Alcoa) was an illegal monopoly and that it had been a monopoly at the time of the first trial. He contended that size alone - in this case measured by the fact that Alcoa controlled over 90 per cent of the ingot market - constituted an offence under the Sherman Act even in the absence of evidence of restrictive practices.

Second, Judge Hand found evidence of a "price squeeze" in the sheet market for the purpose of forcing out independent makers of aluminum sheet. Such action on the part of Alcoa, however, had ceased twelve years prior to the trial, and Judge Hand consequently confined the court's action to an injunction against a resumption of such practices in the future.[3] Judge Hand also conceded the plaintiff's contention that Aluminium Limited's cartel agreements had affected imports into the United States.[4]

One of the outstanding features of the trial was that, although a monopoly had been found to exist, it was established that monopolistic power had not been exercised for some time prior to the trial. Mostly

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[3] Federal Reporter, West Publishing Co., St. Paul, Minn., Vol. 148, 1945, p. 447.

[4] This contention has since been disputed by Louis Marlio: The Aluminum Cartel, Brookings Institution, Washington, D.C., 1947, pp. 43-45. Whether Mr. Marlio's refutation is valid is not considered essential in the present context. A discussion thereof is consequently omitted.

for that reason, the court did not grant the relief sought by the plaintiff, i.e. the dissolution of Alcoa. Instead, the court recommended an attitude of waiting to see if the Defense Department's disposal of war-time Government aluminum plants to new entries into the industry would establish a sufficient degree of competition. The case remained open for a period of five years during which time both parties could seek further relief. Both did, Alcoa petitioning the court to declare that the company no longer had a monopoly of the ingot market, and the United States Government petitioning that competitive conditions had not been established and that this could be accomplished only through a divestiture of some of Alcoa's assets.

In June 1950 Judge Knox handed down his opinion.[5] He rejected both petitions, but afforded the plaintiff some minor relief by finding that certain patents issued by Alcoa were unenforceable. Although still finding no evidence of collusion between Aluminium Limited and Alcoa, he concluded:[6]

> "One must indulge the conviction that the control which may be exercised over Aluminium Limited by the controlling stockholders of Alcoa is of enormous importance. No matter how lawful the relations with Aluminium Limited may have been in the past, were I now to ignore the potential power which resides in the nexus, my duties in this proceeding, as I understand them, would not be adequately discharged."

As a result, the Judge ordered persons holding large blocks of shares in both Alcoa and Aluminium Limited to divest themselves of

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5 Federal Supplement, Vol. 91, p. 333.

6 Ibid., p. 333.

their holdings in either one of the two companies. Furthermore, another waiting period of five years was instituted to determine whether Alcoa would still have a monopoly at the end of the period.

Recently the United States Government asked for an extension of this latest trial period for another five years on the grounds that it was still premature to determine whether Alcoa should divest itself of certain of its assets, and that the competitive situation in the industry remained inconclusive.

Judge J.M. Cashin rejected this plea on the grounds that Alcoa's share of the aluminum market had declined while its chief competitors, Kaiser Aluminum and Chemical Company and Reynolds Metals Company, had "more than maintained their competitive position in the phenomenal expansion of the industry".[7]

Barring a successful appeal by the United States Government, the Aluminum Company of America will now at long last be free from prosecution under the Federal anti-trust laws. Undoubtedly, this turn of events was greeted by the industry with a sigh of relief. To the aluminum people it was a sign that justice had prevailed at long last.

In other quarters, however, the latest, and possibly last, decision in the famous "Alcoa Case" has probably been received with dismay and indignation. Many economists are bound to feel that with this decision a monopolist has been aided and abetted at the expense of the public. An outstanding spokesman of this group is Dr. Adams,

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[7] Business Week, July 6, 1957, p. 38.

who comments on the 1950 decision of Judge Hand as follows:[8]

> "The result is that aluminum today is a three-producer industry; that Alcoa, instead of being a single firm monopoly, now exercises residual monopoly power through price leadership and other means, that the concerted action typical of oligopoly has replaced the unilateral action of monopoly. A ringing judicial denunciation of monopoly has produced little in the way of affirmative relief. Vigorous and effective competition has not been re-established in this basic and vital industry."

This is much stronger language than can be found in the work of D.H. Wallace, perhaps the most famous student of aluminum market control. It would be futile to disagree with either Wallace or Adams on purely technical grounds. We find ourselves, however, in fundamental disagreement with the basic attitudes shared by Wallace, Adams, and a number of other writers on the subject of market control. But rather than joining battle on such questions as whether and how size can be taken as measure of the degree of monopoly, it might be helpful to offer some more fundamental reflections.

The views of Adams cited above have their antecedents in the nineteen-thirties, and it is in this period that one should look for the roots of the thoughts with which we find ourselves in disagreement.

Why did economists attack monopoly so often with an almost religious zeal? Surely not because of the injustice inherent in a stockholder receiving in the form of dividends benefits which should have more properly accrued to an ultimate consumer. If that had

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[8] Walter Adams: "The Aluminum Case: Legal Victory - Economic Defeat". American Economic Review, Vol. 41, 1951, p. 915.

been the economists' concern, welfare economics, taxation principles and the theory of distribution would have to be contested with equal fervor..

The crusading spirit so often encountered in writings on imperfect competition stems undoubtedly from a different motivation. Many writers in the nineteen-thirties foresaw in the seeming decline of competition the doom of our whole social structure. It was during that time that Arthur R. Burns wrote:[9]

> "The rise of 'heavy industries', changes in methods of selling, and the widening use of corporate forms of business organisation are bringing, if they have not already brought, the era of competitive capitalism to a close. These changes have swept across the industrial scene in America with remarkable speed since the closing years of the nineteenth century. Yet there has been astonishingly little analysis of their significance. Much has been written of the history of individual pools and trusts, and accusing fingers have been pointed at the increasing concentration of control over industry. This literature is founded upon naive conceptions of 'competition' and 'monopoly' and unreal assumptions concerning the possibility of reviving the competitive market. It has been too much concerned with judicial efforts to apply the anti-trust laws and too little with the underlying forces making for change and with the consequences of the manner in which they have been transforming the industrial system."

Although Professor Wallace was specifically concerned with the market behavior in the aluminum industry, he had much in common with Burns. Their objectives were similar. Both set out to learn from observation, Burns in a comprehensive way by studying the entire field of industrial and commercial activity, Wallace by concentrating on one particular segment. It is interesting to note that in spite of their difference in subject matter, they arrived at very similar

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[9] Arthur R. Burns: The Decline of Competition, McGraw Hill, Hew York, London, 1936, Preface p. v.

conclusions. They were greatly disconcerted by the threats to our free market system inherent in ologopolistic power.

Although Burns and Wallace had tempered much of the limitations of their economic "tool kits" with a good deal of mature insight into the workings of the economic system, it can now be seen, with the benefit of considerable hindsight, that even they labored under handicaps of far-reaching consequences.

It is doubtful that any economist prior to the publication of Keynes' General Theory seriously questioned Say's Law of the Markets. Prior to the General Theory, economists on the whole believed that if only left to its own devices, the economy would return to full employment equilibrium. The slogan "prosperity around the corner" was more than wishful thinking. It was the manifestation of an almost religious belief in the Natural Law. When improvements did not materialise, economists naturally looked for obstructions in the price policies and restrictive practices of Big Business.

In speaking of the everwidening practice of price maintenance in the face of declining demand, one author gives expression to this belief as follows:[10]

> "The evolution of industrial policy in recent times has thus served in substantial measure to prevent or impede the functioning of the competitive price mechanism. That is to say, over an everwidening segment of the economic system the process of persistently expanding purchasing power by means of price reductions has been checked. Thus one of the primary agencies of adjustment upon which the capitalistic system was supposed to rely has in substantial part ceased to be operative."

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[10] H.G. Moulton: <u>Income and Economic Progress</u> as quoted by E.G. Nourse and H.B. Drury in <u>Industrial Price Policies and Economic Progress.</u> Brookings Institution, Washington, 1938, p. 6.

Keynes is still today a controversial figure in many quarters, and yet there are few people who do not accept, explicitly or implicitly, his refutation of Say's Law. Among economists it is generally agreed now that a stable under-employment equilibrium can exist irrespective of any particular market form. At the same time there are few who would be gravely worried by this possibility. We have now at our command such an impressive arsenal of monetary and fiscal tools that a recurrence of anything approximating the gravity of the Great Depression seems unlikely. Unlike death and taxes, depressions are no longer inevitable. Even business men, to many of whom Keynes is still anathema, would think it inconceivable for a government to stand by idly in times of a serious economic crisis.

During the Great Depression, the curse of Say's Law, and the neo-classical concepts which it epitomizes, was that it made economists look in the wrong direction in their search for the causes of depressions and the decline of competition. Today it is not even certain that competition has declined at all, even though price maintenance has long since become the general rule rather than the exception.

Say's Law is now little more than a chapter in the history of economic thought. Admittedly, in the event of a depression, sharp cutbacks in industrial production together with price rigidity may well aggravate the existing difficulties. Few economists could be found, however, who would seriously advocate that these are the causes of a business downturn. It is generally agreed that a modern government can, by fiscal and monetary means, avoid a serious depression altogether. Thus the problems of the nineteen-thirties need not rise to plague us again.

Apart from their preoccupation with neo-classical concepts, writers in the nineteen-thirties labored under an equally severe, yet less tangible handicap. They wrote against the backdrop of the most severe and protracted depression which modern capitalism had ever experienced.

Men of the calibre of Burns and Wallace had attributed great significance to the dynamics of the economic process which produce a pattern of perpetual change. Their works will in all likelihood prove to be of lasting value mainly because of their emphasis on the dynamics within the economic system. Nevertheless, the markets they observed were more or less stationary. It was thought possible that recovery would bring a return to the high level of prosperity of the late nineteen-twenties, but it seems doubtful that prior to the war anyone would have envisaged the magnitude of the expansion of economic activity as it was experienced in the nineteen-forties and 'fifties. By the end of the war a new school of economists had become established. They had shed to a large extent the tenets of the neo-classicists, but their thinking, too, was so thoroughly conditioned by the experience of the Great Depression that they expected a slump upon the cessation of hostilities.

This slump did not materialize. Instead, North America experienced an unprecedented boom based, unlike war-time expansion, mostly on civilian demand. Economists are gradually accepting the possibility that expansion need not be ephemeral but, rather, may be an integral part of our economic environment. What is more, it is now believed that the growth of the economy can be sustained indefinitely at levels higher than anyone in the 'thirties would have thought possible.

The thought occurs that in a general atmosphere of dynamic growth it is not necessary to be as worried about the problems created by the prominence of the large, powerful corporation as economists were in the past. The problems encountered in a growing economy are different from those in a stationary or declining economy. The problems which were so much in the foreground during the nineteen-thirties may not have disappeared altogether, but they have receded into the background, giving way to new problems.

Many questions pertaining to the functioning of the market system are associated with the large corporation and its influence over markets. The first sentence of Professor Burns' preamble, quoted above, conjures up the vision of an insidious disease which inevitably spreads further and further until it presumably has permeated the entire body politic. Oddly enough, the relative preponderance of the large corporation has not changed at all since the turn of the century.

In 1954 the Brookings Institution published a study on the role of big business in our economy today.[11] This study confirms some of the convictions generally held, while directly contradicting others. It shows, for instance, that large corporations are most prominent in industries where capital requirements per unit of output are heavy, and where only large scale production holds out promise of low unit cost. This is not surprising. But it is surprising to see that the share of corporate business in Gross National Product, profits and

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11 A.D.H. Kaplan: Big Enterprise in a Competitive System, Brookings Institution, Washington D.C., 1954. Although data are taken from the U.S. economy, the conclusions drawn from them can be assumed to apply to Canada as well.

employment has not changed over the decades. Strangely enough, the non-corporate sector of the economy has at least maintained its relative position. Corporate payrolls, for instance, had increased in 1951 over 1929 by 232 per cent, as compared with a non-corporate payroll increase of 227 per cent. Corporate profits were close to four times their 1929 level, non-corporate profits had increased three-fold. These figures are remarkable, considering that capital investment in the non-corporate business sector is much lower than in the corporate sector. Furthermore, while over the last few decades corporations accounted for approximately half of National Income, their number included many medium and small-sized companies which were actually corporations in name only, and which should really be imputed to the non-corporate sector of the economy.

Of the remainder, the one hundred largest corporations accounted for 10.6 per cent of the total national payroll and their assets amounted to almost $50 billion. Taken as a group, these one hundred giants represented no serious threat to the economy at large since they were dispersed through a large number of different, often unrelated, brahcnes of industry. In some industries, however, the dominance of one or of a few large producers was quite apparent. But even here established positions did not often remain unchallenged over the years. The saving grace of this group of one hundred giants seems to have been that their leadership and ranking underwent continuous change.

Some corporations have dropped out from the list of the hundred largest, either because they were outdistanced by others or because they went out of business altogether. New firms found their place on the list, either from the ranks of well established firms or from the ranks of newcomers. In 1948, for instance, only 39 corporations of the one hundred largest in 1908 had remained on the list. Over the decades, whole industries, not only individual corporations, have risen and declined in significance.

With this in mind it would be nearsighted indeed to ignore the impact of the overriding force of continuous dynamic changes within the economic structure. In this everpresent pattern of dynamic change, it turns out that the large corporation, after having found its level, has failed to grow further at the expense of small business. Also, the forces of competition have by no means been smothered.

The Brookings Study does bear out the generally held contention that the correlation between corporate size and the degree of price maintenance is quite high. Contrary to common belief, however, this does not suggest a corresponding decline in competition. Even where pricing policies of large corporate bodies have replaced the market price of the classical model, the market has not thereby yielded the final power of determination. The large corporation generally sets its price with an eye on the longer run, covering a multiplicity of transactions since it does not, like the small unit, live from one single transaction to the next. Whatever the differences between administered and "free market" prices may be, in the last analysis both depend on the responsiveness of the market. In this context the Robinson and Chamberlin approach[12] is not very useful.

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[12] Joan Robinson: The Economics of Imperfect Competition, MacMillan, London 1933, and Edward Chamberlin: The Theory of Monopolistic Competition, Cambridge, Mass., Harvard University Press, 7th Edition, 1956.

As a rule, large firms are not much concerned with the short run, and long run demand curves are often much less steep than commonly assumed. This is certainly true today, and there is even good reason to believe that this was the case under fairly stationary conditions, such as prevailed during the Depression.[13]

Ultimately the difference between administered and free market price is really only one of degree, not of principle. Over the long run an administered price can be set only within a given, more or less narrow, range. The resulting alternatives, large volume with low unit profit or smaller volume with higher unit profit are thus fairly close together.

Today, with the identical product as the exception rather than the rule, competition has become extremely complex. It includes many features other than price. Change in quality, for instance, now is of importance at least as great as changes in price. In the nineteen-thirties it was suggested that the increasing prevalence of price rigidity had considerable influence on business fluctuations. The Brookings Study found, however, that there has been no indication of a significant change in price flexibility of different commodities at least as far back as such price movements can be reliably traced:

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[13] J.M. Clark: "Toward a Concept of Workable Competition", American Economic Review, vol. 30, 1940, p. 241. Professor Clark says in part:

> "In fact, it may appear that much of the apparent seriousness of Professor Chamberlin's results derives from what I believe to be the exaggerated steepness of the curves he uses to illustrate them".

(Ibid., p. 246.)

> "Durable goods ... have remained more stable than non-durable, consumers' goods more stable than producers' goods. The exception to these characteristics have remained exceptions through recorded decades."[14]

Even in cases where there has been no price competition, the Brookings Study has shown that other forms of competition exist which are as strong as any neo-classicist could wish for. Over the years, the incidences where one or a few firms could enjoy a fairly stable market without interference have been rare. In general, the cross-elasticities[15] of different products have been high, a factor which was much enforced by innovations introduced either by a member of an industry or by an outsider. In fact, research and the development of new products has become one of the major means of competition in corporate business. This is particularly true in such volatile industries as the chemical industry, but it also holds true in the more staid industries such as steel.[16]

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[14] Ibid., p. 241.

[15] Professor Boulding defines this term as follows: "The cross-elasticity of demand for commodity A with reference to commodity B is the percentage change in the quantity of A demanded which would result from a one per cent change in the price of B, all other factors being held constant." K.E. Boulding: Economic Analysis, Harper Brothers, New York, 1948, p. 148.

[16] In most applications of aluminum, a high degree of cross-elasticity between the metal and various substitute products, e.g. copper, steel, etc., is undisputed. A similar phenomenon exists in the field of consumers' goods as well. R.M. Robertson, in an article entitled "On the Changing Apparatus of Competition" (American Economic Association, Papers and Proceedings, vol. 66, 1954, p. 51) stresses the modern significance of focussing attention on the service flow which a consumer good yields over time rather than upon the good itself:

"Household appliances in large part remove the want to economize activity which seems to be biologically necessary. Specifically, an electric refrigerator and a vacuum sweeper provide a service flow which enables members of a household unit to avoid expenditures of energy. That the two appliances perform different operations is only incidental ... From the point of view of the individual allocator of income, one way of conserving effort may be clearly preferable to the other, but the fact remains that he has a wide choice of alternatives."

In reading the Brookings Study, one gains in fact the impression that innovations in the form of product development are of such fundamental importance that one begins to wonder if the modern corporation has not replaced Schumpeter's entrepreneur in his role of providing the impetus for economic progress.

Returning now to the commonly expressed concern over oligopoly situations, it may now be possible to gauge where concern is justified, and where it may not be. To begin with, administered pricing is here to stay. It would be too sweeping a generalization to say that all such pricing constitutes an attempt to restrict the market. Of course it may do precisely that under these three conditions: (1) where the demand curve is fairly inelastic, (2) where the demand curve does not move over long periods of time; in other words, where the market is stationary, and (3) where the cost of entry is high.

Where the anti-trust lawyers need not be unduly worried is in the case of a rapidly expanding market. Here the competitive forces based on aspects other than price are felt particularly strongly. Here the traditional meaning of monopoly and oligopoly becomes largely pre-empted of its original content. True monopolies are rare. For in order to be a monopolist, the demand curve facing the firm must be fairly inelastic. If it is not, substitute products from other industries often provide a considerable degree of competition. The same holds true for the more common oligopoly situation. If a rapidly expanding market is supplied by more than one firm, vigorous competition is bound to exist even among the members of the same industry.

At first, there is competition for the additional markets, but since boundaries between old and new markets are not clearly defined, competition tends to spread into the "traditional" market areas as well. The writers of the nineteen-thirties missed this point for the simple reason that it was largely non-existent at the time.

Today economists have the opportunity to observe an altogether different type of economy. Ours is an economy of growth and expansion, and we should adjust our thinking to this fact, rather than having it colored by the thoughts worked out against the backdrop of the Great Depression. The Depression writers failed to see the difference between the consequences of large corporate size in a stationary as compared with a dynamic market situation. Needless to say, this does not belittle their work but in the face of new, more recent experience we would be neglecting our duty if we did not continue our observation of reality and did not make amendments and modifications to the existing body of thought.

Naturally, the above thoughts are oversimplifications in many respects. The great complexity of present day industrial life includes situations where restrictive practices could well coincide with expanding markets. There is thus no reason to relax the vigilance of anti-trust action at any time. On the contrary, the existence and vigilant enforcement of anti-trust laws are powerful deterrents. The fear of drawing attention from the Justice Department or the Combines Commission may well deter a large oligopolist from capturing too large a share of the market even if he could do so. There is little doubt that the existence of anti-trust laws has fostered the development of a live-and-let-live attitude towards competitors which was quite unheard-of in the rough and tumble days of the late nineteenth century.

CHAPTER SIX

PRICING POLICIES AND CASH GENERATION

The ability of a firm, facing a sloping demand curve, to set prices within a given range gives the firm a certain amount of discretion as to volume of output to be obtained. Just where the price is set depends to a considerable extent on whether the demand curve is stationary or whether it moves constantly to the right. In the former case, we have no quarrel with the attempts of Chamberlin and Robinson to furnish a theoretical framework for the behavior of a firm. It is, however, essentially a static theory, a theory which does not fit where the economy, or sectors of the economy, undergo substantial expansion. As a result, it does not allow sufficiently for the all-dominant dynamic elements of present day markets.

The Robinson and Chamberlin models have still another defect. In the last analysis, both these writers assume that a firm faced with a sloping supply curve is guided by the profit maximization principle. To be sure, a business wishes its operations to be profitable but quite often "making money" is no longer an end in itself. If it is not, the classical profit maximization principle would no longer be a useful concept.

In the formative days of our modern capitalist system, the late eighteen-nineties and early nineteen-hundreds, most large corporations were dominated by one personality who wanted not only to make money but also to spend it in a way which would leave no doubt as to the extent of his personal wealth. His successor, the corporation executive, on the other hand, responds to a more complex set of motivations. If he attempts to promote the fortunes of his company, he is unlikely to be guided by hopes for a still higher salary, especially if he is in the 85 per cent tax bracket. This is not to say that there no longer is any connection between executive remuneration and profits. To some extent such a relation still exists. The executive's concern, however, is not so much with his pay check but with the reputation of his firm and with its position vis-a-vis competitors. Being president of General Motors rather than Studebaker carries more social prestige even if executive remuneration in the two jobs were the same.[1]

In order to improve or at least maintain his company's relative market position, the executive's behavior will to a large extent depend on whether he competes in a stationary or in a highly volatile, expanding market. In the former case the neo-classical oligopoly behavior may well occur. In an expanding market situation, however, the oligopolist is forced into competition in the manner described in the previous chapter. Each firm has to attempt to outdistance its competitor or be outdistanced by him.

What is the connection between a firm's attempt to maintain or increase its relative market share on the one hand and its profit motive on the other? To the classical school of economists, competition meant that in the long run no company could make a profit in excess of cost which included a "normal" return on capital. Assuming for the moment that this "normal" return could be defined, say 3 per cent on

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[1] cf. B.S. Keirstead: An Essay in the Theory of Profits and Income Distribution. Oxford, Basil Blackwell, 1953. This book contains a brilliant discussion of the complexities of executive motivation in a dynamic economy.

debt and 6 per cent or 10 per cent on common stock, the long run competitive model would imply that after servicing of debt, common stock dividend and normal replacement no funds would be left over. This was considered the ideal because all the benefits had been passed on to the consumer. If such a firm would then be faced with increased demand requiring expansion of productive facilities[2] the firm would have to raise the money in the capital market.

This is another point where the neo-classical concept of competition is inadequate today. A large modern corporation with no funds left after dividends would have no hope of being able to raise any money in the capital market. In order for a corporation to be able to raise capital for an expansion project, it will have to commit substantial funds of its own, or else no banker or brokerage house would be prepared to grant credit or aid in the flotation of a stock or bond issue.

Thus there exists a paradoxical situation. In order to compete successfully for new markets, the modern oligopolist has to have a fairly substantial cash generation.[3] In order to have that,

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[2] Expansion of facilities is really only one aspect of the problem, although probably the most prominent. Capital requirements may also arise from the equipment becoming obsolescent before it would need replacement on the basis of wear and tear. An example is the automobile industry where capital requirements of retooling for model changes may be a multiple of expenditures on new capacity.

[3] Net income after taxes plus depreciation and depletion. The term cash generation is somewhat more useful in the present context than the term profits. The latter can sometimes be reduced much below their "normal" level by special depreciation allowances, e.g. special war-time allowances, diminishing balance depreciation, etc. Where diminishing balance depreciation is used, the term cash generation should also include the Reserve for Future taxes.

a firm cannot compete on the basis of price as the neo-classical model would have it. As a result we have the widely observed system of price leadership where the price is set so as to strike a compromise between the conflicting requirements of a low price for a larger volume in an expanding market and the need for high cash generation required for financing expansion.[4]

There is, of course, no patent answer just where such an optimum price should be. Miscalculations are quite possible and much depends on one's point of view. In some cases, chances of reaching consensus of opinion as to whether prices of products are too "high" or too "low" are not very good if the disputants are the producers and the buyers.[5] The fact remains that in the event of expanding markets, high cash generation is an essential prerequisite to stay in the running. This is particularly apparent where capital investment required per unit of output is large.

A case in point is the aluminum industry. Most major producers, particularly in North America, are fully integrated. Aluminum Limited, for instance, own extensive bauxite reserves in

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[4] Professor Keirstead, ibid., p. 38 ff. still adheres to a modified form of the profit maximization principle. It may well be, however, that profit maximization and maximization of market share are incompatible. If that is the case, the former would not be a motivating factor in business behavior.

[5] A recent example of this was the increase in the price of newsprint. The major Canadian paper mills claimed that in this era of high prices they simply could not earn enough to finance much needed expansion of capacity. Since their customers, mostly U.S. newspapers, represented an unusually vociferous group of buyers, considerable public - and international - clamor arose.

British Guiana, Jamaica, and French West Africa. It owns alumina plants at Arvida and in Jamaica, and extensive power installations to furnish the electricity required in the reduction plants. The reasons, incidentally, for such complete integration are not so much found in a desire to "regulate" the market. They are mostly the outcome of technical factors. For one, the major raw materials, alumina and power, have such an impact on total cost that they need to be of known magnitude over a considerable period of time. Here, too, the distinction between a stationary market and an expanding one is important. It is conceivable that an aluminum producer could manage quite well without his own sources of raw materials and power if his output did not have to increase over the years. He could presumably secure his supplies by means of contracts with his established suppliers. This is in fact how most aluminum producers started out in the eighteen-nineties, and some newcomers still do so today. If, however, the recent entries into the industry, and there have been several in the United States during the past decade, wish to capture a larger share of the market, they will in all likelihood integrate more fully in the process.

The need for integration of facilities in the event of expansion is not only a matter of avoiding fluctuations in the price of raw materials but also, and perhaps more important, simply a matter of availability of capacity. Alumina facilities, and particularly power facilities, have to be planned years before the completion of additional pot-rooms. Building the potrooms first and then driving the price of alumina up by bidding for an insufficient supply is obviously impractical. It would take too long for venture capital to flow into the alumina field. There is no guarantee that it would and, even if it did, the timing and the size of capacity created would be much too haphazard.

In the absence of government regulation, the dependence of the aluminum producer on integrated power facilities is even more important. At first glance this seems to be disproven by recent developments in the United States. Many plant expansions and the location of new plants in the Pacific North-West are based on contractual, existing power. But this is almost entirely the outcome of a deliberate policy on the part of the United States Government.

In order to bring into production really large blocks of aluminum capacity, say 100,000 tons or more, the amount of power required is so large as to be not normally available on a contract basis from existing facilities. Given favorable enough terms and a contract covering a sufficiently long period of time, aluminum producers would probably be quite happy to have somebody else invest in the required power facilities. The difficulty, of course, rests with the terms of such an arrangement. In order for aluminum production to be feasible, power has to be cheap, and a low price for power means a low return on the money invested. Private or public capital cannot normally be found in sufficient amounts for that purpose. It is not profitable enough to tie up huge sums over several decades with a fairly low return. Thus large aluminum producers often develop their own power by default because power is not to be had any other way.

A case in point is the Kemano project in British Columbia. When the Aluminum Company of Canada (Alcan) drew up plans for a smelter at Kitimat, it invited the Government of British Columbia to build the necessary power facilities and sell power on a contract basis. It was only after the provincial government had specifically declined to do so that Alcan started to develop power at Kemano on its own.

To get an idea as to the magnitude of capital outlay required for the creation of aluminum capacity, let us look at some recent experience in North America.

There is, of course, no exact figure which would indicate the cost of capacity per ton. Cost of construction varies with time and place and capital expenditure figures published by various companies cover facilities in various degrees of integration. Some additional pot-lines may be constructed to be operated with purchased power and with existing alumina facilities sufficient to satisfy additional smelter needs. This is given expression in some measure by the following figures:

TABLE XII

Capital Requirements of Aluminum Producing Facilities

Company	Capital Invested 1951-1955 $ million	Primary Aluminum Capacity Added Tons per annum	Capital Required per Ton of Capacity $
Alcoa	233	205,000	1,137
Reynolds	174	180,000	967
Kaiser	196.65	228,200	862
Anaconda	65	60,000	1,083
TOTAL	668.65	673,200	993

(Source: Materials Survey: Aluminum, p. IV-2.)

Of the four companies listed, Anaconda had entered the field during the period. This company, until 1955 at least, had not constructed any power or alumina facilities. Thus its per ton of capacity figure may be considered fairly representative for new (as compared with additional) smelter facilities with virtually no vertical integration. Kaiser's and Reynold's are lower in spite of the fact that they include some power and alumina facilities, because they represent plant extensions rather than entirely new plant. Alcoa's figure, although also representing plant extensions, is the highest in the group because of a greater preponderance in their expansion program of alumina and power facilities.[6]

The above cases illustrate various degrees of plant cost, depending on the extent of vertical integration, and whether facilities are additional to existing ones, or entirely new. Anaconda attempts - at least at the outset - to do without vertical integration. As a result Anaconda probably will not be able to grow as rapidly as the others.

An example from the other end of the scale is provided by Aluminum Company of Canada's Kitimat project. Here the first stage of 91,000 tons was completed in 1954 at a total cost of some $300,000,000 but these should not be interpreted as suggesting a capital investment in excess of $3,000/ton of capacity. This first stage included some components of power facilities adequate to support a production of about 330,000 tons. Thus, in order to arrive at a more realistic cost per ton of capacity figure, we should consider actual and estimated

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[6] Ibid., p. IV-2.

expenditures to bring capacity to 330,000 tons:

1951 - 1955	$329 m.	Kitimat and Kemano
" "	39 m.	Alumina facilities
1956 - 1959	$180 m.	Kitimat and Kemano
" "	55 m.	Alumina facilities
	$603 m.	

The above figures would indicate that by 1959 investment per ton will have been about $1,840/ton capacity. This compares with an investment in Quebec prior to 1952 of only $1,300/ton.[7] By comparison, the cost of construction of steel capacity has been estimated at between $100 and $150/ton of capacity.[8]

Taken by themselves, without any reference to total capacity brought into operation, cost/ton of capacity figures are of course not very meaningful. It is only when viewed in conjunction with absolute (rather than relative) increases that the cost of construction/ton figure gives an indication as to the magnitude of capital which a corporation should have to procure in order to sustain increases in capacity. Unfortunately, no capacity figures for the Canadian producer which would be consistent over the years are available. As an approximation, however, the actual output figures in Table XIII should suffice in the present context.

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7 It would be difficult to determine how much of the difference is due to higher prices and how much is due to the remoteness of Kitimat. It should be remembered that the Saguenay district had railroads and highways when the first pot-lines were built. In Kitimat, on the other hand, men and materials - initially at least - had to be flown in.

8 Materials Survey: Aluminum, p. IV-1.

TABLE XIII

Production of Primary Aluminum in Canada

Year	Tons	Increase over Period	Period Covered (Years)	Average Tons per annum	Per cent Increase over Period
1905	1,200				
1915	9,200	8,000	10	800	670
1925	15,600	6,400	10	640	70
1929	46,200	30,600	4	7,650	195
1934	17,600	28,600	5	5,700	62
1939	82,500	36,300	5	7,270	200
1943	495,000	412,500	4	103,000	500
1946	192,500	302,500	3	101,000	61
1950	396,000	203,500	4	50,800	105
1956	620,000	224,300	6	37,400	57

Source: Alcan Submission to Gordon Commission, op. cit., p. 15.

When compared with the magnitude of increases during and after the war, production increases prior to World War II are rather modest. The question now arises as to how the increased capacity reflected by the production figures given below has been implemented.

The largest pre-war expansion period ended with the Great Depression. Aluminum facilities in Canada were owned by Alcoa until 1928. Separate balance sheets for the Canadian smelter are not available before 1928, making it impossible to know the source of capital invested in Canadian facilities. Mr. Wallace,[9] however, points out that Alcoa's expansions have been financed largely from own funds. It therefore seems probable that much of the money invested in Canada by Alcoa was earned in similar fashion.

Since the creation of Aluminium Limited, however, the mode of the Aluminum Company of Canada's financing can be seen from Tables XIV and XV, which give a Source and Application of Funds Statement worked out from the published annual balance sheets of the company.[10]

One thing stands out rather clearly from Tables XIV and XV. During the depression there was no expansion and concomitant insignificant cash generation. There were since then mainly two periods of substantial expansion, during World War II and during the nineteen-fifties. Let us consider each one of these in turn.

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[9] Op. cit.

[10] No balance sheets for the Aluminum Company of Canada (Alcan) were available prior to 1943. Prior to that date, however, Alcan's operations figured in Aluminium Limited's consolidated balance sheets even more prominently than they do today. Thus it can be assumed that for the present purpose a Source and Application of Funds Statement for Aluminium Limited prior to 1943 is comparable to one for Alcan after that date.

TABLE XIV

Aluminium Limited, Source and Application of Funds Statement, 1931-1942 (in millions of $)

	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942
Source												
Cash generated	.3	.5	1.6	1.2	2.3	3.7	9.9	13.5	17.2	13.0	34.1	67.1
Debt	1.5						2.8			29.5	98.9	57.3
Common Stock	.6					1.1	4.0		3.2			
TOTAL	2.4	.5	1.6	1.2	2.3	4.8	16.7	13.5	20.4	42.5	133.0	124.4
Application												
Plant, etc.	10.5	.2	.8	.1	1.9	2.9	5.7	3.8	6.3	24.8	86.3	106.2
Work. Cap.	9.1	.2	.5	.6	.8	1.2	3.5	3.3	.7	9.6	37.4	9.1
Repayment, Debt		.5	.5	.4	1.2	.7		5.4	7.1			
" Pref. Stock		.2		.3			4.6					
Dividends	1.0	.2					3.5	.5	6.8	6.5	9.1	8.0
Miscellaneous			.2				.6	.5	.5	1.6	.2	1.1
TOTAL	2.4	.5	1.6	1.2	2.3	4.8	16.7	13.5	20.4	42.5	133.0	124.4

Source: Aluminium Limited, Annual Financial Statements.

TABLE XV

Aluminum Company of Canada Ltd., Source and Application of Funds Statement, 1943-1956 (in millions of $)

	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
Source														
Cash generated	81.2	68.0	11.6	15.1	20.7	29.1	30.4	38.4	46.9	51.5	64.5	60.2	76.4	85.9
Debt						.7		44.5	23.1	107.3	15.0	38.6		37.9
Banks											25.7			
Common Stock										30.0		8.0	12.0	
Pref. Stock	15.0										30.0		60.0	
TOTAL	96.2	68.0	11.6	15.1	20.7	29.8	30.4	82.9	70.0	188.8	135.0	106.8	148.4	123.1
Application														
Plant, etc.	56.4	6.7	.7	3.3	7.2	6.5	5.4	1.6	105.3	174.7	101.8	34.5	47.3	85.8
Work. Cap.	17.4	9.5	26.9	.5	4.1	4.9	2.7	56.2	58.0	1.4	16.2	29.4	36.0	9.7
Repay't, Debt	13.1	43.0	31.0	1.1	1.4		3.5						10.9	
" Pref. Stock													30.0	
Banks												25.7		
Dividends	9.8	9.8	9.8	14.0	15.6	18.6	18.6	18.5	22.1	15.5	16.9	17.1	22.3	27.2
								4.9*						
Miscellaneous	.5	1.0	1.7	3.8	.6	.2	.2	1.7	.6		.3	.1	1.9	.4
TOTAL	96.2	68.0	11.6	15.1	20.7	29.8	30.4	82.9	70.0	188.8	135.0	106.8	148.4	123.1

*Dividend in kind (stock of subsidiary)

Source: Aluminum Company of Canada Ltd., Annual Financial Statements.

Although war-time expansion overshadows even that of recent years, it cannot be mustered to lend support to the present line of argument. As can be seen from the above Source and Application of Funds Statement, cash generation during the war years was rather high. But this was not due to the producer's judgment as to how best to balance cash requirements against long term growth goals. Productive capacity had to be augmented on very short order and cost of construction as well as of operation of possibly inefficient units were of little significance. Substantial funds were provided by Allied governments on a loan basis. Also, war-time accelerated depreciation allowances allowed the Aluminum Company to generate enough cash to ensure the repayment of most of the Company's government obligations over the period of a very few years.

The price charged for aluminum during the war, and war-time special depreciation allowances, have not remained unchallenged. In June of 1943, Mr. Coldwell alleged in the House of Commons that financial relief afforded the Aluminum Company constituted exorbitant war profits at the expense of Allied governments and that special depreciation allowances on capital assets constituted a "gift" to the corporation.[11] A Special Committee was set up to investigate these charges. This committee felt that in view of the severe cut-backs in production to be expected after the war, sufficient profits to write off war-time assets over a short period of time were justified. Cutbacks in due time did not occur to the extent expected during the war, but even so, at least some of the war-time additions had to be dismantled again.

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[11] House of Commons Special Committee on War Expenditures. 3rd Report, 1943, pp. 111/113.

However, the company was left with the giant Shipshaw powerhouse which proved invaluable in the expansion experienced since 1948.[12]

Thus the only period which is of particular interest in the present context are the years 1949 to 1956. Prior to 1949, excess capacity existed in spite of the dismantling of some facilities in 1945. Unfortunately the dividing line between taking up excess capacity and the commencing of additional capacity is rather blurred, but by and large it can be assumed that production increases from 1946 to 1948 were forthcoming from excess capacity.[13]

Thereonafter, however, increases in output came forth from additional production facilities. The financing of this expansion is reflected in Table XVI.

These results are rather interesting. Treating cash generation - after servicing of debt - as belonging to the shareholders, ownership funds accounted for 60 per cent of all funds used, with a

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[12] One writer sees great social injustice in this. She describes Shipshaw as "representing public subsidy for uncontrolled private enterprise, akin to early American railroading". The alternative she suggests is patterned on the Tennessee Valley Authority. (Charlotte F. Muller: Light Metals Monopoly, Columbia University Press, 1946, p. 95.) Without wishing to enter into the time-honored argument of public versus private power, Shipshaw is mentioned here because it has some bearing on a later part of the present thesis. What Miss Muller has failed to see in her evaluation of power owned privately by aluminum producers is the importance of where the power is located: i.e. Whether there exist any true alternatives to the use of power for aluminum reduction. It would seem rather pointless to be concerned over privately-owned power in a region with no genuine alternatives for the use of such power.

[13] Source and Application of Funds Statements for Alcan show net expenditures on fixed plant and equipment of $3.3 million in 1946 and $7.2 million in 1947. These figures are net of retirements. Gross expenditures on improvement of existing facilities may therefore have been higher.

TABLE XVI

Aluminum Company of Canada Ltd. 1950-1956

Source and Application of Funds Statement - Summary

(in millions of dollars)

Source		Percentage	Net of Debt Retired	Percentage
Cash generated	$423.8	50	$423.8	53.5
Debt	266.4	31	255.9	32.5
Common Stock	50.0	6	50.0	6.5
Pref. Stock	90.0	10	60.0	7.5
Banks	25.7	3	-	-
TOTAL	855.9	100	789.7	100.0
Application				
Plant, etc.	$555.9)	75	$644.0	82
Working Capital	81.9)			
Repay't, Debt	10.5)			
" Pref. St.	30.0)	8		
" Banks	25.7)			
Dividends	140.6	17	140.6	18
Miscellaneous	5.1	-	5.1	-
TOTAL	855.9	100	789.7	100

Source: Aluminum Company of Canada Ltd., Annual Financial Statements.

little over 10 per cent thereof being equity money raised publicly. The remaining 40 per cent are debt and preferred stock.[14] In absolute terms, these 40 per cent are tantamount to $316,000,000 which is a lot of borrowing for a company which has had average gross fixed assets[15] over the period of $665,200,000.

To summarize, a study of the Canadian aluminum producer's mode of financing large scale expansion seems to bear out our contention that high level of cash generation and expansion of productive facilities cannot be separated. In the case of the Aluminum Company of Canada Ltd., borrowings amounted to almost one half of average gross fixed assets. It is doubtful that more money could in fact have been raised in the capital market. In Alcan's case, because of the high capital requirements per ton of capacity, the selling price seemed to have been set rather fortuitously. It provided for a combination of "borrowing to the hilt" and sufficient cash generation to carry out the expansion plans of the company. Thus sufficient funds were available, and yet prices were not too high to impede the rapidly expanding demand.

Also very interesting is the fact that of total net funds generated and borrowed, more than 80 per cent were expended on plant expansion and working capital, and only about 18 per cent on dividends. Or looking at it another way, dividends paid over the period were one-third of total cash generation. Since Alcan's dividends are by far the

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[14] Although strictly speaking, preferred stock is equity, in its economic significance it is really debt rather than equity.

[15] Gross of depreciation, but net of retirements.

largest source of earning to the parent company, Aluminium Limited, not all these dividends reached the ultimate individual shareholders. During the same period Aluminium Limited carried out expansion through its foreign subsidiaries in fabricating facilities in Europe, and mining and smelting facilities in other parts of the world.

Before leaving the present line of argument, and in order to forestall misinterpretation, we should mention that the above observations cannot claim to have general validity. We have looked only at one industry and, although it should not be surprising if the present argument could be shown to apply to other industries as well, we can go only so far as to say that at least the industry which we have set out to study does not disprove it. It may well be worth a separate study to determine the more general validity of the above remarks on the interaction of cash generation, expansion, and price policies.

CHAPTER SEVEN

MARKET POSITION AND MARKET POLICY. THE PRE-WAR ERA

This chapter returns to another point which was considered in brief further above. It was claimed that in a rapidly expanding and volatile market, socially useful competition is forced upon the oligopolist in order to maintain his relative share of the market, and that in the process, competition tends not to be limited to new markets but spreads to existing ones. It was mentioned also that such competition does not take place primarily on the basis of price, but rather through the expedient of price leadership, at a uniform price.[1]

We now wish to introduce an important qualification to this contention, again a qualification which seems to bear out the conviction that in an expanding market it is possible to detect some of the more important benefits so familiar to us from the classical model. The previous chapter contained a discussion of the conflict between the need for high cash generation on the one hand, and the need for a low enough price for continued product acceptance and consequent market expansion on the other. In most oligopoly situations there will be low cost and high cost producers sharing a common market, and where that is the case, the question of course arises as to who exerts the most influence on the price finally accepted by all. Is the high cost producer powerful enough to enforce a high enough price to give him a substantial return, and the

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1 This appears to hold true not only in basic industries with little or no product differentiation, but also in consumer's durables. A case in point is the automobile industry where the cross elasticity of demand for comparable cars is so high that a price differential of as little as $25.00 may sway a customer's choice. (Kaplan, op. cit., p. 163.)

low cost producer a return greater than is needed for plant expansion? Or does the low cost producer have the stronger hand? Chances are that in such a situation the high cost producer will lack the necessary strength to enforce a high price policy on the low cost producer against the latter's wishes.

A high cost producer has high operating cost, particularly where heavy investment per production unit is required, at least in part because of higher construction cost. Thus at a given price, he is at a double disadvantage when compared with the low cost producer. For a given increase in capacity he requires more funds, and at the same time his cash generation per volume of sales is lower because of his high operating cost. Consequently, in the absence of artificial barriers, a low cost producer should find it in his interest to pursue a low price - high volume policy. He is better equipped to take advantage of such a policy, and thus is able to expand more rapidly than his competitor. Furthermore, unless the low cost producer's size is very small, he will have the economic strength to enforce his wishes on his high cost brethren. As in the previous chapter, these are tenets for which general validity cannot be claimed but, by and large, they seem to hold true as far as the Canadian producer of aluminum is concerned.

In order to evaluate the Canadian producer's market behavior in the past, and in order to see whether this case "fits" the above explanations, one should keep in mind two features which influenced the behavior of the Canadian firm in the early years to a considerable extent.

1) Alcan was run by Alcoa until 1928.

2) Until the construction of reduction facilities at Arvida, Alcan was not a low cost producer, it was not even a producer of relatively large size.

Prior to the Canadian firm becoming independent from Alcoa, it became party to two European cartels. But before turning to the cartel arrangements proper, let us briefly look at the producers with which Alcan, then the Northern Aluminum Company, associated itself.

As mentioned earlier, the exploitation of the Hall-Heroult process was taken up in Europe by several companies. They were:[2]

Aluminium Industrie, A.G.
Neuhausen, Switzerland.

Societe Electo-Metallurgique Francaise
(Ugine) La Praz, France.

Societe Industrielle D'Aluminium, France
(later absorbed by Pechiney interests).

British Aluminium Company
Foyers, Scotland.

Of these, only the British Aluminium Company was established solely as a fully integrated producer of aluminum. The three continental producers, like Alcoa, started out by purchasing most of their input requirements. But unlike Alcoa, they were already well established firms in the chemical industry before embarking on aluminum production, and in fact with one of the two French producers, Ugine, aluminum is a sidline even today.

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[2] Materials Survey, op. cit., p. II-1.

The general conditions and atmosphere under which the European firms operated were quite different from those in North America. First, there was no single, large domestic market as in the United States but rather a very complex system of domestic and "free" markets. A domestic market in which one of the major producers was located, the "free" markets were those where no domestic producers existed. Prior to World War I, Germany was the outstanding example of the latter type. Second, this division between domestic markets, which the domestic producers considered their home ground, and "free" markets was complicated by the fact that one of the large producers was a Swiss firm with a very limited domestic market. The result was a rather complicated and often conflicting set of market policies. Third, most important and perhaps directly following from second, the attitude of Europeans towards competition has traditionally been quite different from that of North Americans.

The ideological frame of reference which enabled the passage of anti-trust laws in the United States as early as 1890 was one of firm belief in competition and equal opportunity for everyone, economic as well as political. In Europe, particularly on the Continent, many of the feudal practices of the Middle Ages had been adapted successfully by the early industrial leaders to create an atmosphere of vested interest and privilege. The fact that cartels could flourish so well in Europe was no accident. Cartels could thrive only where the economic, social and political thinking was in some measure favorable to them.

When some of the leading chemical concerns in France and

Switzerland entered upon the production of aluminum, it is little surprising therefore to see the principals attempting to bring "order" into the market "chaos" by means of cartels.

Attempts to divide up the market began to bear fruit as early as 1901 when the first aluminum cartel came into being. It was a cartel of a classical type in that it included all the restrictive features normally associated with such an organization. Its membership included all the major European producers, Neuhausen of Switzerland, the two French companies, the British Aluminium Company, and the Northern Aluminum Company of Canada. The latter had originally been incorporated as the Royal Aluminum Company, but because of a statute forbidding the use of "Royal" in Dominion trade names the name was changed in 1902 to Northern Aluminum Company.[3] This represented a rather impressive array since these companies accounted for about 90 per cent of the productive capacity outside the United States.[4]

The agreement provided for a division of the world market into "reserved" and "free" areas. In practice, however, this distinction was not quite as important as it may seem since sales quotas were established and allocated on the basis of percentages of the two types of market areas combined. These quotas were accorded as follows:[5]

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3 Muller, op. cit., p. 104.

4 Ibid., p. 103.

5 Marlio, op. cit., p. 11.

	Per Cent
Neuhausen	48.4
Northern Aluminum	21.0
British Aluminium	12.9
French group	17.7
	100.0

Neuhausen at that time was by far the largest producer, a fact which is faithfully reflected in the quota allotment. Northern's quota, on the other hand, was out of all proportion to the size of its output which in 1901 was probably well below 5 per cent of world production. Rather than reflecting its own size, Northern's quota more likely reflected the influence which Alcoa could command in the European market.

This first cartel is a classic one, not only as regards intent and organization, but also as regards policies pursued. There is reason to suspect that even in these early days there was a struggle between the low cost and the high cost producers. The latter were in favor of, and succeeded in having implemented, a high price policy. It is difficult to say today with authority who among the cartel members advocated a high price policy. One writer, who was intimately associated with the first as well as later aluminum cartels, Louis Marlio,[6] is careful not to point an accusing finger at any particular producer. He does say, however, that the Swiss and the British interests had the final word on price increases under the cartel agreements. This gives rise to the suspicion that they were the high price advocates.

As a result of the high price policy, prices, which had ranged

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6 *Ibid.*, p. 12.

originally from frs. 2.75/kg for lots of fifty tons or more to frs. 2.95/kg for lots between one and five tons (24.2¢/lb. to 25.9¢/lb. at then prevailing rates of exchange), rose to frs. 4.35/kg (38.1¢/lb). At this price the cartel members must have made such staggering profits that many outsiders entered the field in spite of the high cost of entry. In fact, when the first aluminum cartel was dissolved in 1908 in acknowledgement of its failure, there were more outsiders (seven) than cartel members and the output of the outsiders accounted for about 60 per cent of the total.

This is an extremely interesting result. As was their custom, a number of large European concerns, finding themselves with a promising new product on their hands, employed the traditional profit maximization principle, only to find that, in the face of increasing demand, outsiders were ready to step in and supply the product at lower prices if the cartel members were not prepared to do so. The first cartel failed in its objective rather spectacularly, and this must have encouraged the advocates of a low price-high volume policy. Marlio[7] claims that it was the French group which had advocated the latter policy and which finally had forced the dissolution of the cartel.

With no agreement possible between the major participants, a period followed with conditions similar to those prevailing prior to the creation of the first cartel, and the same forces which had brought about the creation of the first cartel brought about the creation of a second cartel.

The second cartel, which was formed in 1912, still employed

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7 *Ibid.*, p. 13.

essentially the same form of organization as did the first, but there were important differences. A minor streamlining was effected by making no distinction between free and reserved markets. Quotas were expressed in terms of percentages of the total market, with each member being free to sell his quota where he could do so to his best advantage.

There were two more important differences from the first cartel. First, the influence of Neuhausen, the probable high price advocate, had declined sharply and more weight in the new cartel was given to the French group:[8]

	Per Cent
French Group	38.9
Neuhausen	21.4
British Aluminium Co.	16.0
Northern	16.0
Anglo-Norwegian	3.9
Societa Italiana	1.9
Aluminium Corporation	1.9
	100.0

Second, the price was set at frs. 2.00/kg where it remained until the dissolution of the cartel in 1915. As a consequence, aluminum output during that time almost doubled.

Alcan's role in the first two European cartels is rather difficult to assess. However, the motives in joining the first cartel seem to be somewhat more clearly recognizable than the motives for joining the second cartel. Prior to World War I, Alcoa had taken an active interest in the European markets. Since Northern was free to

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8 *Ibid.*, p. 17.

enter into cartel agreements whereas Alcoa was not,[9] it was logical that Alcoa should use the Canadian output in its European markets.

During the period between the two cartels, Alcan did not do well when compared with its European competitors. As mentioned before, it is doubtful that Shawinigan Falls had any particular cost advantage, and with the combination of tariffs and Atlantic transport cost, it was at a disadvantage in the European market. In 1912, Alcan joined the second cartel on a somewhat reduced scale. In the inter-cartel period most of Alcan's output had been absorbed in the United States and, when Alcan joined the second cartel, the relative importance of the American market declined only slightly. As can be seen from Graph III, the European market did regain some, but not very much, of its original importance. It is rather academic to speculate what would have happened in the absence of World War I; for the present purpose it suffices to observe that the war did terminate the pre-war market pattern.

In evaluating Alcan's historical markets one encounters a rather frustrating difficulty. One can observe the relative ascendancy or the decline in importance of a particular market area, but it is almost impossible to say whether the observed phenomena are the result of deliberate policies on the part of Alcoa or whether they developed from forces outside the company's influence. In all likelihood, it was a mixture of both with the independent forces having the edge over deliberate company policies. There is little doubt that Alcan's

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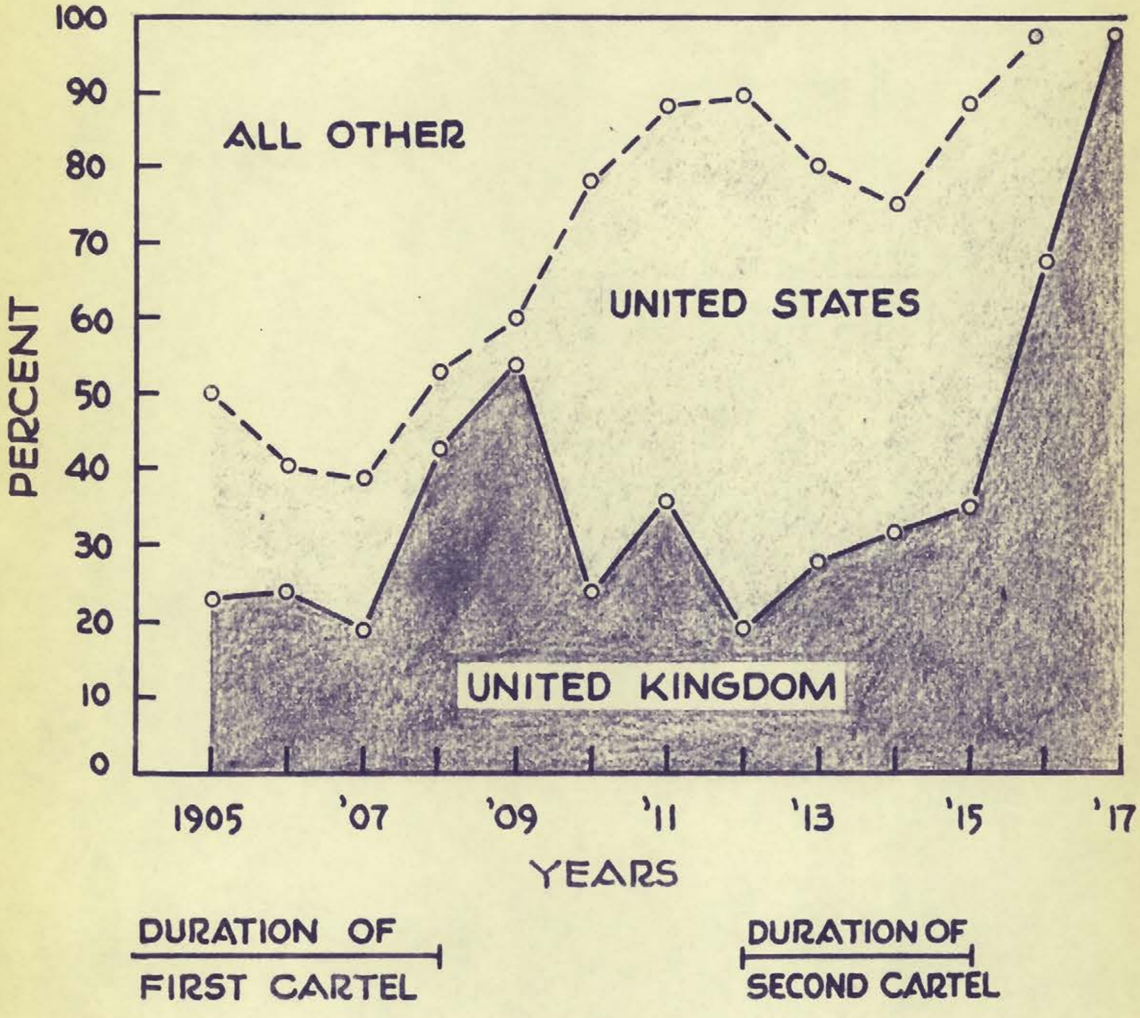
[9] Wallace, op. cit., p. 126, mentions that in a consent decree Alcoa successfully defended its subsidiary's right to enter into marketing agreements as long as they did not affect the United States market.

GRAPH III

Canadian Exports of Aluminum to Major Market Areas as Percentage of Total Exports 1905 - 1917

Source: Government of Canada,
Dominion Bureau of Statistics,
Trade of Canada,
Volume II, Exports.



100
90
80
70
60
50
40
30
20
10
0
PERCENT
ALL OTHER
UNITED STATES
UNITED KINGDOM
1905
'07
'09
'11
'13
'15
'17
YEARS
DURATION OF
FIRST CARTEL
DURATION OF
SECOND CARTEL

extensive sales in Europe during the regnum of the first cartel were due to the Canadian producer's membership in that cartel. But there is no basis for determining whether Alcan was in the high price or in the low price camp of the first cartel. Shawinigan Falls was probably not a low cost smelter but, on the other hand, its basic policies were undoubtedly formed in Pittsburgh and Alcoa, judging by the price policies pursued in the United States, may well have advocated a policy of somewhat lower prices than the first cartel in fact pursued.

In the end, the second cartel, or rather Alcan's membership therein, proved to be unsuccessful in re-establishing the prominence which the European market had once held for the Canadian producer. As can be seen from Graph IV, with the exception of two years immediately following the war, the importance of the European market had quite receded into the background as far as Alcan was concerned.

The decline in the relative importance of the European market is rather faithfully reflected in the less formal relations between Alcan and the European producers. In 1923 an agreement as to prices was entered into by all the major European producers as well as Alcan. While this price agreement was in effect, prices fluctuated from about 2.04 to 2.80 francs.[10] During this time, Alcan was able to increase its sales in Europe, but only temporarily. In 1926 the third cartel was formed by the Europeans, but this time Alcan did not join. By 1928, by far the largest part of its output, about 80 per cent, was sold in the United States.

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[10] Gold francs, as estimated by the French Aluminum Company. See: Marlio, <u>op. cit.</u>, p. 125.

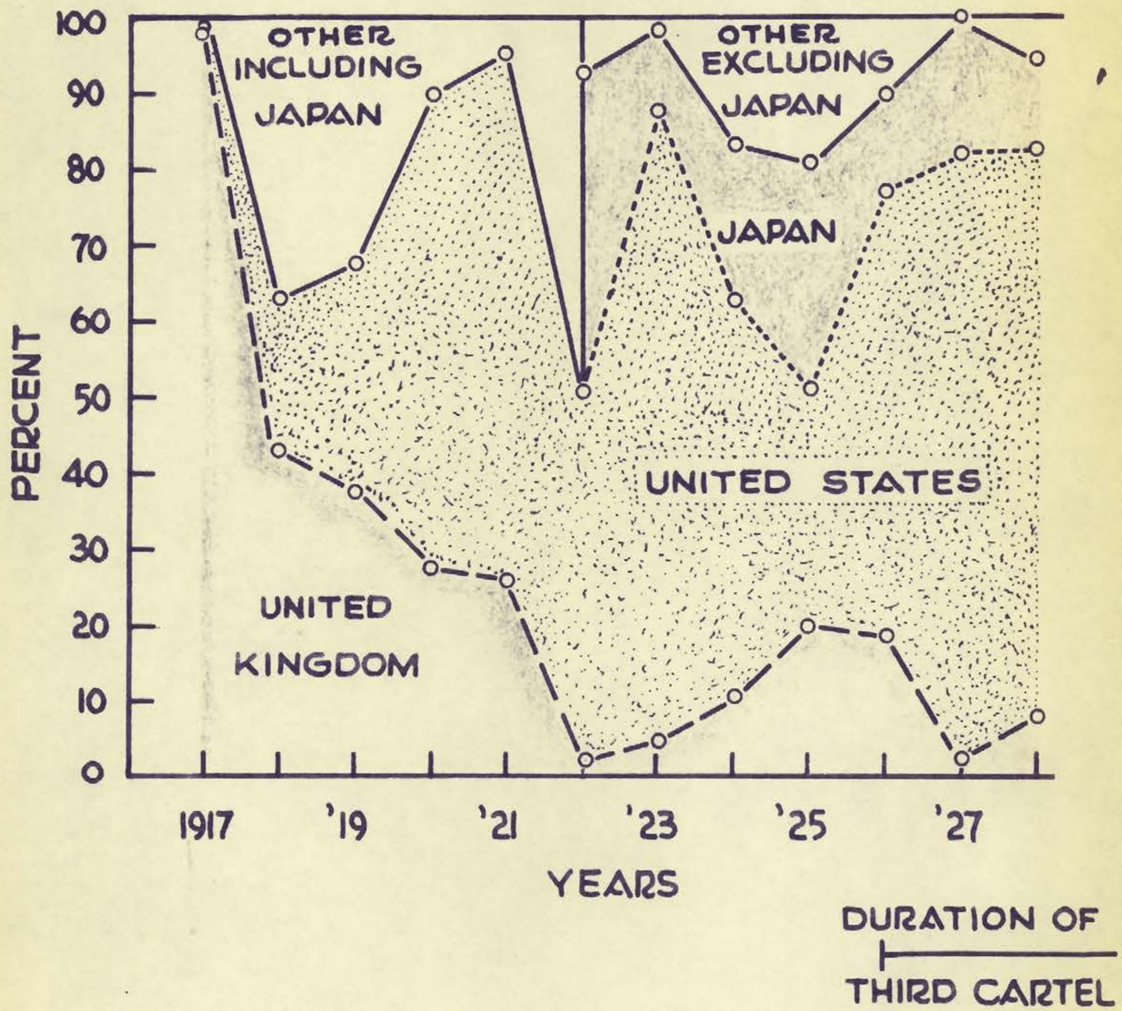
GRAPH IV

Canadian Exports of Aluminum to Major Market Areas

as Percentage of Total Exports 1917 - 1928

Source: Government of Canada,
Dominion Bureau of Statistics,
Trade of Canada,
Volume II, Exports.

GRAPH 4.



100
90
80
70
60
50
40
30
20
10
0
PERCENT
OTHER INCLUDING JAPAN
OTHER EXCLUDING JAPAN
JAPAN
UNITED STATES
UNITED KINGDOM
1917
'19
'21
'23
'25
'27
YEARS
DURATION OF
THIRD CARTEL

We have attempted an evaluation of the development of Alcan's markets prior to 1928. The early development is of interest because it cannot be entirely divorced from subsequent events. Our main concern, however, is with what happened after 1928. This year is the important point of departure because of the creation of Aluminium Limited. In addition, the completion of the Arvida plant two years before established for the Canadian producer a more important position than he had enjoyed previously. Although data on this point are scant, there is little doubt that Arvida established Alcan as a low cost producer. Furthermore, Arvida established the Company as a large volume producer. Prior to the completion of Arvida in 1926, Canadian output amounted to 8 per cent of world output. By 1927, it had jumped to 20 per cent.

While still a subsidiary of Alcoa, Alcan had been able to develop an important new market in Japan, apparently very much to the distress of the Europeans. Aluminium Limited continued to sell in this market but in 1930, upon the request of the Europeans, entered into an agreement with them as to quotas to be sold in Japan by the Europeans on the one hand, and by Aluminium Limited on the other. According to the agreement, Aluminium Limited was to be the sole sales agent in Japan, and quotas were agreed upon terms favorable to the Canadians. From 1931 to 1935 Aluminium Limited was to furnish 34.2 per cent of the Japanese requirements but from then on the Canadian company's share was increased by stages so that it reached 60 per cent in 1938.

When the depression struck, it dealt Aluminium Limited a more serious blow than it did the older producers. As an independent company, Aluminium Limited was only one year old and, contrary to some inferences on the subject, it was financially in a highly vulnerable position. Second, just prior to the formation of the company, most of the Canadian metal was sold in the United States. After 1928, however, sales in that market declined steadily, as can be seen from Graph V. Aluminium Limited was just settling down to establish itself in major market areas outside the United States when the depression struck. Once again Aluminium Limited found it advantageous to associate with the major European producers. The latter had for some time been unhappy about the Canadians not being members of a more formal agreement. When they succeeded in having Aluminium Limited join them, however, the terms insisted upon by Aluminium Limited represented an important point of departure from previous cartels. The fourth cartel, known as the Aluminium Alliance, was not set up for the purpose of dividing markets. In fact, it was designed to achieve its objective with a maximum degree of commercial and industrial freedom. This objective was to reduce the excessive stocks of metal which most producers had as a result of the depression.

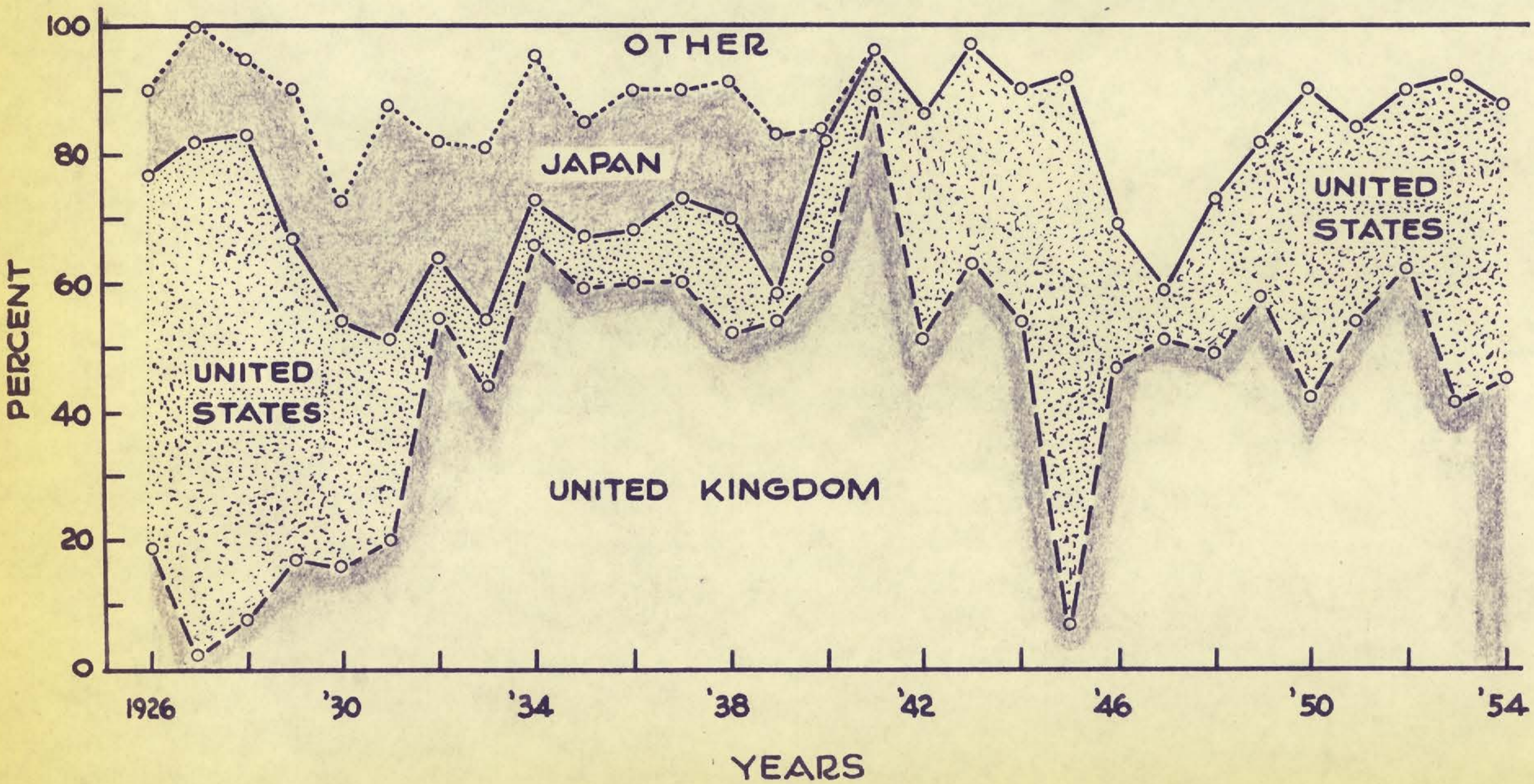
Unlike other industrial activities, aluminum production is for technological reasons not very flexible. If, say, the demand for washing machines or automobiles drops very suddenly, production can be slowed down or halted altogether from one day to the next. Aluminum production cannot be adjusted on such short notice. Closing down pot-lines is simple enough, but starting them up again is both very costly and time-consuming. Thus, if there are fluctuations in demand, it is often better to keep pot-lines in operation and run up inventories of finished ingots. This course is successful only if the drop in demand

GRAPH V

Canadian Exports of Aluminum to Major Market Areas

as Percentage of Total Exports 1926 - 1954

Source: Government of Canada,
Dominion Bureau of Statistics,
Trade of Canada,
Volume II, Exports.



PERCENT
100
80
60
40
20
0
OTHER
JAPAN
UNITED STATES
UNITED KINGDOM
UNITED STATES
1926
'30
'34
'38
'42
'46
'50
'54
YEARS

is temporary. When the Great Depression started, aluminum producers, like everyone else, had no idea that it would last as long as it did and so they continued producing much longer than subsequent developments could justify. As a result, at the time the Aluminium Alliance was established, stocks of the major producers exceeded 16 months of the then prevailing rates of sales. Such a situation forced most producers into a precarious financial position.

The objective of reducing excessive inventory was accomplished by means of production controls. The Aluminium Alliance took the form of a Swiss company, shares of which were purchased by each of the interested parties. Production quotas then depended on the number of shares held by each of the producers. A rather complicated system of buying and selling prices was employed to have all sales of members, from stock at hand or from new production, move through the hands of the Alliance. On the whole, the efforts of the Alliance seem to have been successful, for stocks of members fell from 112,000 tons in 1931 to 65,000 tons in 1935.[11]

Unlike the previous cartels, the Alliance was almost entirely the outcome of a dire emergency. At the beginning of the chapter, the hypothesis was advanced that a low cost producer in an expanding market would find it in his interest to pursue policies of socially useful competition. Prior to the Great Depression, we believe this was largely the case with Aluminium Limited. This company had been able to develop markets in Japan and, although on a smaller scale, in India and Russia

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11 Marlio, ibid., p. 42.

largely in competition with the Europeans. This area of competition free from marketing arrangements existed throughout the period of prosperity from 1922 to 1930. Only when the Great Depression made itself felt did Aluminium Limited find it advantageous to enter into a marketing agreement. The same seems to have been true of the company's participation in the fourth cartel. During the period of prosperity preceding the Great Depression, Aluminium Limited was not a member of the then existing third cartel. When it did enter into another cartel agreement through membership in the Alliance, it was in response to the requirements of a severe crisis.

This severe crisis, however, was essentially over for the major producers by about 1935. Not only had stocks of ingot been reduced to a more manageable level, but sales began to improve as well. World production, which had been as low as 152,000 tons in 1933, had risen again to 256,000 tons in 1935. Mr. Marlio[12] claims that it was Mr. E.K. Davis, the president of Aluminium Limited, who, after having stressed the temporary nature of production quotas all along, now insisted on their discontinuation. His wishes could not be ignored since membership in the Alliance could be cancelled on six months notice, thus giving Aluminium Limited freedom to produce - and of course sell - as much as it wished. According to Mr. Marlio, Mr. Davis in fact gave notice that his company would withdraw if production quotas were to be continued.

Aluminium Limited's motives for this action are quite clear: The company had begun to realize that a low cost producer free of quota

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[12] Ibid., p. 47.

restrictions could expand more rapidly. Canadian production, for instance, rose from 18,700 tons in 1926 to 46,200 tons in 1929. Mr. Davis made his point clear when he acquainted the chairman of the Alliance with the Canadian attitude:[13]

> " I venture to repeat, on account of its importance to us, the formula on which depends Aluminium Limited's continued observation of the Foundation Agreement. It is that we are constrained to say that we need to have, in every market, in addition to the free hand we have always had to sell as much as we please at whatever price we please, also the right to produce as much as we think best."

Consequently, the production quotas were dispensed with and replaced by a royalty system. This was not of long duration either, since some time before the outbreak of World War II the Alliance became dormant. It was not legally dissolved until after the war, but it ceased to operate well before.

Summarizing now Aluminium Limited's market behavior until the outbreak of World War II, there appears to be no evidence of Aluminium Limited being guilty of monopolistic behavior. On the contrary, the findings support the contention that a low cost producer in an expanding market will display all the criteria of socially useful competition so familiar from the classical model. Throughout the World War II era, Aluminium Limited had been a party to several price agreements, not all of which have been discussed here. These price agreements, at least under the influence of low cost producers, were not instruments of market exploitation. The results were no

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[13] Marlio: ibid., p. 47.

different from what can be observed today by the common practice of price leadership. In effect, we have price maintenance today as we had it before the war, only today it has gone "underground" in that the practice of formal agreements is no longer used. Naturally, where price maintenance exists, the danger exists that the dominant firm, or firms, extracts undue profits. As said before, the scope of the anti-trust law should therefore not be pared. But we do believe that the above review of historical events supports the contention that price maintenance in an expanding market, if dominated by a low cost producer, is unlikely to be an instrument of monopolistic exploitation.

PART III

CHAPTER EIGHT

MARKET POSITION IN THE POST-WAR ERA

The preceding analysis has been largely occupied with events of the past. Unquestionably, an examination of the past is essential for any realistic evaluation of what can be observed today. Nevertheless, this link with the past should not deflect attention from the fact that the Canadian aluminum industry today is fundamentally different from what it was for close to forty years.

The point of departure is 1939, the year when the Second World War broke out. The events of the war, in as much as they affected the augmentation of Canadian ingot capacity, have already been dealt with in an earlier chapter. The size of additional output, and the speed with which it was accomplished, was dramatic. The disposal of this war-time output, however, held no element of surprise. It accurately reflected historical events as they happened.

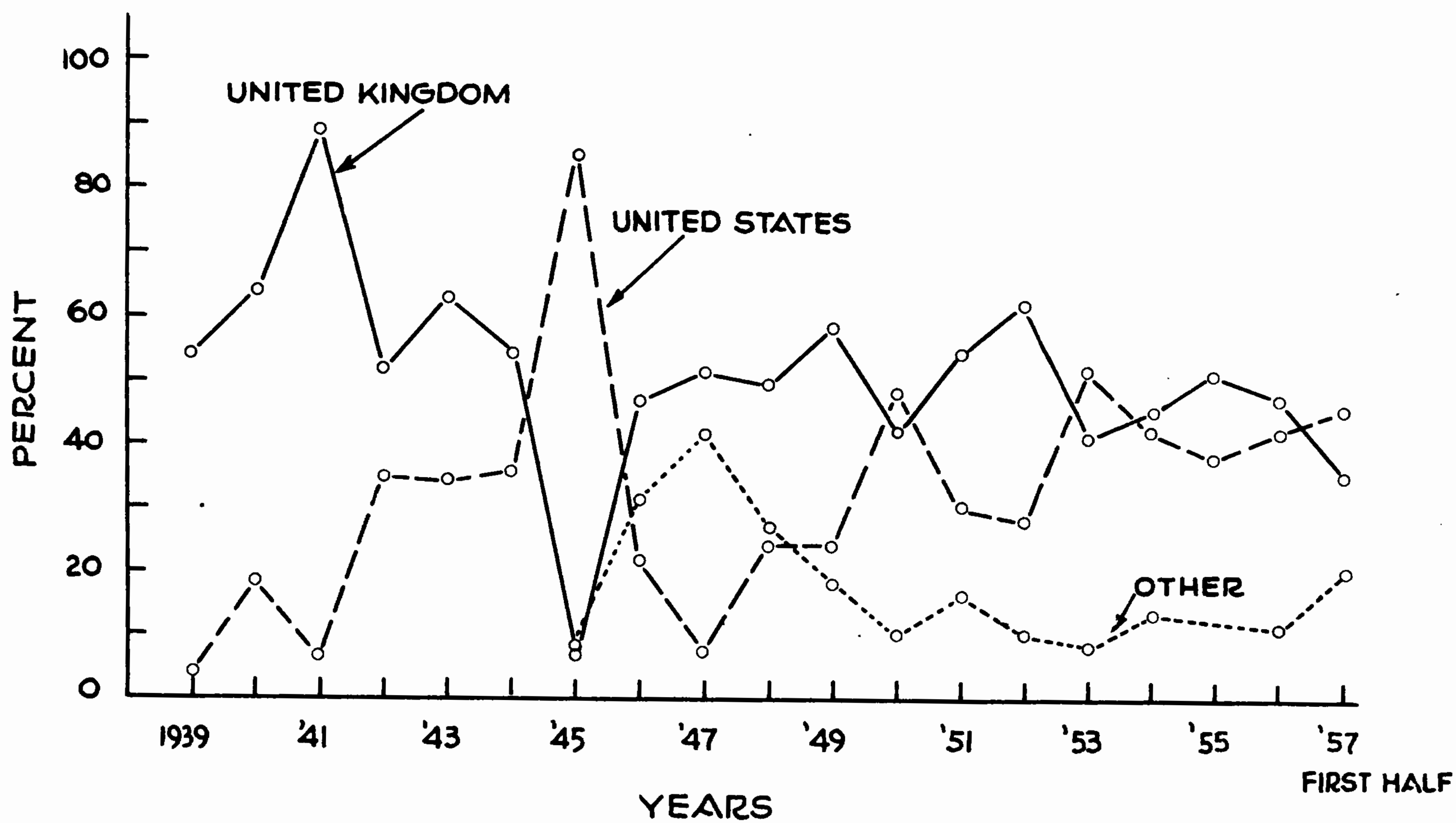
England fought its most crucial battle for survival from 1939 to 1941. During that time, as can be seen from Graph VI, England received an increasing share of Alcan's increasing output. In 1941, the Japanese attack on Pearl Harbor suddenly alerted the American nation to a great emergency for which it was not properly equipped. Consequently, Canada was called upon to supply aluminum required for military purposes in quantities larger than the U.S. domestic industry could hope to supply with similar promptness.

GRAPH VI

Canadian Exports of Aluminum to Major Market Areas

as Percentage of Total Exports 1939 - 1957 (first half)

Source: Government of Canada,
Dominion Bureau of Statistics,
Trade of Canada,
Volume II, Exports.


PERCENT
100
80
60
40
20
0
UNITED KINGDOM
UNITED STATES
OTHER
1939
'41
'43
'45
'47
'49
'51
'53
'55
'57
FIRST HALF
YEARS

Before the war, the Aluminum Company of Canada had been a well established, but relatively small producer. The war catapulted it into the ranks of giant corporations without the benefit of a transition period. Even in 1946, when output dropped to its lowest post-war level, it was still four times as high as that of 1937. Before the war, Canadian aluminum was sold throughout the world with considerable flexibility. From Graph VI it can be understood that the Canadian aluminum people must have seen a return to the pre-war sales pattern in the increasing metal shipments to Europe during the immediate post-war years.[1] With the benefit of hindsight, however, we now know that these sales did not represent a return to pre-war market patterns. The European countries to which these shipments were made had most of their aluminum reduction facilities destroyed during the hostilities, but as soon as economic conditions returned to normal and reconstruction was essentially completed, sales to countries other than the United States and the United Kingdom declined in importance. Since about 1949, metal shipments from Canada to Europe have declined somewhat in relative importance.

The question arises as to whether this is an indication of a long term trend or whether this tendency might reverse itself within the near future. This point shall be of great interest in a later chapter. For present purposes, however, it is necessary to anticipate enough from this later analysis to say that the present

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[1] The category "other" in Graph VI is almost entirely made up of European countries.

insignificance of Europe as a market for metal smelted in Canada is likely to be a permanent one.

Only one feature of the pre-war aluminum industry is to remain with us for sure: by far the largest part of the Canadian output of aluminum will have to be exported.

As for the disposal of the excess of Canadian production over domestic requirements, the United States and the United Kingdom have emerged from the war as by far the most important market areas. Over the recent years, on the average, the two countries absorbed between 80 and 90 per cent of total Canadian exports of virgin aluminum.

A glance at Graph VII will show that these two market areas are today of great importance to the Canadian producer. We also know that aluminum consumption in both these markets is likely to up still further. What will be the Canadian supplier's role in these two markets? On the basis of sales figures covering the last few years, the answer is uncertain. Ever since 1953, Canadian metal sales in the United Kingdom have very roughly been equal to those in the United States. Even if we had a somewhat longer statistical series to observe, it would be unlikely that it would be possible to arrive at any satisfactory conclusions on the basis of sales statistics alone. These figures are the outcome of a number of economic and political factors which we now propose to analyse.

Let us first consider Canada's foot-hold in the United Kingdom. This can best be understood when the following points are considered:

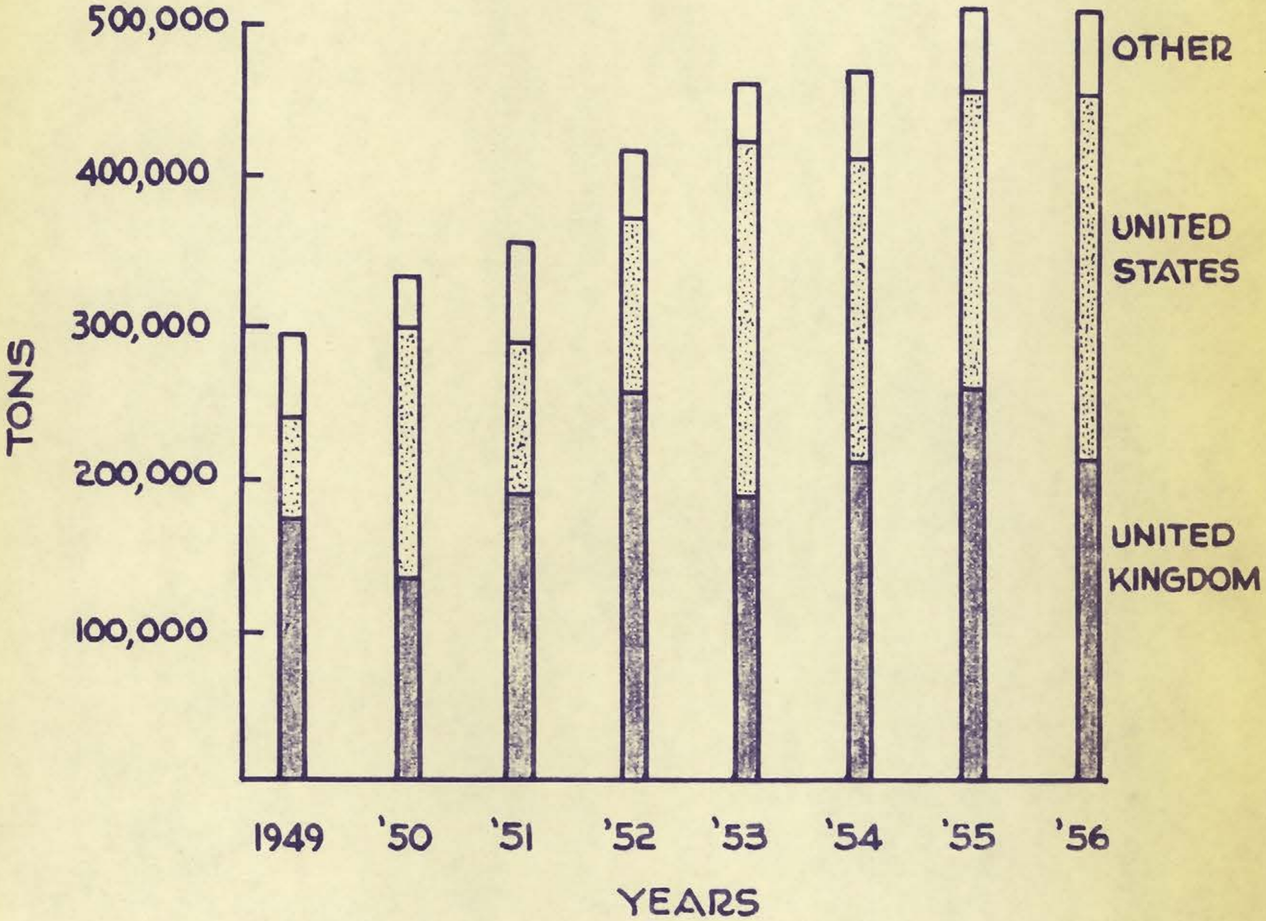
GRAPH VII

Canadian Exports of Aluminum to Major Market Areas

in Short Tons 1949 - 1956

Source: Government of Canada,
Dominion Bureau of Statistics,
Trade of Canada,
Volume II, Exports.

GRAPH 7


500,000
400,000
300,000
200,000
100,000
TONS
1949
'50
'51
'52
'53
'54
'55
'56
YEARS
OTHER
UNITED STATES
UNITED KINGDOM

1) Because of a very marked lack of energy in large enough quantities at sufficiently low prices, England has never had a sizeable primary aluminum industry. Since the recent advent of truly large-scale consumption of aluminum, the sole domestic producer, the British Aluminium Company (Baco) declined in importance. Even in the early years of aluminum, when it was possible to be a fairly influential producer with what would be, by today's standards, a small output, Baco appears to have been in a weak position. The British producer has always been a high cost producer.

2) Until World War II, Canada was by no means the only logical choice for England's imports of virgin aluminum. Like Canada, Norway had traditionally been an aluminum exporting country. In fact, it was the only European country with an industry as heavily dependent on exports as Canada.

However, Norway fell into German hands at an early stage of the war, thus leaving Canada as the only major source for ingot. Canadian pre-war capacity of 90,000 per annum tons was inadequate for British needs. Britain therefore aided in the financing of an additional capacity of 118,000 per annum tons with the proviso that the British Government would have first call on this additional tonnage for 20 years. In the first instance, $55,600,000 were provided on a straight loan basis, with repayment provisions linked to the extent to which this additional capacity was used. Thus through the emergency created by the war, the United Kingdom government acquired a direct financial stake in the Canadian industry.

Since the war, the Canadian company and the United Kingdom government have entered into further, similar arrangements. In fact, total advances from the U.K. Government to Alcan aggregated close to $120,000,000 by the end of 1956. This indebtedness took the form of unsecured, interest bearing notes. In return for these advances, the United Kingdom government holds first call on the Company's production for the following annual tonnages of metal:

Period	Tonnage	Annual Rate
1957	251,000	251,000
1958	303,000	303,000
1959-61	330,600	110,200
1962-70	303,100	33,700
1971-73	55,100	18,300

The agreement further provides that a minimum production capacity of 496,000 tons per annum be maintained until the end of 1970 and 55,100 tons capacity for each of the remaining years covered by the contract.[2]

A contract such as this does not constitute a guarantee that the British Government will always take up the full tonnages on which it has first call. But since repayment is tied to the rate of production maintained, it seems unlikely that England would drop Canada as its main supplier on short notice, even if this were feasible.

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[2] As regards the linkage between interest and principal payment on the one hand, and the level of production on the other, a company source states:

"In respect of each year that the company's ingot production falls below levels specified in the respective notes, the whole or part of the interest thereon, and a portion of the principal thereof, will be abated. So long as the company's annual production of aluminum remains in excess of 496,000 tons, no abatement of interest or principal takes place."

(Aluminum Company of Canada Ltd., Prospectus Apr. 9, 1957.)

The significant factor is that this contract runs out after a number of years, and even before that time the annual tonnages involved become smaller and smaller.

3) The Northern Aluminium Company Ltd., England's largest fabricator, is a fully owned subsidiary of Aluminium Limited. While this in no way insures Alcan's present prominence in the British ingot market, this is a factor in Alcan's favor.

4) Canada is a Commonwealth country. This too is in Alcan's favor. A Commonwealth company operating in England both as an importer and as a fabricator, is likely to be treated as a "domestic" firm. In the United States, for instance, Aluminium Limited is a "foreign" firm, a factor fully exploited by protectionist competitors of the Canadian firm. In England, such difficulties would be less likely to arise.

So far we have considered four points, all of which would seem to strengthen the Canadian producer's hand in the U.K. market. In addition to these points it is, of course, understood that Canadian metal would have to be competitively priced as compared with metal from alternate sources, which it is.

There is another point which may in due time have more weight than the four above-mentioned points taken together. Unfortunately for the Canadian producers, this point militates against the continued prominence of the Canadian metal in the U.K. markets.

Canadian metal must be paid for in dollars. This has been for some time a matter of increasing concern to the guardians of England's gold and dollar reserves.

England's plight in this regard is well known. It has persisted now for many years without showing any signs of fundamental change and the area of agreement on the causes of this problem has been widening.

England's dollar shortage is due only to a minor extent to temporary phenomena which can be expected to rectify themselves in due course. To a larger extent it is due to fundamental, structural changes in the international trade pattern of the country. For some time before the war England had been what writers of textbooks on international trade like to call a "mature creditor nation". As such, its industrial structure had developed to the point where a permanent excess of imports over exports was necessary. Before the war, unlike today, the difference could be financed with the income earned on investment abroad.

World War II and the political and economic events that followed wrought havoc with this pattern. The trade structure of the British Empire underwent profound changes within the span of a few years, and England either lost or was forced to sell many of its investments abroad (e.g. railroads in South America). At the same time, the United States and Canada emerged as the countries which could supply the goods needed most by Britain.

Thus a structural disequilibrium has been created which is exceedingly difficult to correct. A devaluation of the pound can be ruled out as a remedy. In order for a devaluation of the pound to be effective, both the demand of the sterling area for dollar goods and the demand of the dollar area for sterling goods would have to be highly price elastic. There is evidence that neither is the case. On the contrary, British demand for food stuffs and raw materials is highly inelastic and judging, for instance, by the performance of British car sales in North America, price considerations alone do not seem to be a sufficient incentive for the purchase of British manufactured goods in the dollar area.

Thus the only real alternatives seem to be to sell more British goods on this side of the Atlantic, which in the face of United States tariffs may be difficult and, more important, to find sterling area sources of supply for raw materials hitherto bought in the dollar area.

One highly suitable candidate for such a substitution is aluminum. At present, sufficient smelter facilities do not exist within the sterling area to make such a switch possible on a large scale. Plans are being made, however, for very large scale aluminum facilities to be built within the sterling area.

One of the most widely publicized of these plans is the "Gold Coast Project", a fully integrated smelter in what is now the independent state of Ghana. This location has much to commend it since ample hydro power resources and high grade bauxite exist close to tidal waters.[3] Other possibilities are Australia and Malaya, where plans for the construction of aluminum facilities have either been

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[3] The Gold Coast project is a joint venture in which the governments of the United Kingdom and Ghana, the British Aluminium Company and Aluminium Limited are expected to participate. Not much progress has been made in recent years, presumably mainly because of increased costs of the project, rapid growth of competing supplies elsewhere and political uncertainties in Ghana attendant on its recently gained independence.

announced or are being discussed.

It would probably lead us too far afield from our original line of thought if we attempted here to evaluate which of these projects are most likely to materialize, how soon they could be brought into production and what quantities they could expect to supply. We shall merely say that plans for large scale sterling area smelters exist and that these may eventually bring about a decline in the dominance of the Canadian producer in the United Kingdom market.

Summarizing our findings up to this point, we have had in mind the following major market areas for Canadian metal:

1) Canada
2) United Kingdom
3) "Other"
4) United States.

1) As important as the Canadian market unquestionably is, it does not now absorb more than a small fraction of domestic smelter output, nor is it likely to do so in the future.

In 1956, Canada consumed 90,500 tons of aluminum, as compared with primary production of 596,500. Thus Canadian consumption amounted to only 15 per cent of Canadian production. This ratio of exports to domestic consumption is unlikely to change materially. Capacity in Canada can be expected to grow at a rate comparable to the rate of growth of domestic demand.

Canada has one of the highest per capita aluminum consumption figures in the world. Whereas aluminum demand is likely to grow even in countries with a comparatively high present consumption, it is the countries with presently low per capita consumption which hold out the promise of still greater future growth of aluminum consumption.[4] If Canada wishes to maintain at least its present ranking as a producer, Canadian capacity would have to be expanded at a rate greater than that warranted by the growth of domestic demand alone.

2) Chances of Canada remaining the main source of supply for United Kingdom metal are not very good. As soon as it is feasible to establish a sterling area smelter, U.K. imports of Canadian metal are likely to decline.

3) Sales in the market area labelled "other" are less predictable; there may be a moderate increase in the importance of this market area within the near future, but the long term trend is against metal produced in Canada. We return to this point at length in a later chapter. For the present, let us anticipate a possible shift to locally produced metal as against metal bought from Canada. The reasons for such developments are somewhat different from those in the United Kingdom, but the result would be largely the same.

4) By process of elimination, much emphasis is placed on the United States market. In fact, as we shall attempt to establish in what follows, the U.S. market may well become the greatest outlet for Canadian metal. To put it differently, the Canadian primary producer or producers can be expected to grow into a more North-American, rather than truly international role. Interestingly enough, this trend seems to hold only for the Aluminum Company of Canada, and any other primary producer that may become established in this country,

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[4] Future demand will be dealt with in greater detail in Chapter Thirteen.

but not for Aluminium Limited. The latter company's role is one of considerable interest and will be discussed in detail in a later chapter.

Our immediate concern is with the future role of Canadian smelting facilities. In order to evaluate their relative competitive position vis-a-vis the U.S. producers, we have to subject ourselves to a rather detailed digression on technology.

First, without a fairly good understanding of the basic technical principles of aluminum reduction, it would be difficult to comprehend fully the factors affecting location, cost of production, and the relative competitive position of the various North American producers.

Second, a major change in technology could bring about such fundamental and dramatic changes in the industry that our present analysis, based on present production methods, would be completely invalidated. Although no pre-emptive predictions can be made in this regard, an understanding of the basic technical principles involved may help to form an opinion on the likelihood of a major change in technology.

CHAPTER NINE

A DIGRESSION ON TECHNOLOGY[1]

The production of aluminum can be conveniently divided into four stages.

1) Mining of the ore
2) Refining of the ore
3) Reduction of the metal
4) Fabrication.

The choice of ore for aluminum is dominated by a rather paradoxical situation. Aluminum is one of the most abundant elements in the earth's crust, exceeded in abundance only by oxygen and silicon. It occurs mainly in aluminosilicates, such as feldspars and micas, and in the clays resulting from these by the weathering action of water and carbon dioxide.[2] Strangely enough, aluminum is exceedingly difficult to isolate from these materials. Of the ores with the highest alumina content, only the eleventh in order of magnitude lends itself to commercial operations. This ore is bauxite which occurs in very large quantities in subtropical and tropical regions and, to a lesser extent, in temperate zones.

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1 In addition to the references stated below, information contained in this chapter is based on the following sources:
Engle, Gregory and Mosse: Aluminum, Irwin Inc., Chicago, Ill., 1941.
Kirk-Othmer: Encyclopedia of Chemical Technology, Vol. I, The Interscience Encyclopedia Inc., N.Y., 1947.
Mantell, C.L.: Industrial Electrochemistry, McGraw Hill Inc., N.Y., 1950.
Mellor, J.W.: A Comprehensive Treatise on Inorganic and Theoretical Chemistry, Vol. V., pp. 148-170 . Longmans, Green and Co., London, 1929.

2 Middleton and Willard: Semimicro Qualitative Analysis, p. 234, Prentice Hall, Inc., 1939.

A typical bauxite has approximately the following composition:[3]

Combined water	30%
Alumina	58%
Ferric Oxide	5%
Silica	5%
Titanium Oxide	2%
	100%

All ingredients other than alumina are considered as impurities from a smelting point of view. One of these, silica, is particularly crucial since its removal creates special problems. Thus a high grade bauxite not only must have a high alumina content, but also a low silica content. Merely from a technical point of view, it is possible to extract alumina from almost any mineral that contains it.

Since bauxite deposits in North America are small, attempts have been made for many years, particularly during the war, to develop methods for extracting alumina from low grade ores, such as certain types of clay found in great abundance in both Canada and the United States. Pilot plants have been operated at various times, using clays with a silica content as high as 45 per cent and alumina content of less than 50 per cent. These ventures were, however, abandoned sooner or later. Notwithstanding earlier failures, such experiments are still carried on with intensified effort.[4] For the time being however, bauxite is still the

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3 Values are quoted for "alumina" and "silica". Silica is the oxide of silicon and, by analogy, alumina (A_2O_3) is the oxide of aluminum.

4 Anaconda's attempt to establish itself as a primary producer of ingot in the United States depends in good measure on its successful use of domestic clays. See Business Week, November 3, 1956, p. 191.

only ore used for aluminum reduction.

Unlike iron and copper ore, aluminum ore cannot be introduced into the reduction process directly. Because of the presence of silica, it has to be treated chemically first to remove the silica.

The chemical properties of alumina and silica are such that in the electrolytic reduction process, silicon deposits at the anode before aluminum does so. Thus any silica contained in the ore used for the electrolytic reduction process causes a corresponding amount of silicon to be present in the aluminum. Silicon alloys of aluminum are in fact useful for some purposes, and they have at times been produced directly from silica bearing ores. For most practical purposes, however, the presence of silica is undesirable and, where it is needed, it is cheaper to alloy silicon with pure aluminum rather than reduce a silicon alloy direct from a silica bearing ore.

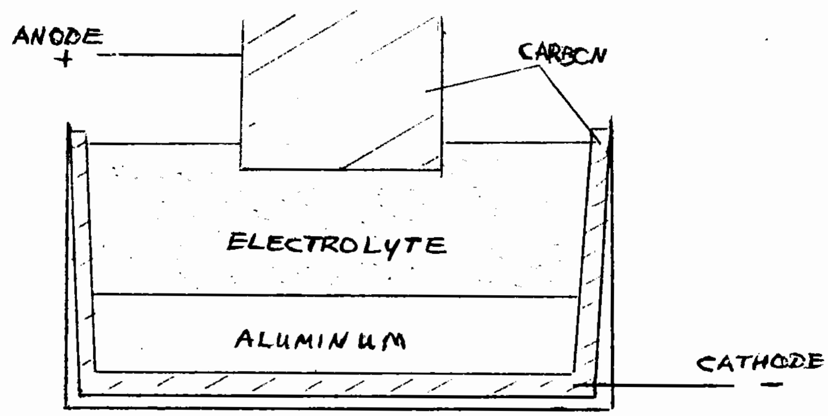
Alumina (Al_2O_3) is extracted from bauxite by means of a chemical separation. Several such alumina processes have been employed at various times and places. The one most suitable to the high purity bauxite presently used in North America, and therefore the most widely employed, is the Bayer process.[5] In this process, bauxite is digested with a hot caustic soda solution. This separates the alumina from the silica and substitutes sodium for silica. As a result, alumina exists as sodium aluminate. In this form, alumina can be separated from the insoluble residue and, once separated, it can be precipitated from the solution and

[5] The North American Bayer process to be exact. There also exists a European Bayer process. Both are variations of the same basic method.

calcined to yield pure aluminum oxide. This product, a fine white powder, is now ready for introduction into the electrolytic reduction process.

The reduction stage is based on the discovery that alumina dissolves in molten cryolite and that the metal could be electrolytically deposited from this solution. This operation takes place in a carbon lined steel tank called a reduction furnace, or, more commonly, a pot.

Simplified Representation of Reduction Furnace



This pot contains the molten electrolyte or bath in which Al_2O_3 has been dissolved. A block of carbon, serving as the anode, is immersed into the bath from the top. A strong direct current flowing from the anode to the cathode through the electrolytic bath then deposits liquid aluminum at the bottom of the pot. From there it can be either syphoned or tapped off without interrupting the continuous reduction process.

Once the metal has solidified, it is used for the production of alloys on the spot, or more frequently, shipped in its pure form to fabricating plants, foundries, etc. These latter normally have their own re-melt furnaces in which they produce the alloys required for their production.

In order to appreciate fully the economic significance of the aluminum production process, we have to consider the following:

The Hall-Heroult reduction process was invented in 1888. The chemical process of making alumina had already been known at that time. Although subsequent technical improvements of equipment and technique have increased the efficiency of the Hall-Heroult process, and constantly lowered production cost, the most modern reduction facilities today still employ this process basically unchanged.

At the reduction stage, there is at the time of writing no immediate hope of any important changes, which would, for instance, materially affect the amount of power presently required. For the foreseeable future, at least, power demands seem inexorable.

At the alumina purification stage, more advances have been made, although they are advances in degree rather than in principle. Through continued experimentation over the years, it has been possible to use ores of progressively lower grade. In spite of these improvements, one fact has remained so far as inexorable as the demand for power: the removal of silica from the ore is still unavoidable and costly. Not only does it require a complicated chemical process to remove the silica content, but with each part of silica removed, about 1.1 parts of alumina are removed as well, and thus lost for further production.

Experiments to overcome the hurdle posed by silicon started about as soon as the industry began. Even before the war, hopes ran high that a process was about to be perfected for the utilization of ores with high silica content. As already mentioned, such experiments were greatly intensified during and after the Second World War. Anaconda's efforts in this direction are the most recent example of such hopes.

On the other hand, Aluminium Limited has just recently decided to spend millions of dollars on the exploration and development of vast new bauxite reserves in French West Africa. This would indicate that at least in the opinion of one experienced producer, domestic clays appear to be an unlikely alternative.

To summarize the present chapter, the basic aluminum production process has remained remarkably stable over the years. As it stands, it imposes several serious obstacles to further cost reduction. In spite of numerous and continuous efforts to increase production efficiency results have so far been very modest. Any cost improvements achieved have likely been thwarted by rises in wage rates and construction cost. Although it would be rash to say that they need be so in the future as well, it would nevertheless appear that chances are against any revolutionary discoveries being made in the production of aluminum for some time to come. It may therefore be assumed, as a basis for further investigation, that the presently known production process will remain essentially unchanged.

Admittedly, this is a sweeping assumption, but some sort of an assumption on this point is necessary as a basis for further discussion.

CHAPTER TEN

THE EVOLUTION OF THE REGIONAL PATTERNS OF PRODUCTION IN NORTH AMERICA

In 1888, when production of aluminum by the electrolytic method was started in North America, the primary concern was largely a technical one: to make the newly discovered Hall process work. However, once the first ingots had been produced successfully and stored in the office safe, cost considerations came into the fore. Since power was at that time an even more important ingredient than it is today, operations soon had to be moved from the original location, the Smallman Street plant of the Pittsburgh reduction Company in Pittsburgh, to New Kensington.

The Smallman Street plant had used gas, the New Kensington plant used coal. In those days, however, the technology of steam generation was a far cry from what it is today, and the cost of generating sufficiently large amounts of power were exorbitant. This started Alcoa's ventures into the field of hydro-power, which are shown on Map I.

Only one of the five smelters, the plant at Badin, North Carolina, did not originate with Alcoa. It was started by a French group prior to World War I in one of the rare attempts on the part of outsiders to break into the aluminum business in the United States. Their venture was foiled by the outbreak of World War I and they eventually sold out to Alcoa. Alcoa then completed the facilities.

MAP I

Aluminum Reduction Facilities up to and including World War I

Legend	Location of plants
Smelters	(1) Niagara Falls, N.Y.
Alumina plants	(2) Shawinigan Falls, Que.
Chief Market area	(3) Massena, N.Y.
	(4) Alcoa, Tenn.
	(5) Badin, N.C.

North American Production 1919 *

Canada:	11,000 short tons
U.S.:	64,000 short tons
Total:	75,000 short tons

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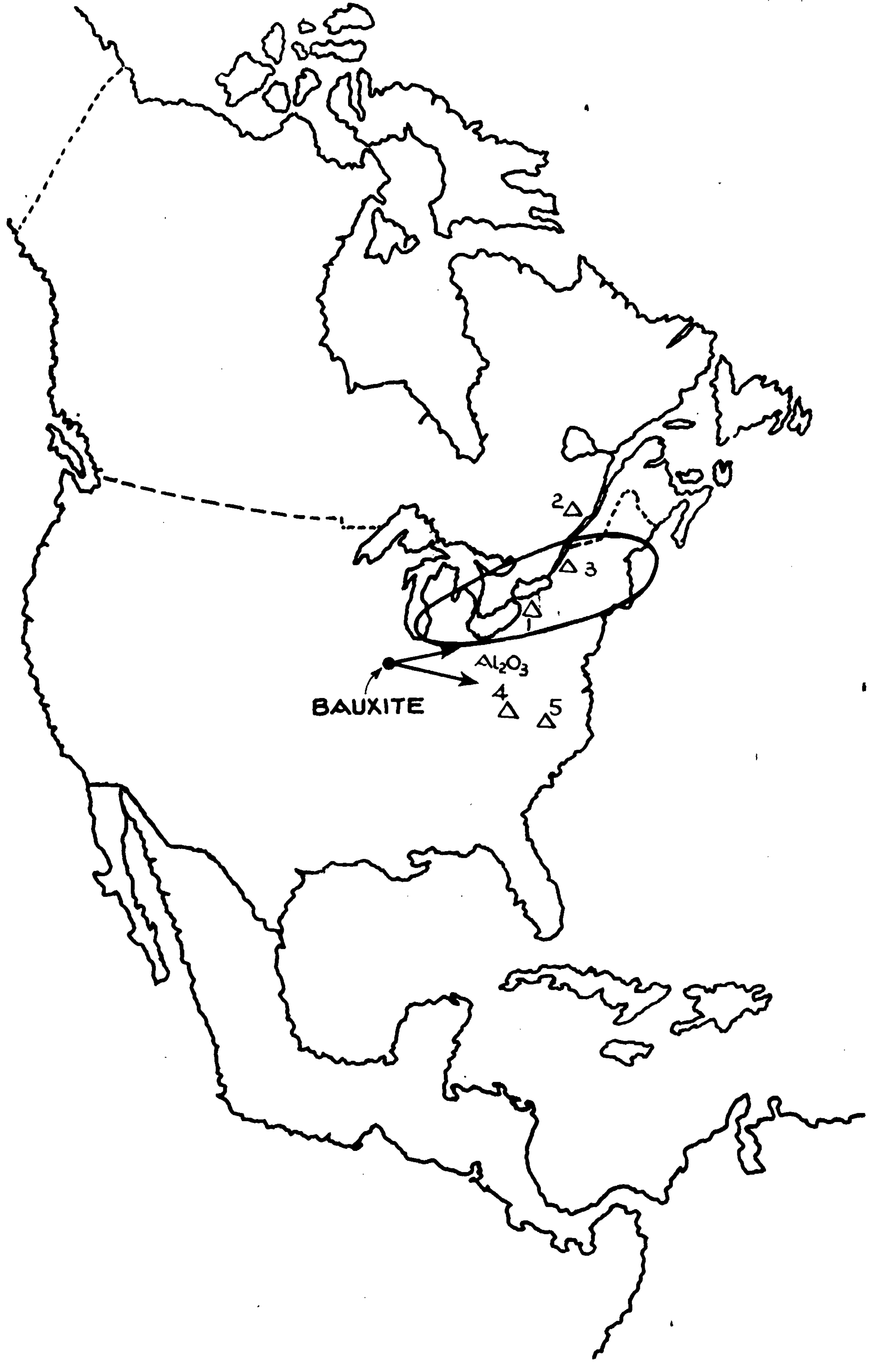
* Source: Aluminum Company of Canada, Submission to Gordon Commission, op. cit., p . 15
Materials Survey, op. cit., p. VIII-26.

MAP-1



By the end of World War I the basic pattern of North American production looked as follows: Sources of raw materials were close, transportation costs were low. Most of the bauxite came from Arkansas, although Dutch Guiana bauxite started to supplement domestic sources during World War I.

Smelter facilities based on hydro-power sought locations on the fringes of industrial settlement, since other industries competing for a limited supply of power could easily out-bid the aluminum producer. With the early smelter facilities shown on Map I, difficulties eventually arose from the expansion of the frontier of industrial settlement. When the plants were built, there was little or no alternate use for the power they consumed. Today, most of these plants are surrounded by areas of acute power shortage. In some instances, such as Alcoa's plant at Niagara Falls, N.Y., operations were discontinued altogether. In others, such as Massena, N.Y., and Shawinigan Falls, Que., they continued, but these latter sites were bypassed to a large extent by later expansion moves.

The outstanding feature of this earlier era of aluminum production in North America was the reliance on privately owned and privately developed hydro-power as a source of cheap energy. This pattern remained basically unchanged until World War II.

The impact of substantial civilian demand after the first war prompted the industry to tap further resources of hydro-power. By the nineteen-twenties, although hydro-reserves in the United States had by no means been exhausted, Alcoa had sufficient experience to think of its future in increasingly longer terms. Thus, in addition to rounding out its American facilities, Alcoa turned to Canada where seemingly unlimited amounts of firm power could eventually be made available. A smelter was constructed at Arvida, Quebec, but soon after it had been started up, further developments were slowed by the advent of the Depression.

The Great Depression prevented further changes of any consequence throughout its duration. The basic pattern remain unchanged, although existing facilities were augmented gradually during the latter part of the nineteen-thirties as the foreshadows of the new war stimulated the demand of aluminum. The regional distribution of the industry in 1938 is shown in Map II.

We have so far spoken rather loosely of the"industry". Until 1928, this was tantamount to Alcoa, and its Canadian subsidiary, Alcan. The pattern of privately-owned and privately developed hydro-power was inherited by the latter from the former, and was retained when Alcan came to steer a more independent course after the creation of Aluminium Limited in 1928. Both these companies, Alcoa and Alcan, have come in for criticism at various times for their penchant for hydro-power.

In the United States Government anti-trust action against Alcoa, it was alleged that Alcoa had attempted to "monopolize" the supply of hydro-power in some areas. In fact, Alcoa's early power contracts, such as the one with the Shawinigan Falls Water and Power Co., carried provisions enjoining the supplier of power from selling power to any other aluminum producer. When Alcan took over Alcoa's contracts in

Canada, these clauses remained valid, but allegedly have never been invoked[1] and were in fact cancelled by mutual consent in 1943.[2]

During World War II, Mr. M.J. Coldwell in the House of Commons levied charges against Alcan similar to those levied by the United States Government against Alcoa. The special Parliamentary Committee set up to investigate these charges judged them to be unjustified.

Today, with the benefit of hindsight, we can add that the danger of hydro-power being monopolized by the aluminum producers need not be taken too seriously. Cost control and long term production planning would seem to be more logical explanations for privately owned hydro facilities. This can now be said with some confidence since aluminum producers in recent years have been only too glad to avail themselves of existing power facilities on favorable terms. Capital expenditures of hyro-power stations are by far the highest of any phase of integrated production and aluminum producers, particularly in the United States, have much preferred to put available funds into reduction and fabricating facilities if a genuine alternative presented itself to company developed power.

Such an alternative presented itself on a grand scale during World War II. In the United States, as in Canada, the primary consideration was to bring in the maximum of additional capacity in the minimum time. There was, however, one important difference in the way

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1 Government of Canada Special Committee on War Expenditures, 1943, p. 126.

2 Ibid., p. 126.

MAP II

Aluminum Reduction Facilities prior to World War II

Legend	Location of Plants
Smelters	1) Niagara Falls, N.Y.
Alumina Plants	2) Shawinigan Falls, Que.
Chief Market Area	3) Massena, N.Y.
	4) Alcoa, Tenn.
	5) Badin, N.C.
	6) Arvida, Que.

North American Production 1938 *

Canada:	71,000 short tons
U.S.:	143,000 short tons
Total:	214,000 short tons

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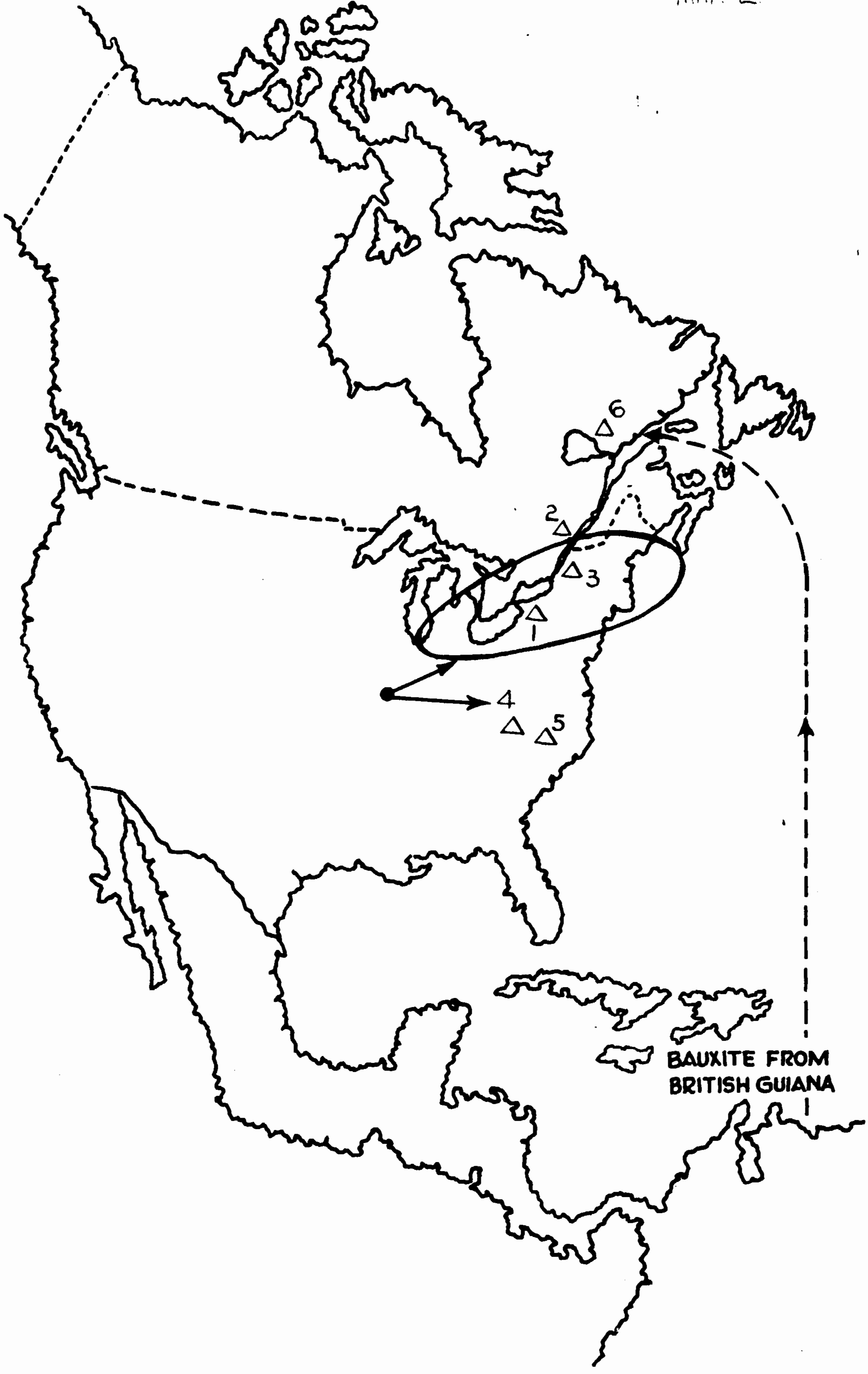
* Source: Aluminum Company of Canada, Submission to Gordon Commission, *op. cit.*, p. 15
Materials Survey, *op. cit.*, p. VIII-26.

MAP 2



this was accomplished in the two countries.

In Canada, there was available a huge, exceedingly economical power site, Shipshaw on the Saguenay River, for which plans had been made, but shelved by the impact of the depression. This was utilized, and as a result, the bulk of war-time capacity was able to continue after the war as highly economical, low cost facilities. Other smaller and less economical facilities, such as a plant at La Tuque, Quebec, were closed down after the war.

The situation in the United States was more involved. During the nineteen-thirties, more and more of the remaining power resources of the United States had been taken up by public power corporations. In fact, Alcoa had already become a customer of one of them, the Tennessee Valley Authority, as early as 1937.

War-time expansion took place mostly within the precinct of another, much larger public power development, the Bonneville Power Administration of the Pacific North West. Power cost here was cheaper than in other parts of the United States, about 2 mills per kwhr as compared with 4 mills in the Tennessee Valley and, what was at the time even more important, large blocks of power were available for aluminum production on short notice.

Once the war emergency was fully felt, speed was essential. It takes years to complete a system of dams and power stations capable of delivering firm power the year round. Thus Bonneville power was committed to aluminum reduction to such an extent that towards the latter part of the war, aluminum production in the Pacific North West was more than twice the 1935-1939 average for the United States as a whole.[3] In 1943, the year of peak war-time production, production of primary ingot in the Pacific North West amounted to about 300,000 tons.

As a glance at Map III will show, the shift to the Pacific North West had to bring some profound changes to the cost structure.

First, pig aluminum had to travel much further to the major fabricating centres of the Mid-West and North-East. Only during a relatively short period of time during the war did the airplane industry of the Pacific Coast absorb a substantial part of the output of the Pacific North West.

Supply lines of bauxite were also greatly lengthened. This was intensified by the fact that by then the United States had to rely greatly on imported bauxite. Even before the war, foreign bauxite, mostly from Dutch Guiana, had come to augment domestic sources to an increasing extent.[4] In 1939, aluminum production in the United States amounted to 164,000 tons. Four years later, in 1943, production reached a peak of 920,000 tons.

The bauxite requirements for such an output were met by domestic reserves as much as possible, virtually depleting high grade reserves in the United States. From then on, foreign bauxite had permanently entered the United States aluminum scene.

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3 Engle, op. cit. p. 63

4 Close to two million tons in 1943 out of a total of seven million, or about 25 per cent. By 1954, imports of bauxite had increased to over 70 per cent of total United States bauxite requirements.

MAP III

Aluminum Reduction Facilities during World War II

Note:

Individual U.S. reduction plants are not shown for lack of space. Instead, the aggregate of output from all plants of one particular region are expressed as percentages of total national production as follows:

40%

North American Production 1943 *

United States			Canada
East:	610,000 tons	66%	Quebec: 496,000 tons 100%
Pacific N.W.:	310,000 tons	34%	
TOTAL:	920,000 tons	100%	

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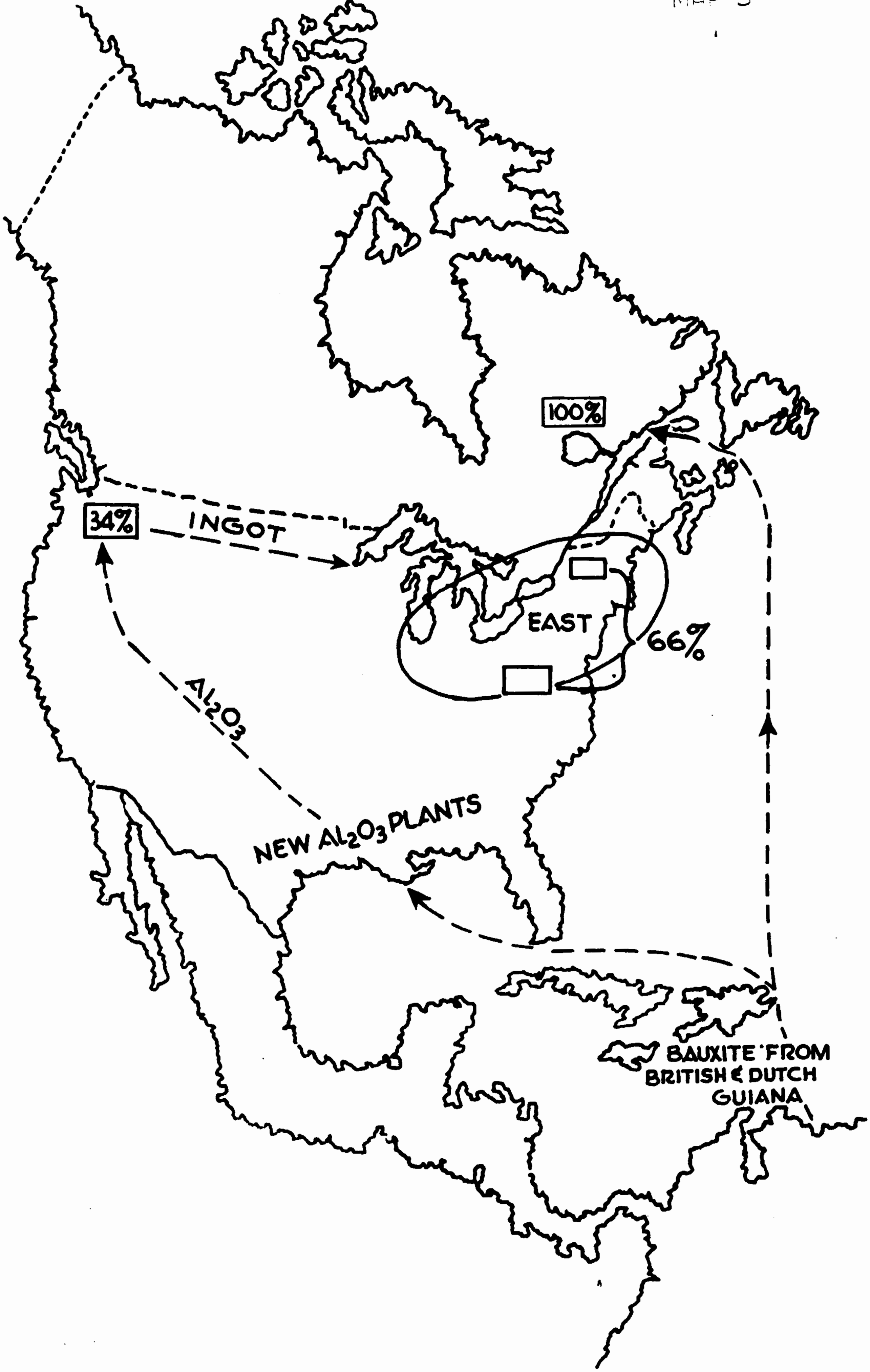
* Source: Aluminum Company of Canada, Submission to Gordon Commission, op. cit., p. 15.
Materials Survey, op. cit., p. VIII-26.
Engle, op. cit., p. 102.

MAP 3



100%
34%
INGOT
EAST
66%
Al_2O_3
NEW Al_2O_3 PLANTS
BAUXITE FROM
BRITISH & DUTCH
GUIANA

Along with the additional reduction facilities, corresponding alumina facilities had to be constructed. Since as a rule two tons of bauxite yield one ton of alumina, alumina plants normally should be built at or near the mines, as is the case for facilities processing domestic bauxite at Bauxite, Arkansas, and East St. Louis, Illinois. Alumina facilities for bauxite from Dutch Guiana, however, were not built in Surinam but rather in the Gulf Coast states.

The reason for such an apparent dislocation is not hard to find: Prior to 1948, alumina was subject to a tariff of $10.00 per ton, as compared with approximately $0.85 per ton for bauxite.

From an accounting point of view, the cost of alumina produced on the Gulf Coast, which includes the duty on bauxite, is less than the cost of foreign alumina, C.I.F. United States port of entry. The latter cost would include the much higher duty on alumina. Chances are, however, that the "real" cost of production of foreign alumina would be lower than those of Gulf Coast alumina. If that is the case, ultimately the cost of producing aluminum in the United States is higher than what it ideally could be, and thus its competitiveness vis-a-vis foreign metal is reduced.

The location of World War II aluminum plants in the Pacific North West, based on public power as they were, marked the end of the era of privately developed hydro-power for expansion needs in the United States. After a post-war slump in the demand for aluminum, civilian demand began to make itself felt sufficiently to keep some war-time facilities in operation and to warrant the rehabilitation of others. Some plants such as the high cost smelter in New York City, were not re-opened. The larger, more economical units, which Alcoa had constructed and operated for the government during the war, were sold to the new entries into the field of aluminum reduction, Kaiser and Reynolds.

This was the situation when the Korean War broke out. Civilian demand had grown to such an extent that the more economical parts of war-time capacity were again in full production. As in the case of World War II, substantial additional capacity was required on short notice, about 500,000 tons, to be exact.[5] Here the following alternatives presented themselves.

1) The metal could be obtained from Canada. Alcan had offered to supply the United States government for its strategic stockpile with substantial tonnages on a contract basis. In order to accept this offer, however, the United States government would have been compelled to commit itself unequivocally to a policy whereby Canada would be treated as an integral part of the North American defense production potential. Such a course of action was strongly opposed by the American producers and politicians whereas some groups within the government were in favor. After much hesitation and repeated change of direction, the Canadian offer was allowed to lapse.[6]

2) An alternative course of action was to use more public power, chiefly in the Pacific North West. This course was not taken. The official reason given was that it would take too long to make the necessary power available by means of augmentation of existing facilities, such

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5 Actual production, 1949: 600,000 tons.

6 For a somewhat impassioned, but lucid account of these events, see Fortune: "The Great Aluminum Farce", June 1951, p. 93.

as the construction of storage dams. This has to be taken with a grain of salt. If we can believe a Fortune article on the point[7] the Bonneville Power people did everything in their power to direct the aluminum expansion move in their direction. The producers, on the other hand, showed great reluctance towards still further expansion dependent on public power so far from their markets. For one thing, the use of public power for aluminum has always been a politically controversial matter, for another, the producers this time came up with a feasible alternative to public hydro-power: natural gas.

3) This third alternative was the one finally taken. For the present and near future, the natural gas fields of the Gulf Coast States were eminently suitable. They are privately owned which the aluminum producers have come to consider an advantage. Smelters based on natural gas could be built close to already existing alumina facilities, and the cost of electricity generated by natural gas was competitive with that from other sources.

There is, however, one very serious disadvantage. Natural gas is a wasting asset. Unlike hydro-power, where costs are determined almost entirely by the historical cost of construction, cost of producing natural gas tends to go up as gas becomes less abundant. Consequently, contracts would have to include an escalator clause providing for a rise in the cost of production. Furthermore, gas producers now, or in the future, are not able to enter into contracts covering as long a period of

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7 Ibid., p. 98.

time as hydro-power contracts. It is doubtful whether there are any contracts between producers of aluminum and natural gas which would run for more than 20 years. For an integrated aluminum plant to be an economical investment, however, it would have to run for as much as 50 years.

This was the situation created by the Korean War. Although the bulk of the expanded capacity necessitated by the Korean War emergency was completed by 1953-54, it was not until 1955 that the expansion phase had run its full course. The picture, as it presented itself then, is illustrated by Maps IV, V, and VI.

It should be stated here that none of the various phases of expansion described have clear demarcation lines. For instance, while construction of Gulf Coast facilities based on gas was in full swing, Alcoa built another plant, using hydro-power, in the Pacific North West, near Wenatchee, Washington. Construction of this plant was started in 1951, and a capacity of 100,000 tons was attained by 1953. It can be seen that this exception to the rule is far from being a minor one, even though this capacity is supported by uninterruptible power only to the extent of 70 per cent.[8]

Another Alcoa plant, at Rockdale, Texas, which started up in 1952, foreshadowed still another geographical switch in production. This plant uses lignite as a fuel for the generation of electricity. Although an isolated case in 1952, this for the first time employed a

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8 Materials Survey, op. cit., p. III-3.

MAP IV

Aluminum Reduction Facilities at End of Korean Boom

Production 1955 *

United States		
East:	360,000 tons	23%
Gulf Coast:	626,000 tons	40%
Pac. N.W.:	580,000 tons	37%
Total:	1,566,000 tons	100%

Canada		
Quebec:	541,000 tons	89%
B.C.:	67,000 tons	11%
Total:	608,000 tons	100%

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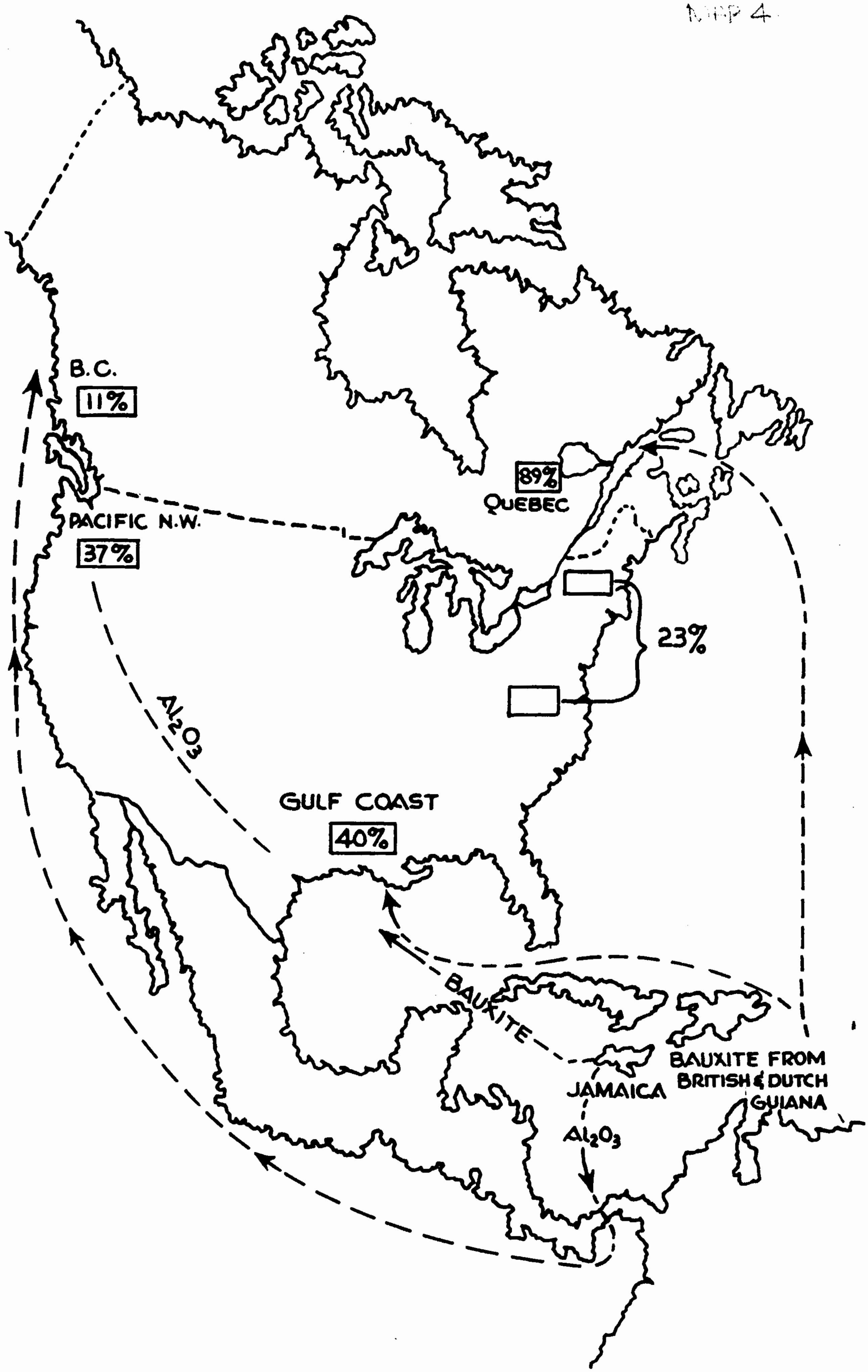
* Source: Aluminum Company of Canada: Submission to Gordon Commission, op. cit., p. 15.
Materials Survey, op. cit., p. VIII-26.

Note: Regional distribution of United States production estimated by author on basis of capacity data given in Materials Survey, op. cit. p. III-2.

MAP 4


B.C.
11%
PACIFIC N.W.
37%
89%
QUEBEC
23%
Al_2O_3
GULF COAST
40%
BAUXITE
JAMAICA
BAUXITE FROM BRITISH & DUTCH GUIANA
Al_2O_3

MAP V

Alumina Plant Locations and Rated Capacity Data

1956 *

United States

1) Bauxite Ark.	402,000 tons	11%
2) E. St. Louis, Ill.	329,000 tons	10%
3) Mobile, Ala.	876,000 tons	25%
4) Hurr. Creek, Ark.	730,000 tons	21%
5) Corpus Christi, Texas.	365,000 tons	10%
6) Baton Rouge, La.	816,000 tons	23%
Total:	3,518,000 tons	100%

Canada

1) Arvida, Que.	1,275,000 tons	70%
2) Jamaica	540,000 tons	30%
Total:	1,825,000 tons	100%

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* Source: Materials Survey, op. cit., p. III-1
Aluminum Company of Canada Ltd., Sinking Fund Debenture Prospectus, Apr. 9, 1957.

MAP-5

MAP VI

Aluminum Reduction Plant Locations and Rated Capacity Data

January 1956 *

Canada

1)	Arvida, Que.:	355,000 tons	55%
2)	Isle Maligne, Que.:	92,000 tons	15%
3)	Shawinigan Falls, Que.:	66,000 tons	10%
4)	Beauharnois, Que.:	36,000 tons	6%
5)	Kitimat, B.C.:	91,000 tons	14%
Total:		640,000 tons	100%

United States

1)	Alcoa, Tenn.:	157,000 tons	10%
2)	Badin, N.C.:	47,000 tons	3%
3)	Massena, N.Y.:	112,000 tons	7%
4)	Point Comfort, Tex.:	95,000 tons	6%
5)	Rockdale, Tex.:	100,000 tons	6%
6)	Vancouver, Wash.:	95,000 tons	6%
7)	Wenatchee, Wash.:	100,000 tons	6%
8)	Arkadelphia, Ark.:	55,000 tons	4%
9)	Jones Mills, Ark.:	97,000 tons	6%
10)	Listerhill, Ala.:	50,000 tons	3%
11)	Longview, Wash.:	50,000 tons	3%
12)	San Patrico, Tex.:	80,000 tons	5%
13)	Troutdale, Ore.:	83,000 tons	5%
14)	Chalmette, La.:	200,000 tons	13%
15)	Spokane, Wash.:	175,000 tons	11%
16)	Tacoma, Wash.:	33,000 tons	2%
17)	Columbia Falls, Mont.	60,000 tons	4%
Total:		1,589,000 tons	100%

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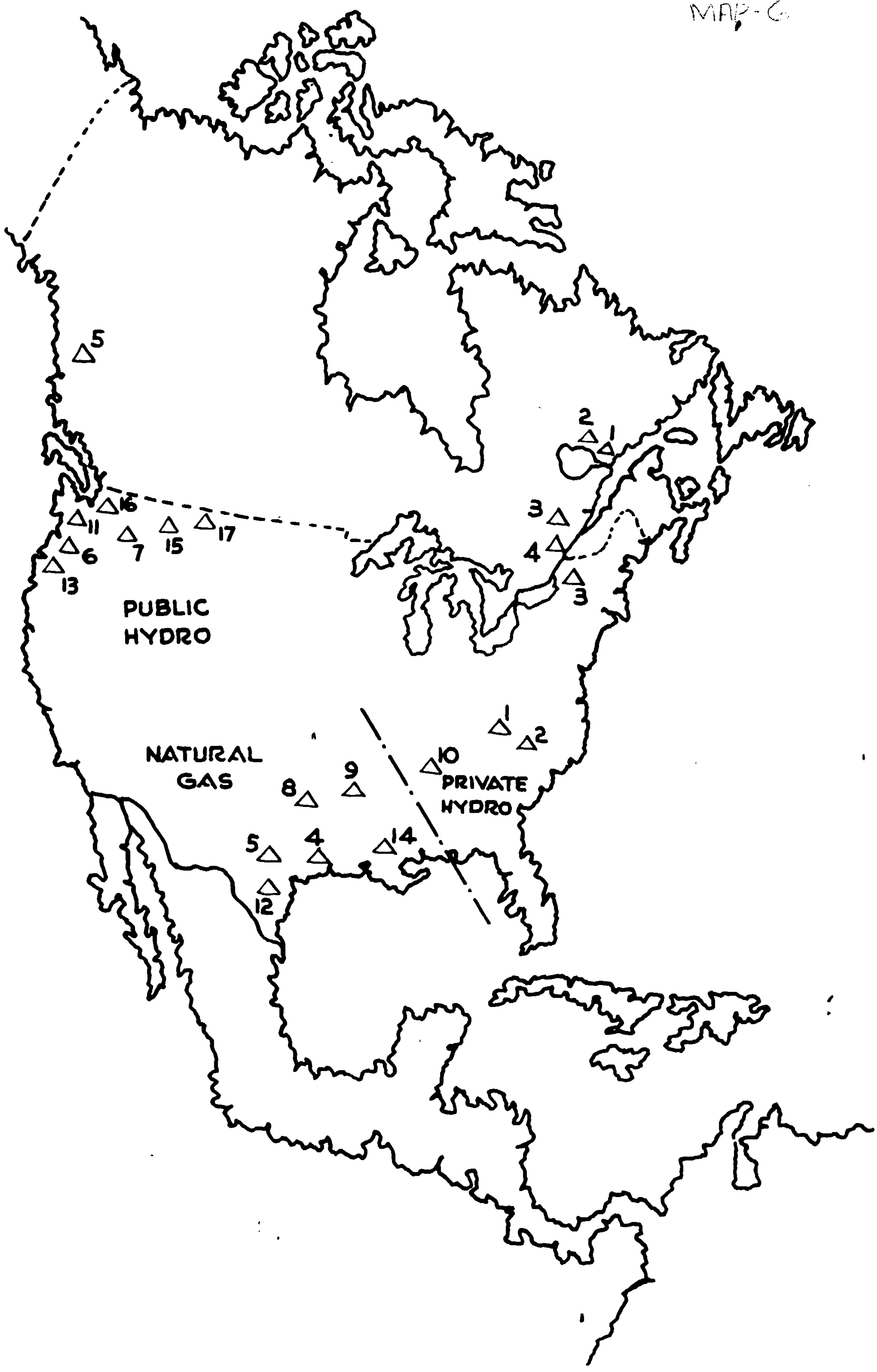
* Source: Materials Survey, op. cit., p. III-2, p. X-2

MAP-6



5
2
1
3
4
3
16
11
6
7
15
17
13
PUBLIC HYDRO
NATURAL GAS
1
2
10
9
8
PRIVATE HYDRO
5
4
14
12

new process which has come to play an important role in the most recent, not yet completed expansion phase.

Almost as soon as the post-Korean War aluminum expansion in the United States was completed, total capacity was again inadequate. In the meantime demand including stockpile requirements had again increased to such an extent that still further substantial additions to capacity became necessary. This time the producers turned to coal as a source of energy. Coal was first used by Alcoa in the eighteen-nineties in its New Kensington plant, but Alcoa had to abandon its use, as already mentioned, because steam generation in those days was too inefficient. Today, however, the technology of steam generation represents such substantial advances that power can now be generated in the neighbourhood of four mills per kwhr.

The region most suitable for aluminum plants based on coal is the Ohio Valley. This region has three advantages: First, there are extensive coal deposits, and reduction plants can be built in close proximity to the mines. Second, alumina can be barged up the Ohio Valley from alumina plants on the Gulf Coast at a cost considerably lower than for alumina shipped by rail over an equal distance. Third, the aluminum is produced in the industrial heart land of the United States; transportation cost to the chief fabricating centers is thus low.

At the time of writing, no plants have actually started production in the Ohio Valley, but at least three plants are under construction, and more are likely to follow.

Map VII is an attempt to take this new phase of expansion into account. It shows all existing facilities as well as those scheduled facilities which are expected to be in production by 1960.

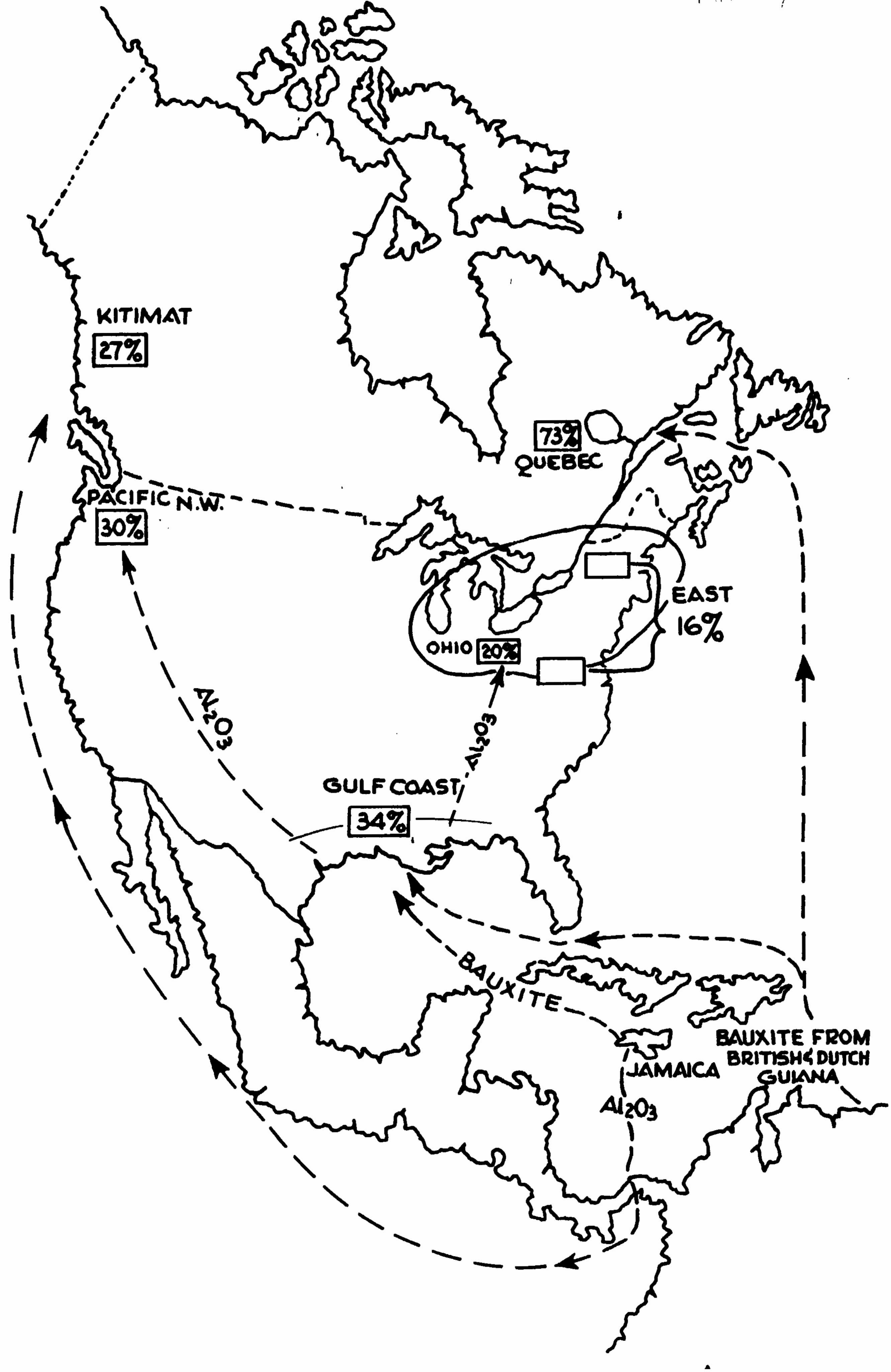
MAP VII

Estimated North American Aluminum Reduction

Capacity 1960 *

Canada		
Quebec:	800,000 tons	73%
British Columbia:	300,000 tons	27%
Total:	1,100,000 tons	100%
United States		
East:	360,000 tons	16%
Pacific North West:	670,000 tons	30%
Gulf Coast:	760,000 tons	34%
Ohio Valley:	450,000 tons	20%
Total:	2,240,000 tons	100%

* Source: Materials Survey, op. cit., p. III-2
Aluminum Company of Canada, Ltd.: Sinking Fund Debenture Prospectus, op. cit., p. 3


KITIMAT
27%
73%
QUEBEC
PACIFIC N.W.
30%
EAST
16%
OHIO
20%
Al_2O_3
Al_2O_3
GULF COAST
34%
BAUXITE
BAUXITE FROM
BRITISH & DUTCH
GUIANA
JAMAICA
Al_2O_3

CHAPTER ELEVEN

THE ECONOMICS AND POLITICS OF LOCATION IN NORTH AMERICA

In Chapter Ten an attempt was made to sketch briefly the development of the United States industry to date. We are mainly concerned with these developments as they tend to shed light on the competitive position of the Canadian producer vis-a-vis his American counterparts.

In evaluating the historical development of the American industry, three main features stand out.

1) The departure from hydro-power as the chief source of energy, and the attendant search for new alternatives.

2) The change in the relative importance of power cost and the emergence of transportation cost as the main determining factor.

3) The role of the United States government in aluminum affairs.

1) The Departure from Hydro-Power

As already mentioned briefly, aluminum producers normally located on the fringes of the industrial frontier. As industrialisation followed them into the wilderness, they had to move on and develop new sources of energy. The crucial problem of the industry in the United States today is that the industrial frontier has passed. The settlement of the Western plains came to an end around 1900. In the same way, the "settlement" of the untapped hydro-power resources of the United States was essentially completed fifty years later. From then on, any additional power used had to come from within the area of industrial settlement.

The American aluminum industry in effect entered the second half of this century by shifting from an extensive to an intensive development of power. Naturally, there are certain physical limits to intensive development, so that increasingly less efficient sources have to be brought in. There is, however, one way out of this predicament: Improvements in technology can extend the limits of intensive development.

This is exactly what is happening. The use of gas to drive internal combustion generating units, and the use of coal to drive steam turbines have in fact given the aluminum industry in the United States a new lease on life.

In the past, producers could move on to virgin power sites when the expansion of existing facilities was not feasible or not sufficient. Now they have to expand by using existing sources more efficiently through improvements in the technology of generating electricity. This is both more complicated, and in the end more costly.

Present improvements in the technology of steam generation, which make possible a postponement of the decreasing returns to power development, are themselves subject to eventually diminishing returns. The use of neither coal nor gas has been made feasible by means of dramatic new discoveries. Instead, it has been made possible by means of painstaking engineering studies which all employ well known principles. It is possible, for instance, to perfect a steam engine still further, but beyond a certain point, the difficulties encountered with such further perfections can be expected to increase exponentially.

Another factor to keep in mind is that, no matter what technique is being used, the fuel used is in scarce supply.[1] This is particularly true for natural gas, and to a lesser extent for coal as well.

In 20 years, natural gas may be altogether unavailable for aluminum production, and coal is almost certain to be more expensive than at present. Labor accounts for a fairly large part of the cost of coal, and it is highly unlikely that the wages of coal miners would remain any more stable than those of other industrial workers. Although presently known deposits of coal are extensive, it will become increasingly costly to mine the existing deposits.

All this compares rather unfavorably with hydro-power. Not only are amortization charges the largest part of total cost, but what is being written off are the historical costs of construction which are of course completely impervious to increases in the current cost of labor and raw materials.[2]

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1 This is not true for atomic power, but atomic power is too remote to be considered here. See below, Chapter Twelve.

2 Some qualification should be admitted here: In the event of a serious inflation, as compared with a gradual, secular rise in prices which we are experiencing, the problem of historical versus replacement value as a basis of depreciation may become of primary importance. Since we consider a run-away inflation to be unlikely we shall not consider this problem.

In the supply of power, Canada has a very marked advantage over the United States. As mentioned in an earlier chapter, climatic and topographical factors constitute very serious obstacles to the advance of Canadian settlement towards the North. There seems to exist wide agreement on the point that much of the northern parts of Canada are not equally suitable to settlement as the plains of Southern Canada and of the United States. Much of these less accessible areas of Canada, particularly in British Columbia and Quebec, still harbor extensive hydro-resources. Even those developed some time ago in a settled area, the Saguenay region, will continue to be available for aluminum production. A repetition of Alcoa's experience at Niagara Falls is unlikely in the Saguenay Valley. The Lake Ontario region proved capable of very intensive settlement and industrialisation with the result that the aluminum producer in the region, Alcoa, was eventually compelled to close and move away. The Saguenay-Lake St. John region, on the other hand, is not capable of a similar degree of development.

As will be remembered from Chapter Three, the Saguenay region has well defined boundaries beyond which settlement would be impractical. The population within this region will unquestionably increase but its growth to the point where the aluminum producer would become an undesirable resident of the area is not practicable.

In taking the view that the aluminum producer is unlikely to be crowded out of the Saguenay region altogether, the following qualification should be kept in mind: As aluminum output and the population of the region grow, the point will come where the two will approach a plateau of development. Aluminum will eventually be hindered in its further growth in the region when all the attractive power sites of the region are fully utilized. In fact, this phase of development is already in sight; Alcan is presently engaged in rounding out its existing power facilities through the construction of further storage dams and power stations. This should boost aluminum capacity of the Saguenay region (Arvida and Isle Maligne) to the 600,000 tons per annum level. This may well be the final capacity of the region, since already today the claim on power on the part of non-aluminum users can be felt to an increasing extent.

Alcan and its associate companies generate power not only for their own use but, in lieu of a public utility, to supply the industrial and domestic power requirements of the region. This they have to do as one of the conditions under which they were granted power concessions by the Province of Quebec. This dual role of private producer and public utility has already led to a conflict of interest. In the spring of 1956, Alcan was confronted with a serious water shortage. Instead of rationing power on a pro rate basis, Alcan (its affiliated power companies, to be exact) had to keep deliveries to non-aluminum users at 100 per cent of requirements. Consequently, Alcan had to cut back production and absorb the full power shortage itself.

Similar situations are likely to recur again only in the event of exceptionally low water conditions. It can be concluded, however, that aluminum production is unlikely to exceed to any appreciable extent the existing capacity plus what is under consideration. This would leave sufficient smaller power sites capable of satisfying future non-aluminum demand which may arise from a further growth in population.

Let us turn to the second major site of power development for aluminum production in Canada - Kitimat, British Columbia. Here one can be even more confident than in the case of the Saguenay, that the aluminum producer need have little fear of being crowded out. Kitimat is wedged narrowly in between high coastal mountain ranges and the sea. There is little room for any agricultural or industrial development to develop. Furthermore, Kitimat is beyond the range of economical transmission of power to other market centers.

To summarize, whereas the United States may have to cope with increasingly higher power cost in the future, Canada because of its continued reliance on hydro-power will not experience the same trend. This brings up the second point, the question of how important power costs really are.

2) The Change in the Relative Importance of Power Cost and the Emergence of Transportation Cost as the Main Determining Factor

Perhaps the most widely used slogan in aluminum literature is "packaged power". This slogan is today as prevalent as ever, although in using it one might easily be led to overlook an unobstrusive, but eminently significant change in the importance of power cost relative to the cost of other components.

Here we have a rather vexing problem. There are strong indications that in spite of the increasing scarcity of power and the upward trend in power cost, the importance of power as a percentage of total cost has declined significantly. At the same time, transportation, another component of total cost, has gained in relative importance. Unfortunately, practically no reliable precise data on transportation costs are available for the following reasons.

Aluminum companies are somewhat secretive about their costs, and one can rarely find a breakdown more detailed than what can be gleaned from Annual Reports and share prospectuses. Some data are available, for instance, for Alcoa in the evidence presented to the court in connection with the United States Government's anti-trust action against that company. Fairly detailed cost data are also available for Alcan from the Canadian Government Report of the Special Committee on War Expenditures on Shipshaw, 1943. The data are given in Table XVII.

Such data, however, are of limited use because they are old, and the emergence of the importance of transport cost is quite recent. Furthermore, cost components are expressed in conventional accounting terms. Power costs can be easily distinguished but transport costs are entirely invisible.

Looking at Table XVII, for instance, one can easily select the largest single item, which is "ore", i.e. refined ore, or alumina. The bauxite from which this alumina was made has travelled some three thousand miles from British Guiana. It was unloaded at Port Alfred and shipped by rail for approximately twenty miles to the alumina plant at Arvida. The 7.55 ¢/lb, however, also includes the cost of mining the bauxite in British Guiana and the cost of labor, chemicals, fuels, overhead, etc., incurred in the alumina plant. Thus, even if we had more recent cost accounting data, we still would not be able to measure the transport cost as a separate entity.

TABLE XVII

Aluminum Ingot Cost in Cents per Pound Produced

Aluminum Company of Canada, January to June 1943

Pot lining	.16
Electrodes	1.16
Power	1.94
Ore	7.55
Electrolyte	.56
Alloys	.07
Labor	.71
Repairs and Maintenance Equipment	.16
Repair and Maintenance Buildings and Misc.	.09
Plant Administration	.34
Miscellaneous Plant Expense	.13
Depreciation - aluminum plant only	.10
Ingot Pouring Charge	.17
Total carried to Invent a/c:	13.14
General Property Expense	.04
Proportion Administrative and General Expense	.27
Special Depreciation	5.48
Cost before Interest, Taxes:	18.93
Interest (proportion)	.24
Total Cost:	19.17

Source: Government of Canada Special Committee on War Expenditures 1943. Report on Shipshaw, p. 112.

SUMMARY

Alumina	7.55	40%
Power	1.94	11%
Labor	.71	1%
Raw Materials, electrodes, etc.	1.95	11%
Semi-var. and Fixed Charges	1.20	7%
Total Depreciation	5.58	30%
Cost before Interest, Tax:	18.93	100%

Nevertheless, certain cautious observations can be made, some only in terms of "more" or "less", others can be given numerical value.

As regards power cost, it is known that Alcan's cost in Arvida in 1943 was less than two mills per Kwhr.[3] For 1949 there exists another estimate for Arvida[4] which puts power cost at .59 mills. Conceivably these two figures are not strictly comparable if derived in different ways. For the present purpose, however, they should suffice as an indication that Arvida power costs are certainly below two mills, and probably below one mill. Although the above figures are several years old, they are unlikely to be materially different today since power costs are so heavily made up of amortization charges on historical cost of construction.

Kitimat power is considerably more expensive at least at present but the trend there is down rather than up.

By comparison, rates in the United States are higher throughout. Power in the Pacific North West ranges from 2 to 2.5 mills[5] to at least 4.4 mills in the Tennessee Valley.[6] In between the two are the power costs of the Gulf Coast region, 3.5 to 3.9 mills[7] and more recently the Ohio Valley, 3.5 mills.[8]

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[3] Special Committee Report, ibid., p. 112.

[4] The First Boston Corporation: Aluminum, The Industry and the Four North American Producers, New York, 1951, p. 37.

[5] John V. Kratilla: "Locational Factors Influencing Recent Aluminum Expansion". Southern Economic Journal, Vol. 21, 1954-55, p. 278.

[6] Krutilla, ibid., p. 278.

[7] Krutilla, ibid., p. 278.

[8] Business Week, June 16, 1956, p. 92.

The pacific North West has most of its power cost advantage dissipated by higher transport cost. Alumina has to be shipped by rail from ore plants located on the Gulf Coast. Strangely enough this is less expensive than shipping bauxite by ocean going vessel direct to the Pacific North West for processing into alumina there. The combined cost of shipping bauxite (including canal tolls, higher cost of labor and raw materials) to the Pacific North West would put the delivered price of refined ore produced in the North West above that produced on the Gulf Coast.

On balance, it has been estimated[9] that total mill costs for the two regions, Pacific North West and Gulf Coast, are approximately the same. In the new location for aluminum reduction, the Ohio Valley mill costs are probably similar to those on the Gulf Coast, particularly since power costs are just about the same.

Taking into consideration the delivered cost of metal, say in Cleveland, the overall advantage is decidedly on the side of the most recent plant locations, the ones located in the Ohio Valley. It has been estimated[10] that sheet selling in Cleveland for $846.00/ton would incur a transportation charge from the West Coast of $96.00 (11 per cent) but only $28.00 (3 per cent) from Kaiser's Ravenswood, W.V., plant.

There is another development which reduced costs in the Ohio Valley and which would not be feasible elsewhere: At least one aluminum

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9 Krutilla, ibid., p . 279.

10 Business Week, ibid., p. 94.

producer has entered into a contract with one of the Big Three in the auto industry for the supply of molten metal. This would involve the construction of a foundry on the part of the automobile firm adjacent to the aluminum smelter. Thus liquid metal could be transferred direct from the pots into the foundry for casting. The handling and re-melt charges saved in this way could be significant.

Although it cannot be said exactly how much, the savings in transport cost for reduction plants located in the Ohio Valley are substantial. They are probably large enough to have somewhat narrowed the gap between United States and Canadian cost, although Canada is generally considered to have still a margin. This is at least the consensus of trade publications which are likely to reflect the views of the major producers.

The conclusions to be drawn from the above can be summarized as follows: Increases in overall cost, mostly through higher transportation cost, have opened up new regions for aluminum production. Thus in the Ohio Valley, higher power costs can be compensated by savings in transport cost.

A rise in transport cost tends of course to work against the Canadian producer with his traditionally long lines of supply. To what extent, however, higher transport costs have affected Alcan's overall cost advantage is difficult to say. One might venture a guess that these effects have not yet been very substantial.

5) The Role of the United States Government in Aluminum Affairs

The outbreak of World War II wrought some fundamental changes for the American industry, although of a different nature than it had done for the Canadian industry.

Prior to the war, Alcoa, then the only producer in the United States was truly a private enterprise. Decisions as to the location of new plant, the whether, when, where, and how much of expansion was left to its own discretion. Only one Government Department was interested in the activities of the company, and that was the Justice Department.

Extensive Government control had already been experienced during World War I. Seemingly, controls during World War II were no different. However, unlike what happened after the First War, Government withdrawal from industry was only temporary. Virtually all major expansion phases since then have taken place under government auspices.

Reasons for Government concern are not difficult to find. International tension after the war caused the United States Government to stockpile substantial quantities of aluminum, still a strategic material. The impact of the Korean War and a concurrent substantial growth in the civilian demand for the metal rendered post-war reduction facilities inadequate.

It should be kept in mind that peak war-time production in the United States had been possible only with the construction of uneconomical, high cost smelters which were closed down after the war. When the Korean War broke out, the following alternatives presented themselves:

a) Augment public hydro-power facilities, particularly in the Pacific North West.

b) Re-activate uneconomical war-time facilities.

c) Import from Canada.

d) Construct new facilities based on natural gas.

As already mentioned, the first alternative was rejected largely because of the lack of time. The second alternative never did get very serious consideration since it would have been possible only with government subsidies and/or higher priced aluminum. The third alternative, to import from Canada, was much more attractive. Canadian metal would have been available both in sufficient quantities and at an attractive price. Although some groups within the government were in favor of buying Canadian metal, the American producers opposed such a move strongly. As a result, a Canadian offer to supply the United States Government with substantial tonnages on a contract basis was allowed to expire.[11]

Natural gas provided the alternative actually chosen. Although financed by the producers, Gulf Coast plants were built at the instigation of the Government, and with the aid of liberal tax amortization certificates as well as market guarantee contracts.[12] This was the famous "first round" expansion which added just under half a million tons of annual capacity.

By 1951 it was apparent that another 220,000 tons of capacity were needed. Thus a "second round" of expansion was authorized by the Defense Production Administration along the lines of the first round.

Late in 1952, a "third round" was announced, but later partially cancelled. Since then the guiding hand of the government has been less

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11 Fortune, ibid., p. 98.

12 Materials Survey, op. cit., p. VII-14.

certain and the most recent expansion plans for the Ohio Valley appear to have been largely industry initiated.

Let us now summarize the observations made in the present chapter:

On purely economic grounds, Alcan still has a cost advantage. As far as availability of power is concerned, Alcan has little to worry about for some time to come. Improvements in the hydro-system of the Saguenay region will support another 100,000 tons of reduction capacity when it is needed. Kitimat is capable of expansion to 300,000 tons with only comparatively small further investment. If a second tunnel and additional penstocks are driven through the coastal mountains of Kemano, an ultimate expansion up to 550,000 tons is envisaged.

The American producers, on the other hand, are beginning to scrape the bottom of the power barrel and it will become increasingly difficult for them to develop sufficiently large blocks of power. Ohio coal is likely to stave off this trend for some time, but is unlikely to reverse it.

By moving to the Ohio Valley, theAmerican producers have been able to effect some real economies through a reduction in transport cost. Although possibly the lowest cost new facilities in the United States, Ohio Valley smelters are unlikely to have costs lower than Alcan's. Even if they were the same, aggregate American costs would still be above Canadian cost since Ohio Valley production will be only about one fifth of total United States production by 1960.

On the political side, however, the outlook is not equally encouraging for the Canadian producer. Alcan has attempted - and failed -

to be considered by the American Government as part of a North America wide pool of industrial defense resources. This was a major setback. As aluminum production takes place on an ever increasing scale, large contracts become increasingly desirable as a safe floor for future smelter production.

Over the short and intermediate run, prospects for the Canadian producer are brightened by the fact that, at the moment at least, the United States Government no longer plays an all-important role in the expansion of facilities. When additional capacity was needed for defense purposes, the argument for national self-sufficiency was a powerful one. If purely civilian demand predominates, however, it is not equally effective. In the latter instance the independent fabricators in the United States are on the Canadian producer's side. They live in the constant fear of being the first ones to be deprived of their supply in the event of a sudden shortage. Here Alcan recently played its hand well by guaranteeing a minimum annual supply specifically to the independents in the United States and by offering special services and technical assistance which may not be available from U.S. producers.

Over the long run, Canada may or may not have a powerful weapon in its fight for a more prominent position in the United States market: cheap <u>and</u> abundant power. Whether and to what extent this may be of advantage to the Canadian industry in the more distant future will be discussed in the next chapter.

CHAPTER TWELVE

THE ECONOMICS AND POLITICS OF ENERGY RESOURCES

An attempt to evaluate the future prospects of the North American aluminum industry means to venture onto thin ice. Nevertheless, this need be done, with all due caution, to gauge the main underlying forces which motivate the industry. Of these, the future supply of power is a major factor which should be examined more closely.

In the previous chapter emphasis was placed on the rise in the relative importance of transport cost and the attendant decline in the relative importance of power cost. So as to forestall possible misunderstanding, it should be added that this shift is entirely one of degree only, and not of principle.

In 1949 the weighted average price for aluminum in the United States was 17 ¢/lb.[1] Assuming power cost of two mills and an energy consumption of 10 kwhrs/lb. (i.e. power to pots plus all ancillary power requirements), power cost per pound would amount to $2\frac{3}{4}$ ¢/lb. or 12 per cent of sales price. Should the cost of power increase to four mills, its relative share of the total would jump to 21 per cent. At the present sales price of 25 ¢/lb, however, the two percentages would be only 8 per cent and 15 per cent respectively. Percentages, of course, are only meaningful in comparison with other cost components. In absolute terms an increase in power cost has far-reaching consequences even at the higher price.

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1 American Metal Market, Metal Statistics 1956, p. 623.

The decreased relative importance of power cost means in effect that the "threshold" of acceptable power cost has been raised. Thus today in some regions power cost in the 4 mill/kwhr range is feasible, but it should be remembered that such high power cost must go hand in hand with a substantial reduction in at least one of the other cost elements.

This is essentially the situation in the Ohio Valley. Power from new sources is practicable at a higher cost because it is so located that aluminum production can shave transport cost both on the supply of raw materials and on the delivery of finished products.

This seems to be a rather important point. Power cost could rise with impunity only in a certain location, and because of the higher selling price of the metal. Naturally, if aluminum prices should increase still further, power cost would be given more leeway. Chances are, however, that further substantial increases in price are no longer feasible since increasingly wide areas of aluminum demand show themselves to be highly price elastic.

To put it still another way: Subject to locational restrictions, the range of what is considered acceptable power cost has widened. To that extent, the predominance of meticulous power cost considerations which were the number one concern of aluminum producers in the past, has been blurred. Within the new limits, however, power cost and the availability of sufficiently large blocks of power are still major problems. In the past, American aluminum producers had to strive to bring down the price of power as low as possible. Today their problem is to find large blocks of additional power at no more than a given price.

Three sources of power are being used for aluminum reduction today: hydro-power, gas, and coal. In the more distant future, atomic power would appear as an additional source of energy.

As a basis for additions to American reduction facilities in the near to intermediate future, natural gas can be ruled out with some degree of confidence. Of the two remaining sources of energy, both are abundant in North America as a whole, but in the United States only coal is abundant. Thus if the U.S. industry wished to weigh both alternatives, they would have to consider locating outside their own territory as well.

In the past, American producers have shown great reluctance to leave their domestic territory, and if given the choice they are likely to locate additional smelter facilities within their borders. Until some time after 1960, coal in the Ohio Valley may make this possible, but what will happen thereafter? Will American producers continue to find sufficient additional energy within the United States or will they eventually be forced to seek further sources of energy outside their own borders?

Although on the surface this question mainly concerns the American industry, it is ultimately of vital importance to the Canadian producer as well.[2] For should the American producers be forced eventually to look outside their own country for new energy, Canada's importance as a North American supplier would be greatly enhanced. On the other hand,

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2 Continued reference is made to the Canadian producer in the singular. There will be one other entry this year. In the present context, however, it does not matter much whether there is one or are several.

if the United States were to find a long term, low price solution within its own territory, the prospects for the Canadian producer might indeed be dim.

In order to appreciate more fully the problems involved, perhaps it may be helpful to reflect on some of the basic facets of the pool of energy available to the whole industrial society of North America.[3]

For North America[4] as a whole, the long run supply outlook for energy is briefly as follows: Of the present supplies of natural gas, petroleum, coal, and hydro-power - disregarding wood as insignificant - natural gas will be the first one to run out. Here an absolute physical decrease, quite apart from a rise in price, has to be reckoned with within our lifetime. Hydro-power is a scarce commodity in most parts of the United States and some parts of Canada even today. In most of those areas, some increase in hydro facilities is possible, although diminishing returns may be experienced to an increasing extent.

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[3] The following discussion is largely based on two publications, both by Dr. J. Dales: Energy Resources of Canada, Canadian Institute of International Affairs, Toronto 1957; and "Fuel, Power and Industrial Development in Central Canada", A.E.R., Vol. XLIII, No. 2, May 1953, p. 181. In this instance, the mere footnoting of a reference does not suffice. Without Dr. Dales' very lucid reflections on the nature and functions of energy resources, I would have probably been unable to clarify my own thinking on how the aluminum producers fit into the framework of the North American Energy household.

[4] For the sake of convenience, the term North America exludes Mexico in the present context.

The picture is somewhat brighter for oil and coal. Supplies of natural petroleum, at least in North America, may gradually begin to fall short of aggregate requirements within the span of one generation. Fortunately, it is possible to make most petroleum products from oil shales and tar sands, both in abundant supply on this continent. It is more expensive to use these materials but as oil supplies begin to be scarce prices will rise, and make feasible the more expensive processes.

Coal is a different matter. Although not inexhaustible either, proven deposits are so large as to put the day of their depletion well beyond the period of time with which one need be concerned. Furthermore, according to Dr. Dales, it should be possible to produce coal for several decades at about the same "real" cost as today.

The portents of all this for the aluminum producers are as follows. In basing themselves on coal, they have seemingly made a fortunate move, Because of the immense supplies of coal they can get all the energy they need. Also seemingly, the Canadians may be placed in a precarious position because virtually all their capacity is based on hydro-power. In fact, however, the odds are in favor of the Canadians rather than the Americans. In order to see why, one has to keep in mind two points:

First, a clear distinction should be made between two types of energy requirements: For heating on the one hand, and for motive and lighting power on the other.[5] Natural gas, petroleum and coal fall squarely into the first category since for most industrial processes they

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[5] Dales, ibid., p. 181.

are technical substitutes. The use of one to the exclusion of the others then depends largely on their relative prices.[6] Motive (i.e. industrial motive) and lighting requirements are almost entirely based on electricity. While electric heat is usually too expensive on a B.T.U.[7] basis, fuels are often used to generate electricity. In other words, hydro-power is largely restricted to electricity requirements. Fuels are much more versatile and can be used for almost all energy requirements.

In countries where hydro-power is abundant, one could expect to find the demand for electricity essentially a demand for hydro-power, while in countries insufficiently endowed with hydro-power, the demand for electricity would be one for both hydro-power and fuel.[8] Thus we could expect hydro-power to be more prominent in Canada than in the United States. Figures confirming this expectation are given in Table XVIII.

The second point of interest in the present context is that for most purposes, energy resources should be discussed on a regional basis. The cost of transportation creates definite limits to the distances over which energy materials can be moved economically. This is particularly true of water power.

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6 One major exception is fuel requirements of the internal combustion engine.

7 British Thermal Unit.

8 Dales, <u>ibid</u>., p. 185.

TABLE XVIII

Relative Importance of Major Sources of Energy in The Energy Consumption of Central Canada and the United States in 1943

	Central Canada		United States	
Fuels		62.2%		95.8%
Coal	52.6%		54.8%	
Petroleum	9.0%		29.2%	
Natural Gas	.6%		11.8%	
Water Power		37.8%		4.2%

Source: Dales, ibid., p. 182.

"Because water power in the form of hydro-electricity cannot economically be transported for much more than 300 miles, its reserves must be studied on a regional basis. If petroleum is the most international of energy sources, water power is the most parochial. Nor does technology appear to offer much hope of relaxing the present transmission limits of 300-350 miles in the foreseeable future. In a very few special circumstances it is even now practicable to force electricity over distances of up to 500 miles by using conventional alternating current transmission systems, but despite much research on this problem the commercial practicability of such a system seems almost as far away from achievement today as it did twenty-five years ago."[9]

Dr. Dales goes on to point out that in Canada a substantial portion of total hydro reserves, such as the ones in the Hudson Bay drainage basin, are too remote to be economically significant. He concludes:

"Thus when we think of the 'vast riches of Canadian water power' and their stimulus to industrial development we are in fact thinking of the St. Lawrence Valley and British Columbia."[10]

Now the stage is set to return to the energy requirements of the aluminum producers. In order to be suitable for aluminum production, power must have these features:

1) large blocks available
2) low cost
3) no competitive bidding[11]
4) closeness to water transport.

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9 Dales, op. cit., Canada's Energy Resources, p. 10.

10 Dales, ibid., p. 10.

11 Competitive bidding here refers to that from "average" industrial and private users to whom power cost is a negligible part of the total. It is quite conceivable that other electrolytic industries, such as copper, magnesium, titanium or ferro-alloys, could coexist with aluminum.

Let us first consider hydro-power. In Canada, both Quebec and British Columbia have extensive, unexploited power sites. The latter, however, has a wide margin over the former as can be seen from Table XIX. British Columbia has the added advantage, as far as aluminum production is concerned, that most of the undeveloped potential is in the northern part of the Province near tidal waters. These sites are too far from centers of population to be of interest to users other than electrolytic metal reduction. Quebec does not fare too well on this score since its waterpower near navigable water is already extensively utilized.

The chief factor in cost of hydro-power is the historical cost of construction. Once construction has been completed, costs per kilowatt-hour will eventually go down, rather than up. Variable costs are negligible and the hydraulic energy is inexhaustible. Thus, in an era of secular expansion with an attendant rise in prices, companies building a power station today can look into the future with equanimity. If power costs today are low enough to support profitable operations, they will be even more so in the future.

From Table XIX it can be seen that hydro-power, especially in British Columbia, would meet the power requirements of aluminum producers admirably. In locating the Kemano-Kitimat project there, Alcan has taken advantage of this fact. Whether the American producers will, at some future date, wish to locate in British Columbia depends largely on how suitable coal proves to be as an energy source.

Coal complies easily enough with the first of the above listed aluminum power requirements. It does not, however, fare equally well with the others. As mentioned before, the "real" cost of producing coal

TABLE XIX

AVAILABLE AND DEVELOPED WATER POWER IN CANADA

December 1956

Province	Available 24-hour power at 80% efficiency - H.P. At Ordinary Min. Flow	At Ordinary 6 Months' Flow	Installed Turbine Capacity H.P.
1	2	3	4
British Columbia	10,200,000	17,300,000	2,514,960
Alberta	508,000	1,258,000	285,010
Saskatchewan	550,000	1,120,000	109,835
Manitoba	3,333,000	5,562,000	796,900
Ontario	5,407,000	7,261,000	5,443,766
Quebec	10,896,000	20,445,000	8,489,957
New Brunswick	123,000	334,000	164,130
Nova Scotia	25,500	156,000	179,718
P.E.I.	500	3,000	1,882
Newfoundland	958,500	814,000	33,240
Canada	32,384,000	57,007,000	18,356,148

NOTE

The figures in columns 2 and 3 do not include the power potential of major river diversions such as the Chilko-Homathko River diversion which has been estimated at 1,000,00 H.P.

The above figures also do not include unexplored and unrecorded sites of which there are many, particularly in the Northern regions. Thus, regarding both the total number of sites and the possible head at each site, the listed figures of available power represent only the minimum water possibilities of Canada.

Source: Government of Canada
Department of Northern Affairs and National Resources
Water Resources Branch:

Water-Power Resources of Canada, Ottawa, 15 March 1957, p.2.

is likely to remain constant for at least another 30 years. By real cost is meant the physical quantities of capital and labor required for coal production. There is no guarantee, however, that the price of these physical input units will remain unchanged. With the technical coefficients of production remaining the same, an increase in the price of inputs will result in an increase in the price of the output.

It is expected that labor costs will rise during the next 30 years. Coal mining has not prospered these past few decades, and yet wages of miners have gone up. Modern labor unions with personalities like John L. Lewis ensure that the earnings of their rank and file keep pace with wages paid in other industries.

The most serious count against coal as a future source of energy for aluminum production is the existence of alternative uses. The location of Ohio Valley coal is a formidable advantage today because of the saving in transport cost. In the future this location will probably become a serious drawback due to coal's versatility as an energy source for both heating and electricity. As other fuels become scarce, the demand for coal will experience a brisk upsurge. The Ohio Valley is now, and will be the center of possibly the largest concentration of industrial users of coal-based energy in North America. The rising concentration of industry will tend to raise the price of coal.[12]

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12 The "real" cost may remain the same, but "opportunity" cost will rise. This view is supported by John Davis in Canadian Energy Prospects, a study for the Gordon Commission to be published separately. At the time of writing, this study was not yet publicly available. If it becomes available before the completion of this thesis, more specific reference to it will be made.

As a result, aluminum producers with smelters in the Ohio Valley will have to pay a higher price for power expansion than they paid for their existing facilities.[13]

Before drawing any conclusions from the above, two further alternatives to Ohio coal should be considered:

Coal fields in the Western United States (as well as in Western Canada for that matter) are, to date, virtually unexploited. Deposits are vast, and although most of them are low grade lignite, modern technology permits power production from lignite at a cost no higher than power from better grade coal. If, however, American producers were to switch to the use of Western lignite they would lose their transportation advantage.[14]

Another alternative to power based on Ohio Valley coal is atomic power. At present, this is produced for industrial purposes - in the Western World at least - only in two countries, England and the United States.

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[13] Existing reduction facilities based on company owned power or protected by long term contracts, would, of course, not be affected.

[14] Theoretically, there exists the possibility that the St. Lawrence Seaway might make it feasible to produce aluminum west of Lake Superior. Bauxite would be shipped to Duluth, Minn., and lignite by rail from North Dakota. Even though the Seaway toll may be an insignificant part in the cost of such an operation, it would seem unlikely that such a scheme would hold much attraction to the aluminum producers. It is significant that none of the major producers has ever seriously considered such a project. Anaconda has given some thought to this region but it is understood that aluminum production there would be feasible if domestic clays could be used instead of bauxite.

To the layman, the array of problems surrounding atomic power is rather bewildering. Fortunately, development of atomic power has progressed to the point where the whole complicated procedure can be reduced to a mill per kilowatt-hour cost basis. Even today, this cost is as low as 18-20 mills per kwhr. (See Table XX). Some authors[15] claim that enough basic research has been done to point the way towards power cost which should ultimately be as low as 7-8 mills.

Such costs, however, seem a long way off. First a formidable number of engineering problems have to be solved and, as with any revolutionary new process, this takes time. Basic research, which has been essentially completed for commercially feasible atomic power, can be carried out on an entirely theoretical basis, and one major break-through may save years of further research. With cost reducing engineering problems, however, experience still seems to be one of the major aids in accomplishing the desired goal, and experience takes time.

It will be possible to produce atomic power, say at 8 mills,

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[15] Nucleonics. D.P. Herron and A. Puishes: "P.W.R. and Calder Hall - How do they Compare?", June, 1957, p. 72.
"Significance of E.B.W.R.", July 1957, p. 54.
Shorter Notes. "E.B.W.R. Power Costs", July 1957, p. 58
" " October 1956, p. 28.
" " December 1956, pp. 5-30.
" " April 1957, p. 61.

Atom: Monthly Information Bulletin of the United Kingdom Atomic Energy Authority: <u>Cost Factors in Nuclear Energy</u>, No. 7, May 1957, p. 11.

TABLE XX

Present Cost of Atomic Power

In Mills per Kwhr

	Calder Hall (England)	PWR (U.S.)
Invested Capital		
Construction	12.8	7.4
Capital Charges during Construction	1.2	.8
Start-up	.1	.1
Investment in First Ore	.3	1.1
Total:	14.4	9.4
Fuel Cost		
U^{235} Burn-up	1.4	2.0
Plutonium Credit	1.4	.5
Net Burn-up	0.0	1.5
Rental of Fuel	0.4	0.2
Fuel Fabrication and Processing	1.6	7.5
Total:	2.0	9.2
Site Operation:	1.5	1.0
TOTAL POWER COST:	17.9	19.6

Source: Nucleonics, June 1957, p. 73.

25 years from now. North America, although a leading force in perfecting this new form of energy, is, however, unlikely to be the first of the major areas of the world to use it to any significant extent. The day when coal generated electricity in North America costs more than 8 mills/kwhr at present prices, seems quite far off.

Other countries which are much less favorably endowed with conventional sources of energy are likely to employ atomic energy in significant amounts long before the United States and Canada. Of course, if atomic power in North America is slow in being adopted for general use because of high cost, the aluminum producers are even less likely to resort to it. Thus we feel that we can discount the use of atomic power for aluminum production for our present purposes.

Drawing together the threads of the present chapter, the following conclusions can be now stated:

Of the energy resources available for additional aluminum capacity in the future, only hydro-power and coal will be of any consequence. The latter, as was pointed out, has certain cost disadvantages which will be accentuated in time. Will American producers therefore have to make a concerted bid for northern British Columbia power?

For the immediate future, say for the next three to five years, this seems unlikely. American producers have a very pronounced aversion to locating outside a territory for which they can always demand tariff protection. They will consequently continue to use coal as long as possible. Somewhere along the line they will encounter an effective limit to further price increases due to higher fuel cost. Present aluminum prices are quite high, and there is a very real possibility that the point beyond which prices cannot be raised with impunity may have already been reached. Demand for aluminum softened substantially early in 1957. A chronic metal shortage which had persisted for several years disappeared almost overnight, and at the time of writing there are still no signs of demand again exceeding supply at present prices.

Should rising coal prices in the future force American aluminum producers to consider British Columbia hydro-power as a basis for further expansion of reduction capacity, the situation would not be without precedent. Late in 1955 the Aluminum Company of America discussed with the Premier of British Columbia plans for an Alaskan smelter based on British Columbia power. Mr. Bennet seemed willing enough, but before any commitments were made the Federal Government stepped in with a categorical rejection of the project. The reasons for this attitude on the part of the Federal Government are not difficult to divine. Had Alcoa been allowed to build with Canadian power another Kitimat behind the protective screen of United States tariffs, this would have been a serious blow to the Canadian producer.

On a cost basis, Alcan would not have been worried unduly by the construction of American smelter in Alaska. Metal produced at the latter site would be at least as expensive, probably somewhat more so, as metal produced at Kitimat. Even at the presently existing rate of tariff on ingot, which is low[16], Alcan would have been in a strong

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16 1½¢/lb. See Materials Survey. Aluminum, op. cit., p. VII-23.

competitive position. What would have injured Alcan seriously is the fact that a United States smelter in Alaska would have upset the precarious "balance of nature" which, at the moment, keeps the United States tariff on ingot as low as it is.

The American producers, particularly Reynolds, have at various times attempted to have the tariff on basic ingot raised. In this they are strongly opposed by the independent fabricators. The latter group claims that because of the identity of the Big Three[17] as ingot suppliers as well as competitors in the fabricating field, they can wield an undue degree of market control over the independents. In this argument the independents can point to some bitter experience. The Big Three have been only too ready in the past to block the entry of Canadian metal without being able to completely supply the independents from domestic facilities.

An Alaskan smelter would change this situation appreciably. It would give the American primary producers a powerful argument in favor of a United States policy of self-sufficiency in aluminum to the exclusion of Canadian metal from the American market. The entry of Canadian metal could be curbed very swiftly and effectively by raising the tariff.

There is little doubt that the Canadian Federal Government, as well as Alcan, is aware of such a potential threat. So as to forestall future attempts to raise United States tariff, they would probably welcome the location of American producers on Canadian soil. In fact,

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17 Alcoa, Kaiser, Reynolds.

the Canadian Government's refusal to let Alcoa use Canadian power applied only to a smelter proposed for location outside Canada. There is no indication anywhere that the right to use hydro-power sites would be withheld for a smelter to be located inside Canada. In that case, it would be in the interest of an American company building a plant to advocate the continuation of a low tariff, or possibly its eventual elimination.

It would be hazardous to try to forecast which of the opposing attitudes will win out in the end. Too much depends on how attractive British Columbia hydro-power will seem to the Americans five or six years from now. Let us assume for the moment that they will find it necessary to use British Columbia power.

Purely from an economic point of view, there is probably general agreement that hydro-power in northern British Columbia can be of use only to aluminum producers or other heavy users of electricity. The sooner it is being utilized for that purpose, the better from the point of view of maximum utilization of available resources. Like the loss of output during a strike, water running down the mountains unharnessed is energy lost forever.

Utilization of British Columbia power by United States producers should even be feasible from a political point of view. Instead of either power made available to American producers with no strings attached, or urging them to locate in Canada, a compromise solution might eventually be quite acceptable to all concerned.

In selling in the United States in the future, Canadian producers may be in a rather favorable position cost-wise. A prerequisite for successful United States sales would of course be a tariff on ingot no higher than at present and, what is more important, no threat of higher tariffs in the future. In return, the American producers would be free to develop northern British Columbia power for smelters located in Alaska. This would satisfy United States civilian demands since it would assure adequate supply from both domestic United States and Canadian sources, and it should also go a long way towards allaying American fears of inadequate domestic aluminum facilities for defence purposes.

The result of such a solution would eventually be that all North American producers of aluminum would be able to sell throughout the North American market area on an equal basis. This would serve best the interest of all concerned: The ultimate consumer of aluminum would be reasonably assured of an adequate supply of low cost metal, the American producers would no longer be plagued by a shortage of low cost power, and the Canadian producer would be greatly aided in his transition from an international to a North American supplier.

PART IV

CHAPTER THIRTEEN

FUTURE DEMAND: WHERE WILL IT GO?

Up to this point the argument has been developed only in terms of "future growth of demand", judiciously avoiding any quantitative measure of such demand. To give meaning, however, to the discussion of the past chapters and that which is yet to follow, some concept should be given of the magnitude of further demand which may be expected.

The main problem in the present context is the fact that economics has as yet developed no wholly dependable tools of forecasting and, in the opinion of some, possibly never will. Thousands of factors of varying degrees of importance come to bear upon each development which may be chosen for forecasting. Yet in some instances one can arrive at forecasts of some validity by isolating a few of the more important parameters. For convenience, the rest can be made to disappear with the magic "ceteris paribus" assumption. On this basis one can forecast future developments if the parameters chosen behave in compliance with the assumption made, and if the mixed bag of other factors does not turn out to be "ceteris non paribus".

At first glance, aluminum demand would seem an unsuitable candidate for the limited forecasting possible with present tools. As mentioned in an earlier chapter, aluminum demand is the aggregate of some 4,000 different individual demands which often have very little in common. At this point two difficulties are encountered, one a conceptual, the other a practical, empirical one.

The former relates to the concept of the demand curve. Forecasting future demand is often thought of as an attempt to draw a long range demand curve. However, it is believed to be impossible to construct a long range demand curve, not so much because of the lack of sufficient statistical information, but because of the suspicion that there is no such thing as a long range demand curve. In fact, it is difficult even to imagine a short run aggregate demand curve. Such a short run curve would have to constitute an aggregate of some 4,000 individual demand curves. Theoretically, this is possible. In fact, however, there is no curve, but only a demand point. It is known only what amount is demanded today at present prices. It is not equally certain what demand would be at somewhat higher or lower prices. Thus all one can go on is a point in the quadrant at the intersection of price and output, which is rather little. It may even be possible to make a guess as to the slope of the line going through the point in the immediate neighborhood of the point. The further one moves away from it, however, the greater the uncertainty about its slope. (See Figure I.)

Knowing so little about an aggregate demand curve, a set of <u>ceteris paribus</u> assumptions has to include such important factors as price, not only of aluminum, but also of the major competing materials. With such assumptions a forecast of future aggregate demand is nothing but an attempt to forecast a <u>shift</u> in the demand curve and the tonnage resulting therefrom at something approximately the present price.[1]

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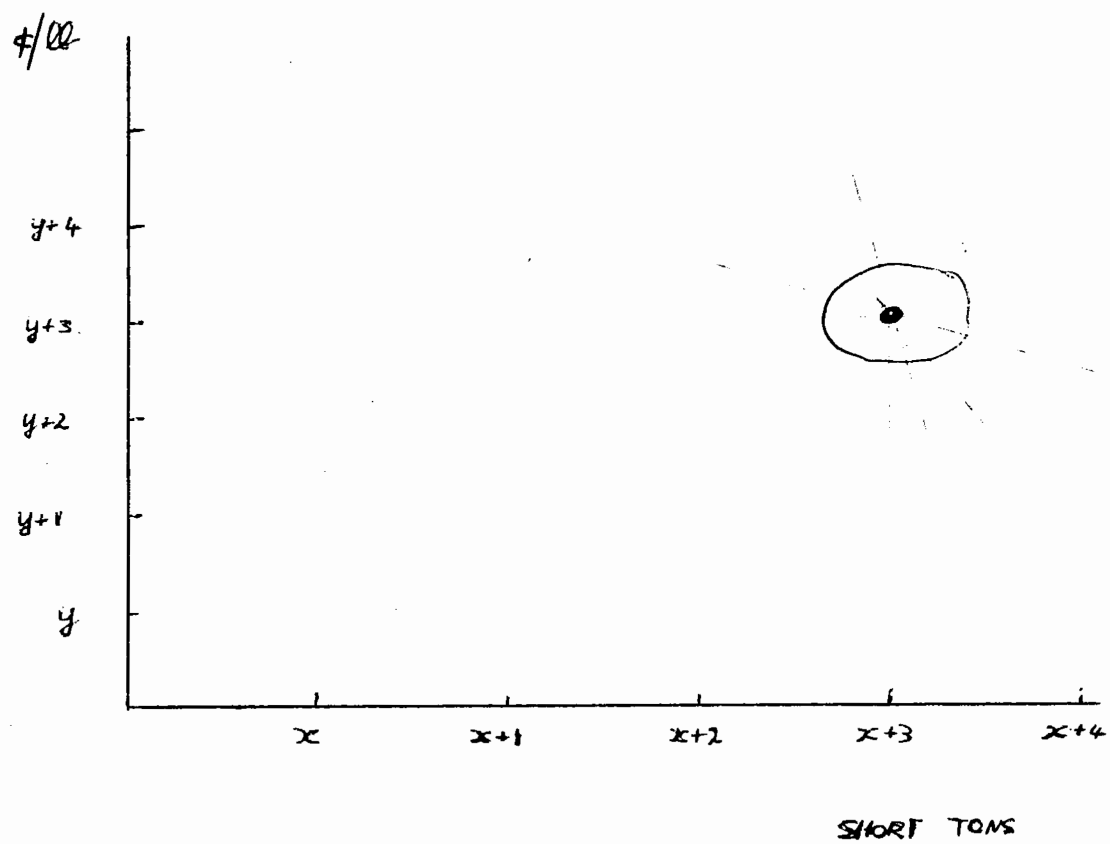
[1] E.J. Working: "What do Statistical 'Demand Curves' Show?", <u>Quaterly Journal of Economics</u>, Vol. XLI, 1927, pp. 212-235. Reprinted in <u>Readings in Price Theory</u>, American Economics Association, Vol. VI, Chicago, 1952.

FIGURE I

HYPOTHETICAL AGGREGATE SHORT RUN ALUMINUM DEMAND



Considering the fact that aggregate demand is made up of some 4,000 end uses, even an attempt to forecast a shift in demand would seem a formidable task. Fortunately, one can lump together most of the end uses into a few major categories which are listed in Table XXI.

The first three categories taken together account for about three quarters of the total. Thus if it were possible to come to some conclusion as to the future prospect of aluminum in these three categories, we would have gone a long way towards gauging the extent of further shifts in the demand curve for aluminum.

The growth of aluminum consumption in the past has been dominated by two features: One, the favorable price of the metal relative to those of substitute products, and two, technological improvements both in the making of an ever-increasing variety of alloys and in fabricating methods. The latter factor is likely to be of greater importance in the future than the former. In Chapter Twelve it was mentioned that aluminum prices - because of higher cost of production - cannot fall much below their present level. If they change at all, they will go up rather than down. The prices of competitive materials, on the other hand, are likely to be kept more stable than in the past. Thus the prices of aluminum and its competing materials can be expected to move more closely together than they have in the past. The time when aluminum prices showed not only relative, but even absolute decreases is unlikely to return.

Thus it will be largely technological improvements which, at a given price of aluminum, will assure the continued growth of aluminum consumption.

TABLE XXI

Canadian Aluminum Consumption 1955 (Estimate)

	TONS	PER CENT
Building and Construction	27,800	30
Electrical Industry	25,200	28
Transportation	15,500	16
Household and Consumers' Supplies	6,200	6
Canning and Packaging	5,200	5
Food and Farming	2,200	2
All Others	12,400	13
TOTAL	94,500	100

Source: Aluminum Company of Canada, Ltd., Submission to the Gordon Commission, *op. cit.*, p. 20.

By way of example, the introduction of the A.C.S.R. (aluminum cable steel reinforced) transmission cable has helped aluminum to capture the high voltage transmission line market to the virtual exclusion of copper.[2] In such a case expansion of aluminum consumption is governed by the expansion rate of transmission lines.

In recent years aluminum has also entered the field of low tension transmission lines, a field which previously had been supplied entirely by copper. Copper production, however, is expected to grow only at the rate of 4 per cent as compared with 8 per cent for the electrical industry. Thus, even if the copper/aluminum price ratio were somewhat less favorable to aluminum than it is today, the latter would still have to replace copper because of the lack of adequate supplies of copper.[3] Naturally, if the long term supply outlook for copper is dim, there is little chance that the copper/aluminum price ratio will change in favor of copper.

Analogous examples can be found for each of the major categories of aluminum consumption. In the field of transportation it is generally believed that the aluminum consumption per automobile in North America will eventually increase to 200 lbs/car from the present 40-45 lbs/car. In the field of building and construction the use of aluminum for windows has expanded in the United States from nothing to 40 per cent of the total within the span of a few years.[4]

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2 Alcan Gordon Commission Report, op. cit., p. 26.

3 Ibid., p. 26.

4 Ibid., p. 24.

The present rate of expansion in fields such as those described above has, however, a physical limit. If, for instance, the rate of growth of aluminum consumption in the window business were to continue, some day 100 per cent of the windows would be made of aluminum and further application could progress at a rate no higher than that of the manufacture of new windows. In all likelihood the use of the metal in this particular application will level off before reaching 100 per cent of the total; but even so the present rate of growth seems assured for another few years.

The conclusions from the above examples are fairly clear: as long as aluminum can expand into a market which it has not yet fully saturated, the rate of growth of its demand can be in excess of that for the economy as a whole. Once a saturation point has been reached, the rate will have to slow down to that of the field in which the metal is used. A case in point is high voltage transmission lines. Some uses, such as the use of aluminum in automobiles, are progressing at a very high rate.[5] Still others, such as the use of aluminum in railroad equipment, have yet barely begun.

Thus one can be fairly confident that the presently observed rate of growth will continue, although it is uncertain for how

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5 Such uses often involve very substantial tonnages. Assuming that aluminum consumption per car would increase by 150 lbs/car, and assuming that North American car production is 8,000,000 vehicles per annum, the additional tonnage required would be 600,000 tons, about the same as Alcan's entire 1956 output.

long.[6] It is certain, however, that it cannot go on indefinitely. Eventually, aluminum will reach the saturation point in an increasing number of applications. We are far from becoming the modern light metals version of Midas with everything we touch turning to aluminum.

A more immediate and perhaps more far-reaching obstacle to the maintenance of the present rate of growth can be expected from the supply side. The historic rate of growth of aluminum demand both in the United States and in Canada has so far been about 10 per cent.[7] Should this rate continue until 1980, total United States demand would be in excess of 20,000,000 tons, or 10 times present demand. Chances that such a figure will be reached within less than 25 years are not very great. Quite apart from the problem of securing sufficient energy to support such an output, the capital required would be so large as to stagger the imagination. Assuming an investment cost of $2,000/ton of fully integrated smelter capacity, about $40,000,000,000 would be required to supply the hypothetical demand of 1980 for the United States.

Even if it were feasible to raise such an amount of capital,

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6 The rate of growth of future demand is an elusive entity. In the past it has been mostly underestimated. In 1952 the Pailey Report (Resources for Freedom, A Report to the President by the President's Materials Policy Commission, United States Government Printing Office, Washington, D.C., 1952), United States aluminum consumption was estimated to reach 4,500,000 tons by 1975 (ibid., Vol. II, p. 67). On the basis of a more recent estimate discussed further below in the present chapter, this figure may be reached as much as ten years earlier.

7 J.E. Rosenzweig: The Demand for Aluminum: A Case Study in Long-Range Forecasting. University of Illinois Bulletin, Aluminum Company of Canada Ltd., op. cit., and Materials Survey, op. cit.

it would be quite impossible to put up anything approximating such a staggering capacity without increasing substantially the cost of production. If cost of production increases, however, the point of intersection between price and demand curve could be expected to move to the left on a given demand curve.

Glancing at Figure II, it can be seen how the actual increase in the quantities of aluminum demanded over, say, the next 25 years may fall well short of a theoretical increase based on present prices and present rate of growth. In the last analysis it is not so much of interest what future demand will be at present prices, as what it will be at future prices. In other words, it is of interest to gauge future consumption and this, in view of the less than perfectly elastic supply of aluminum, will be less than future "demand" as defined above.

For the present purpose, fortunately, it is not crucial to know exactly when the present rate of growth of aluminum consumption will change. In any event this change will be a very gradual one, extending over several years. Thus, as long as the direction of the trend for the more immediate future is known, it is possible to be somewhat vague as to the timing and the extent of changes in the rate of growth of consumption. Primary concern is with the location of future additions to North American capacity. Whether a given additional capacity of, say, 2,000,000 tons becomes feasible within 9 or 13 years does not necessarily have a significant bearing in the present context.[8]

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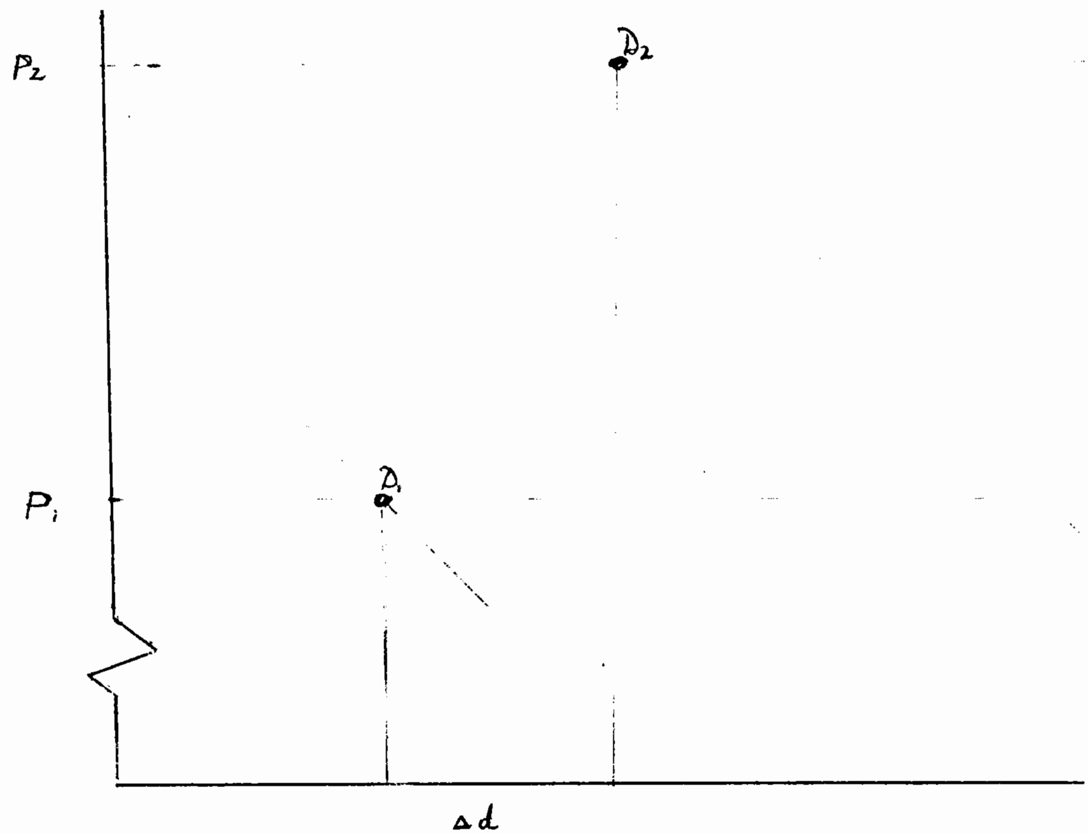
[8] It will be remembered that one of the basic assumptions in this thesis is that there will be no revolutionary change in the technology of producing aluminum. If this assumption is relaxed, the timing may well be more crucial.

FIGURE II



p_1 = present price D_1 = present demand

p_2 = future price D_2 = future demand

Δ d = actual increase in quantity demanded over time.

With this in mind, let us now turn to actual forecasts made for aluminum demand. For North America there exists some good material, but for the other market areas less is available. From the point of view of Canada as a North American supplier present concern is mainly with the future aluminum consumption in North America. It is also of interest to consider in brief the demand in other market areas of the world from the point of view of Canada as a supplier of capital and managerial talent to aluminum ventures abroad. More of this in Chapter Fifteen.

For North America there are two forecasts, both recent and authorative. One is for the United States and one for Canada. The former, by J.E. Rosenzweig,[9] represents a sophisticated attempt to bring into play several statistical methods, as well as one non-statistical method of forecasting. All of these point to one result: 4,250,000 tons per annum by 1965.

The two statistical approaches, trend projection and correlation analysis, are based on a historical series of United States aluminum consumption. The non-statistical approach examines the major areas of aluminum consumption along similar lines as indicated above, and compiles the findings of a survey conducted by Dr. Rosenzweig which solicited estimates of future aluminum shipments from various industry branches.

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9 Op. cit.

Dr. Rosenzweig's forecast of 4,250,000 tons should perhaps be accepted with some caution. It constitutes future demand at past and present prices. No consideration was given to the supply side of the picture, and the author may well have missed the significant difference between 1965 demand (at present prices) and 1965 consumption. This distinction is blurred, particularly because of the use of a historical consumption series, which includes periods of decreasing aluminum prices (both in absolute and in relative terms) in the projection of future "demand".

In all fairness, it should be mentioned that it was not within the scope of Dr. Rosenzweig's study to take account of the influence of supply factors. For the present purpose, on the other hand, it should be kept in mind that higher cost of production may well cause future consumption of aluminum to fall short of forecast future demand.

The Canadian forecast is contained in the Aluminum Company of Canada's submission to the Gordon Commission. The methods used to arrive at the stated results are not mentioned. Chances are that they were not quite as sophisticated as those of Dr. Rosenzweig, but Alcan's forecast appears to be guided by a good deal of intimate knowledge of markets and may well approximate more closely future consumption rather than future demand at present prices.

In fact, Alcan gives two forecasts, one for 1960 which is reproduced in Table XXII and one for 1980. For the latter year, Alcan estimates Canadian consumption at 550,000 tons a figure which is

TABLE XXII

Estimated Consumption of Aluminum in all Forms in Canada in 1955 and 1960 by Trade Classifications

	1955 (tons)	1960 (tons)
Building and Construction	27,800	42,500
Transportation	15,500	29,200
Household and Consumers' Supplies	6,200	12,200
Electrical Industry	25,200	34,000
Food and Farming	2,200	3,300
Canning and Packaging	5,200	11,600
Other Industries	12,400	12,400
TOTAL	94,500	145,200

Source: Alcan Gordon Commission Report, p. 29.

based on a rate of growth of 7.8 per cent per annum from 1955 to 1965, and 7.0 per cent from 1961 to 1980. It is also based on several assumptions which are set out in Table XXIII.

To express the Canadian figures on a basis comparable to that for the United States forecast, one can take the estimate for 1960 and project it to 1965 at the rate given in connection with the 1980 estimate. One would thus obtain an estimated Canadian consumption in 1965 of 210,000 tons.

Turning now to aluminum consumption in the other major market areas of the world, one striking fact stands out. Aluminum is a rich man's metal. As can be seen from Table XXIV per capita consumption would appear to be in high correlation to a country's standard of living.[10]

With an industrial structure similar to our own, one would expect Europe to follow a consumption pattern similar to the one observed in North America. However, since aluminum supply in Europe could not, in the past, be expanded at sufficiently low cost, the rate of growth of aluminum consumption may in some instances have been retarded by high prices. Also, the economic conditions influencing aluminum consumption often vary considerably from one country to another, making the task of bringing all these factors to a common denominator an exceedingly difficult one. No attempt shall be made, therefore,

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[10] No per capita income figures are given for the countries listed in Table XXIV. To have any meaning, such figures would have to be brought to a common denominator which is difficult.

TABLE XXIII

Major Assumptions for Estimate of Total Canadian Consumption of Aluminum in 1980

1) Population of Canada will be 27 million.

2) A substantial portion of all house wiring and telephone lines will be aluminum.

3) Electric generating capacity in Canada will have increased at a rate of 6½% per annum.

4) Production in the transport industry will be:

Passenger cars	1,000,000 units
Trucks	296,000 units
Semi-trailers	20,000 units
Railway cars	5,300 units.

Source: Alcan Gordon Commission Report, p. 34.

TABLE XXIV

Per Capita Consumption of Aluminum in Selected Countries, 1953.

		lbs.
North America:	United States	19.89
	Canada	11.32
	Mexico	0.51
Europe:	United Kingdom	10.26
	Sweden	8.09
	Switzerland	6.29
	West Germany	6.22
	Norway	5.68
	France	4.59
	Italy	3.48
	Belg. Luxemburg	2.57
	Holland	2.55
Other:	Japan	1.13
	Brazil	0.58
	India	0.05

Source: Materials Survey, op. cit., p. VIII-5.

to give any figures for future European aluminum consumption.

Turning now to the rest of the world, the ground seems even less certain. Future aluminum consumption, particularly in what are commonly described as the underdeveloped regions, will depend largely on two factors, relative prices and the degree of industrialization. As mentioned before, about 50 per cent of aluminum's total output competes with steel. In most of these applications the price elasticity is very high. Thus, it would be quite conceivable that if priced too high aluminum would not find acceptance similar to North American standards. If, on the other hand, sufficiently low cost supplies are available, aluminum consumption in underdeveloped countries can be expected to increase quite dramatically. Even then, however, tonnages in absolute terms are likely to remain a small part of total world consumption for a long time to come.

In Europe, as well as in other parts of the world, much will depend on the availability of sufficient low cost supplies. The availability of such supplies is important enough to warrant a brief review of recent and possible future developments in this field.

CHAPTER FOURTEEN

NATIONALISM AND WORLD SUPPLY

Not much more need be said about the future supply of metal in North America. Assuming for 1965 a demand in the United States of 4,250,000 tons and in Canada 210,000 tons, presently scheduled capacity for 1960 would have to be augmented by more than one million tons to meet demand in 1965.

At least part of such additional expansion will be located in the Ohio Valley. As time progresses, however, it would become increasingly unlikely that Canadian hydro-power could be ignored entirely by the American producers.

According to one estimate[1] at least 20,000,000 horse power of undeveloped hydro-potential exists in Canada which could be used for the economic production of aluminum. If this were considered firm power, such a potential could support a production of as much as 6,000,000 tons per annum. Although not all of this power is likely to be as low cost as that of the Saguenay Valley, it would still have the advantage over coal in that once built, it would be impervious to price increases. Because of its remoteness, it would also be safe from other industrial users of power with their record of crowding out the aluminum producers.

At least part of this potential will undoubtedly be developed by Canadian firms, the Aluminum Company of Canada, the Canadian British Aluminium Company, and possibly other firms which may yet enter the field.

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[1] Aluminum Company of Canada Ltd., Submission to Gordon Commission, op. cit., p. 46.

If the American producers should find in the future that Canadian producers are able to make appreciable gains in the United States market because they can expand their supply more readily, the former may well learn to overcome their reluctance towards the conditions attached to the use of Canadian power.

Unlike the North American industry, aluminum facilities in Europe have just about pressed to the limits of available power resources. Up until now, Continental Europe has been very largely self-sufficient. (See Table XXV) England, on the other hand, had to depend almost entirely on imports which may soon gain greater importance in other European countries as well. This is particularly true of West Germany, the largest consumer of aluminum on the Continent. In cognizance of the inability to expand German smelting facilities much further, the West German Government recently permitted a group of West German fabricators to enter into a long term contract with the Canadian producer for the following tonnages:[2]

1957:	15,400 tons
1958:	26,400 tons
1959:	37,400 tons
1960:	44,000 tons
1961:	55,000 tons.

The tonnages involved are modest. Nevertheless, this might be the beginning of Canada becoming Germany's chief supplier of demand in excess of domestic capacity. If that were the case the tonnages

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2 Aluminum Company of Canada, Prospectus, April 9, 1957.

TABLE XXV

Production and Consumption of Aluminum in Western Europe 1953

(Short Tons)

COUNTRY	PRIMARY PRODUCTION	SECONDARY PRODUCTION	IMPORTS	EXPORTS	CONSUMPTION
England	34,626	90,206	201,037	64,973	260,896
West Germany	117,881	50,600	26,865	42,922	152,424
France	124,627	25,419	2,469	54,107	98,408
Italy	61,130	17,000	10,629	5,110	83,649
Sweden	10,635	200	18,626	449	29,012
Austria	47,924	9,967	74	33,449	24,516
Switzerland	30,865	n.a.	3,918	19,446	15,337
Holland	nil	nil	15,387	2,016	13,371
Belg. Luxemb.	nil	1,620	16,505	6,466	11,659
Norway	59,043	2,271	3,206	54,976	9,544
Denmark	nil	nil	5,316	438	4,878

Source: Materials Survey. Aluminum, op. cit., p. VIII-5.

involved might eventually be far more than the modest figures above. Unfortunately for the Canadian producer, such a development appears to be unlikely.

There are indications that the whole industrial and commercial organization of Europe may soon undergo gradual and yet fundamental changes which would lead to the virtual exclusion of Canadian metal in the European market.

For decades the frame of mind of the European industrial community has been oriented towards vested interests and protection of home markets. The greater occurrence of market agreements, cartels, etc., in Europe as compared with America, was not so much due to a greater degree of ruthlessness on the part of European industrialists in exploiting the consumer, as it was the result of a different attitude towards economic activity. This attitude was condoned and even fostered by various European governments. A result of this industrial parochialism was that most market areas were relatively small, and the economies derived from large scale mass production were inadequately developed.

Before the war this was not very apparent. The Great Depression was a great leveller which saw to it that everyone was equally poor. The wave of post-war prosperity which followed did much to break down the traditional attitudes of Europeans. For several years after the war, Europe's primary concern was of course the reparation of war damage. This phase of reconstruction, however, was essentially completed some years ago and since then the idea of a large mass market in Europe has been gaining support. The desire to overcome the impediments of small national markets has recently found expression in the European Common Market scheme. This scheme appears to have sufficient merit to the major industrial nations of Europe so as to make its eventual implementation quite probable.

On the whole, Canada need not to be very worried about the repercussions of the European Common Market scheme on Canadian exports. This at least is the attitude reflected in a number of press opinions on the subject.[3] By and large this makes good sense since most Canadian exports to Western Europe are made up of raw materials and semi-processed goods in which Europe is deficient. This is particularly true of wheat, Canada's largest export item to Europe. In the absence of a genuine alternative within the European Common Market area, Canada need have no fear of tariffs on wheat.

Aluminum is not so fortunate. Although traditional sources of supply within Europe do not lend themselves to much further expansion, the Common Market scheme would comprise African territories which are politically and/or economically linked with Europe. Some of these areas would lend themselves quite well to the economic production of sizeable quantities of aluminum.

England will gradually tend to buy less metal from Canada as sterling sources of supply, such as the Gold Coast scheme, become feasible. Since the European Common Market scheme also comprises parts of Africa, it will have similar opportunities for the development of

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[3] Joyce A. Marshall: "A Canadian Guide to the European Common Market", Canadian Business, Sept. 1957, p. 44. Also: Financial Post, August 17, 1957.

future sources of supply for metal.

At present two schemes are being discussed, one in French West Africa and one in the Belgian Congo. Both these schemes have excellent chances of being executed within the next few years.

The smaller of the two, the French West African scheme, holds the promise of coming into production well before the Inga scheme. The details of the French West African plans are somewhat involved.[4] Both French producers, Pechiney and Ugine as well as Aluminium Ltd., hold title to extensive bauxite reserves in the region. Since 1950, the latter company has been exporting bauxite from the Los Islands off the Coast of French West Africa. The present annual rate of these exports is estimated to be about 500,000 short tons. In addition to its Los Islands deposits, Aluminium Ltd.. owns extensive deposits of bauxite in the Boke region, about 185 miles north west of Conakry. To exploit these deposits Aluminium Ltd.. plans to build an alumina plant adjacent to the mines with an initial annual capacity of 250,000 short tons.[5]

In another part of French West Africa, near the Konkoure River, another alumina plant is scheduled to be built jointly by the two French Producers before 1960. Capacity of this plant is expected to be 480,000 tons. The refined ore from this plant is to supply a 250,000 to 300,000 ton smelter to be built on either the Konkoure or Kouilou River. The latter plant is to be built by "Afral", an international

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[4] The Metal Bulletin, Nov. 23, 1956, p. 20.

[5] The Metal Bulletin, ibid., p. 21.

consortium of aluminum producers, including Pechiney and Ugine of France, V.A.W.[6] of Germany, Montecatini of Italy, A.I.A.G.[7] of Switzerland, and Aluminium Ltd. of Canada. Still another, although smaller smelter[8] is to be built by 1958 at Edea in the French Cameroons. This latter project appears to be carried out by French interests entirely.[9]

Although no complete time schedule is available for these French West African projects, it would appear not unlikely that the Konkoure smelter would come into operation some time in 1960, the year when the adjacent alumina facilities are expected to be completed.

Another still more ambitious project is shaping up in the Belgian Congo.[10] Here the Inga site has been shown to be eminently suitable to the development of an ultimate power output larger than anything known hitherto outside North America. Inga is located on the lower Congo River about 25 miles from a seaport. After having fallen 400 feet within 10 miles the Congo is forced through narrow rapids at Inga with a daily flow of approximately four times as large as Niagara Falls.[11]

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[6] Vereinigte Aluminium Werke, G.m.b.H.

[7] Aluminium Industrie, A.G.

[8] 45,000 tons ultimate capacity.

[9] The Metal Bulletin, ibid., p. 21

[10] Financial Post, August 17, 1957.

[11] Financial Post, August 17, 1957.

One of the attractions of the scheme is that Inga is suitable for development in stages, up to an ultimate capacity of 25,000,000 horse power. Such a capacity, if firm, could theoretically support an aluminum production in excess of 7,000,000 tons.

The parties interested in the Inga project would, however, not like to see all this power go towards aluminum production. They envisage an industrial complex developing around this power which might eventually parallel some of the major industrial concentrations in Europe itself. Such hopes may in the end prove to be somewhat over-optimistic. The initial stages of the project, on the other hand, if backed by sound plans centering on aluminum production, are more likely to be realized.

Any such power scheme would involve heavier capital expenditure at the start than at the later stages. This is reminiscent of Kitimat where a good part of the total had to be built before the first stage of production could be brought into operation. Furthermore, although it was said that Inga could be developed in stages, the nature of hydro-electric developments makes such stages quite large. In such a case, aluminum smelting is an ideal first customer. Aluminum capacity can be designed such as to coincide very closely both in time and in size with hydro-capacity. Also, because of its high load factor, aluminum smelting is one of the most economical users of power.

It is therefore not surprising that an impressive array of aluminum producers have formed a study group to determine the aluminum potential of the Inga site. They are led by a Belgian aluminum syndicate and include the two French producers, Aluminium Ltd., A.I.A.G., V.A.W., Montecatini, and Reynolds.[12]

Inga is short of perfection in only one respect. Unlike the proposed Konkoure smelter, it has no bauxite in its immediate neighborhood. Ore would have to be imported from French West Africa, the Gold Coast, or possibly even from the Carribeans. All these regions have been exporting bauxite in large volume for some time.

As far as Canada is concerned, the timing of these African schemes will be of some importance. If European demands were to increase more rapidly than the African projects could be brought into operation, Alcan would stand a good chance of supplying much or all of the deficiency. However, even if such deficiencies developed, they would be only temporary. The French Edea project is expected to come into operation some time next year, and the first stage of the Konkoure smelter not much later than 1960.[13] Inga appears to be somewhat further off. Even if no delays occur, it may be ten years before power is available from that source.

Considerable importance should be attached to these African schemes even though it is not known whether aluminum can be produced at costs comparable to those in Canada. In all probability, cost considerations will be of secondary importance. Of primary importance will be nationalistic influences which may well make possible the realization of projects which, without protective measures, would not be feasible.

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12 Financial Post, ibid.

13 The Metal Bulletin, op. cit., p. 21.

These nationalistic motivations can be expected to be even stronger in other parts of the world than in North America, particularly in underdeveloped countries. There is no immediate prospect of sizeable aluminum schemes coming into operation in these areas, since consumption does not warrant production facilities as large as, say, those of Western Europe. In 1953 North America and Western Europe together accounted for approximately 95 per cent of Free World consumption. Of the remaining 5 per cent, Japan alone accounted for almost half, and that country is at present self-sufficient in primary aluminum.

Should industrialization of underdeveloped countries ever develop to the point where aluminum consumption would increase appreciably, this demand would in all probability be supplied from locally developed sources, not from Canada. Embryonic aluminum reduction industries already exist in those countries which hold out the promise of developing more rapidly than others. Cases in point are India and Brazil. In fact, Japan, the only highly industrialized nation of the Far East, was in 1953 the world's sixth largest producer of primary ingot.

CHAPTER FIFTEEN

THE ROLE OF ALUMINIUM LIMITED

It is interesting to note that all aluminum schemes referred to in the previous chapter have Aluminium Limited as a possible participant. The Gold Coast scheme involves four parties, Aluminium Limited, British Aluminium Company, and the Governments of England and Ghana. The French scheme involves all major European producers as well as Aluminium Limited. The Inga project has not yet progressed to the point where an aluminum company need be formed. However, Aluminium Limited is a party to the study group which is investigating the site.

In Japan there are three primary producers, the largest of which, Nippon Light Metals Company, Ltd., is owned 50 per cent by Aluminium Limited.[1] Brazil, the only producing country in South America, has two primary producers, one of which is owned by Aluminium Limited.[2] Similarly, India has two producers, in one of which Aluminium Limited has a majority interest.

All this is no accident. The European schemes being mooted at the present time exceed by far a size that individual European firms are accustomed to handle. Here is room for a firm with substantial financial strength and experience in the development of large construction projects in the wilderness. In the Far East and in South America, such a firm is needed not only because of the lack of local

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1 Materials Survey, <u>op. cit</u>., p. XI-45.

2 To be exact, Electro Quimica Brazilieira, as the company is called, is owned by a fabricating company which in turn is owned by Aluminium Ltd. Materials Survey, <u>ibid</u>., p. XI-7.

capital and experience, but also because of the lack of determined leadership and initiative.

The reasons why Aluminium Limited, rather than another large producer, should find itself cast in this role are manifold, but not difficult to divine.

The only other aluminum producers with sufficient financial strength to enter into so many ventures at the same time would be the Americans, who at this point are still primarily concerned with their domestic market. Aluminium Limited's prominence in the International investment picture is, however, not the result of "negative selection". Rather, it is brought about by a number of positive qualifications which that company has.

The qualifications which Aluminium Limited brings to the job of international investor are both tangible and intangible. Of the more intangible ones is the fact that Aluminium Limited is a Canadian corporation, not an American one. Sufficient prejudice exists against United States capital in many parts of the world to make it an advantage not to be American.

Much more important is the fact that Aluminium Limited was originally conceived as an international enterprise. It has a wealth of experience in operating in numerous countries throughout the world. In the process it has developed a corporate structure which is perhaps unique and which is eminently suitable to the task of running a far-flung international enterprise.

Aluminium Limited is in the last analysis a legal fiction. Its legal residence is Montreal, but it has only one employee, the President, who lives in Boston. Aluminium Limited does not have an office of its own in Boston, so the President shares the premises of an affiliate company.[3]

Aluminium Limited to a large extent is the titular head of some sixty subsidiaries and affiliated companies making up the "Aluminium Limited Group of Companies". Most of these enjoy an unusual degree of autonomy. Only broad policy lines are determined by Aluminium Limited through the instrument of a top level management team located in New York City. This top management team is made up of the chief administrative officers such as finance, secretarial matters, sales, etc. Oddly enough, their professional and technical staff are all in Montreal.

The role of the president also seems to be an unusual one. He appears to be more of a chairman of the management committee, and a coordinator of occasionally conflicting policies within the organization.

The emphasis within the Aluminium Limited Group of Companies is clearly on decentralization, local autonomy and avoidance of too rigid an administrative framework. As a consequence nothing really exists that could be suitably expressed in an organization chart. Whatever organization does exist is highly pragmatic thus affording the flexibility which is so important for operation in a complex and diversified environment.

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[3] Details of the description of Aluminium Ltd.'s organization are taken from an article entitled "Aluminium Ltd.: Unlimited Aluminum", Fortune, June 1954, p. 105.

The present organization of Aluminium Limited probably came about through past experience and historical accident,[4] rather than through deliberate planning.

When Aluminium Limited was formed in 1928, Alcoa's former holdings abroad occupied a far more prominent position in the Aluminium Limited Group of Companies than they do today. They were the result of the transplantation to Europe of some of Alcoa's early practice of "pushing" the metal. We mentioned in an earlier chapter that Alcoa's early years were dominated by the need to fabricate their own metal because of the lack of interest on the part of independent fabricators. In Europe, fabricating plants served at first still another purpose. Because of the existence of several suppliers of ingot, company owned fabricating facilities were a safe and dependable outlet for metal produced in company owned smelters.

Alcoa had acquired what at the time were very extensive bauxite reserves in Europe, participations in local smelters (Norway and Italy) and hydro-power rights (France). It would thus appear that Alcoa's original intention was to become entrenched in the European market along similar lines as it had become established so successfully in its own home ground.

Aluminium Limited inherited this network of European companies when it was still short of the same degree of full integration as that of other European producers, and of Alcoa in North America. At about the same time Arvida set the stage for Aluminium Limited to become a powerful,

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[4] According to the Fortune article to which reference is made above, the reason for the Boston residence of Aluminium Ltd.'s president is that his father, whom he succeeded in the post, was an ardent Cape Codder who refused to live anywhere else.

large-scale and low cost producer. There were thus two distinct, if not conflicting, traits in Aluminium Limited's organization. It operated a partially integrated aluminum empire in Europe, and at the same time was a major exporter. These traits apparently co-existed for a time without one gaining a clear prominence at the expense of the other. This was particularly true under the stagnating influence of the Depression.

World War II and the magnitude of post-war demand almost completely obliterated the European end of the business. The fact, however, that these investments figured so prominently during the "formative" years of Aluminium Limited as an independently functioning unit has undoubtedly given the company a wealth of experience in carrying on operations abroad. This is also true for the sales organization which Aluminium Limited maintained before the war, not only in Europe, but also in South America and the Far East. It is not unlikely that Aluminium Limited's top sales policies are still guided today by men who gained their experience in the nineteen thirties when a contract for a few dozen tons represented a major accomplishment.

With such a background it is not surprising to see that the Aluminium Limited Group of Companies has its own School of Business Administration, the Centre d'Etudes Industrielles in Geneva, Switzerland. This school, which was founded after the war, has the avowed purpose of training young men of executive ability in the complex field of international economic activity.[5]

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[5] Centre d'Etudes Industrielles Program 1956-1957.

While the outbreak of World War II relegated Aluminium Limited's foreign interests outside Canada, United Kingdom and British Guiana to a secondary role, the termination of the war appears to have done little to change their status quo within the organization. Most of the European companies originally acquired by Alcoa still exist today and are still owned by Aluminium Limited. Judging from the latter's Annual Reports and share prospectuses in recent years, the European companies - with the exception of the Northern Aluminium Co. Ltd., of England - appear to have been largely bypassed in Aluminium Limited's post-war allocation of investment funds. Since for many years after the war no funds could be transferred from Europe to North America, one can presume that whatever improvements Aluminium Limited's companies in Europe made were financed out of local cash generation.

Although Aluminium Limited invested little or nothing in Continental Europe, it invested in increasingly large projects in other foreign countries. Most of these were in direct support of Canadian smelter operations. They included the extension of mining facilities in British Guiana and Jamaica, the construction of entirely new mining, rail and port facilities on the Los Islands off the French West African Coast, and alumina facilities in Jamaica. The expansion of ore facilities in Jamaica is still in progress, and recently plans for the construction of similar facilities in British Guiana were announced. The aggregate investment in such supplementary facilities in Jamaica alone over the period 1951-1956 amounted to approximately \$70 million.[6]

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[6] Aluminium Limited, Annual Report 1956.

In spite of the magnitude of the investments described above, they can hardly be viewed as the chief "raison d'etre" for Aluminium Limited. Conceivably they could be planned and carried out by Alcan with whose scheduling of capacity increases they would have to dovetail in any case. Were it for these investments alone one might indeed be tempted to conclude that Alcan has come to be the tail that wags the dog.

Such a view would overlook another type of investment to which Aluminium Limited has been giving increasing attention in recent years and which may well lead to a re-emergence of Aluminium Limited as a major power in the international aluminum industry. This may happen in spite of the fact that Alcan may be growing into a North American supplier to an increasing extent.

Developments of this nature are already clearly marked by Aluminium Limited's entry into the field of primary production in countries like Japan, Brazil, and India. Although the latter two investments are still quite small, Aluminium Limited's participation in the Gold Coast scheme, its interest in the French West African aluminum smelter and the Inga scheme would seem to indicate that the company is ready to venture into more sizeable projects.

Aluminium Limited's main limitation in this regard will be its ability to raise sufficient capital. The expansion of Alcan's smelting in Canada and ancillary facilities abroad will for some years to come constitute the prime call on Aluminium Limited's investment funds. Should Alcan be included by the United States in a continent wide defense production concept, Alcan's claims on available investment funds may even be so large as to seriously hamstring the pursuit of

Aluminium Limited's independent foreign investment plans. Even if Alcan's future development is a very gradual one, the procurement of sufficient funds for its dual objectives will be one of Aluminium Limited's major problems.

Referring back to our chapter on the relationship between cash generation and borrowing for expansion purposes, it would seem that, within certain limits, total funds available to Aluminium Limited for investment in Canada or abroad would be a function of the company's cash generation.

Here Aluminium Limited faces a dilemna. Unlike the large American producers, the Canadian company has by tradition been chiefly a supplier of ingot with only limited fabricating interests. Profit margins on ingot are generally considered to be lower than on fabricating operations. Investment outlay per ton of capacity, on the other hand, is higher for ingot than it is for fabricating. As a result, a company with full integration extending to the fabrication stage would, for a given size, possess greater financial strength than a company whose integration did not extend much beyond the smelting stage.

Should Aluminium Limited wish to increase its cash generation, it could do so by concentrating more heavily on fabricating than it has done in the past. Increasing ingot prices is no real alternative. During times of soft demand Aluminium Limited might well find demand so highly elastic that its profits would decrease, rather than increase. During times of scarce metal, the animosity created by a unilateral price increase would by far outweigh whatever limited profit advantages the company might gain. The fact that the company refrained from trying to charge "what the market would bear" in the recent shortage years demonstrates this point.

Placing greater emphasis on fabricating, however, is not without pitfals either. Aluminium Limited's main difficulty here can perhaps best be understood when the following is considered: By far the largest part of the Group's fabricating capacity is located in only two countries, Canada and England. All other Group fabricating companies are but a small percentage of the total. Since balance sheets, Statements of Net Income, etc. for all but a few Group companies are not publicly available, the employment figures in Table XXVI must suffice to indicate the relative size of Group companies in various geographical regions.

With the exception of Canada and the United Kingdom, Aluminium Limited has traditionally been a "marginal" supplier of ingot in the event of local shortages. Because of the constant threat of domestic producers taking recourse to greater tariff protection, Aluminium Limited never could afford to be an aggressive seller trying to break into the home market of local producers. The company has rather endeavored to benefit from a growth in demand in excess of domestic production. In cases where domestic producers were able to supply all the metal required, Aluminium Limited has often bowed out voluntarily and shifted its supplies to other market areas.[7]

The chief exception to this pattern has been England where Aluminium Limited is in a sense a domestic producer and where local production could supply only about 15 per cent of demand. The chief case in point has been the United States. The very large tonnages delivered to that market in recent years should not distract from the

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[7] Fortune, June 1954, op. cit., p. 105.

TABLE XXVI

Geographical Distribution of Aluminium Ltd. Employees and Nature of Business Operations as of December 31, 1956

Area	Nature of Operations*	Employees of Consolidated Subsidiaries Only	Per Cent
Canada	M.S.F.	22,492	48
United Kingdom	F.	7,332	15
Carribean	M.	6,683	14
Europe	M.S.F.	3,828	8
Asia	M.S.F.	3,438	7
South America	M.S.F.	2,315	5
Africa	M.F.	1,333	3
United States	n.a.	192	nil
Other	n.a.	14	nil
			100

* M. stands for mining, S. for smelting, and F. for fabricating. n.a. stands for not applicable.

Sources: Aluminium Ltd. Annual Report for 1956, p. 19
Materials Survey: Aluminum op. cit. ch. XI.

fact that they were marginal in the sense defined above.

What makes it difficult for Aluminum Limited to expand the fabricating branch of its business is the fact that the company's role as a "marginal" supplier of ingot is hard to reconcile with being a competitor of its own customers. As mentioned earlier, in its role as a supplier of ingot Aluminium Limited has powerful allies in the American independent fabricators. Should Aluminium Limited be unwise enough to enter the fabricating field in the United States, it would only drive the independents to make common cause with the Big Three producers against the "foreign" competition.[8]

A similar line of argument may hold for Western Europe as well. If that is so, Aluminium Limited showed reluctance to advance in the fabricating field beyond its pre-war position, not so much because of the tonnages it did sell, but because of the tonnages it hoped to sell. If it turns out to be true that Western Europe is less of a customer of Canadian metal than may have appeared probable a few years ago, this would remove the chief reason for not being aggressive. It should therefore not be surprising if Aluminium Limited started to intensify its fabricating activities in Europe before very long.

Fortunately for its long term outlook, Aluminium Limited need not be concerned about the feelings of established local producers and fabricators in all regions of the world. In some countries, less industrialized than those of North America and Western Europe, Aluminium

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[8] The fact that well over 70 per cent of Aluminium Limited's common stock is owned by United States investors does not appear to modify the Americans' practice of considering Aluminium Limited as a foreign company.

Limited has been the first firm to start aluminum prodution or fabricating or has breathed life into faltering local attempts to do so. In such an environment there is no reason to leave fabrication to independents. In fact, the Canadian company may well have to follow the example of the Pittsburgh Reduction Company and take the initiative in fabricating as well. In the case of the Pittsburgh Reduction Company this was due to the lack of interest among independent fabricators. In the case of Aluminium Limited's investments in underdeveloped countries it may be due to the lack of local capital and technical knowledge. It is not surprising, therefore, to see that in countries like Brazil, Japan and India Aluminium Limited's investments are fully integrated from the mining of bauxite to the fabrication of the metal.

Investments of the type now existing in India and Brazil are still a rather small part of Aluminium Limited's investment portfolio. As time goes on, however, they may well grow to be an important part of the Canadian firm's activities.

CONCLUDING REMARKS

It is difficult to summarize the foregoing analysis in a few, simple statements. Reality is too complex to make generalisation easy. Nevertheless, it should be possible to offer a few observations on some of the issues involved.

It is of more than passing interest to note that the traditional monopoly concepts are woefully inadequate in viewing the industry. At the moment of writing the Aluminum Company of Canada Limited is still the only producer and the only seller of primary aluminum ingot in this country. By textbook definition, the company is a monopolist. In the broader meaning of the term so commonly employed in economic literature, this fails to describe the Canadian aluminum producer usefully.

In the classical thinking, a monopolist is a firm which is the only seller in a market with a sloping demand curve. It has often been observed that such firms do not display the traditional textbook behavior expected from them. Usually, over extended periods of time, their prices are lower than "what the market would bear". This, it is then argued, is no basic departure from the expected pattern, in such a case a firm merely maximizes its monopoly profit over a longer period of time. The question may well be asked as to what extent the Aluminum Company of Canada resembles this concept.

By far the largest part of the company's product is sold abroad where it competes with that of other suppliers. Even in England Alcan has no vested position. It should be remembered that England has drawn in the past on other sources of supply and that in the future sterling metal is likely to edge out Canadian metal. In other markets Canada is a marginal supplier with continued sales depending heavily on the goodwill which the company has to create. In such a situation monopolistic practices can be dangerous. Even in Canada there is not much point in speaking of the monopolistic position of the company. Supposing, for the sake of argument, Alcan decided to charge independent Canadian fabricators 2¢/lb. more than it would normally charge. There is no duty on ingot in Canada, so the independents could import their metal requirements instead of buying from Alcan. Should such price discrimination be practised in a time of acute metal shortage, it is conceivable that Alcan would earn a "monopolist's profit". It would do so, however, only on less than five per cent of its total output.[1] It is most unlikely that the considerable damage to the company's reputation and to future sales prospects resulting from such an action would be compensated even in small measure by the rather insignificant incremental earnings.[2]

Aluminum producers in North America have charged prices which by and large did not maximize profits in the textbook sense.[3] To argue, however, that they did so to maximize their long-run profit would not be very useful either.

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1 Only about 15 per cent of Alcan's output are consumed in Canada. Of that, about two thirds are processed by Alcan itself.

2 This is quite apart from the effects of substitution which would ensue. As mentioned earlier, the cross elasticity of aluminum and substitute materials is high.

3 This is also acknowledged for the pre-war period by Wallace, op. cit. p. 233. In this context, incidentally, Wallace defines a "normal" return as consisting of earnings of 8 percent. Anything which is over this rate is a monopoly profit. Having in mind the truly dynamic nature of profits, as compared with the static, neo-classic concept, such a definition would seem to be of limited value. Profits vary over time. What may seem good during a business downturn may be judged disappointing during a boom. Also, profits may vary from one industry to another. But, most important, all profits are in the last analysis dynamic "windfalls".

The term "maximisation of profits" is unfortunate because of the connotations it carries. It conjures before the eyes of the reader a socially detrimental act, that of exploitation of the economically weaker party. To be sure, under the static assumptions of the classical model, this connotation is correct. In a dynamic situation, however, "maximizing profits" is often accomplished by a low unit profit, high volume policy. Such a policy yields essentially the same socially useful results as are expected from the classical model of competition. To return to the Aluminum Company of Canada, there is little doubt that this company's policies fall within the latter category.

Questions of market control and whether a profit is "too high" or "normal" are truly universal and not confined to distinct geographical areas. An issue with a more Canadian flavor which concerns Alcan as well as a large number of other Canadian companies is the predominance of foreign, mostly U.S., capital in Canadian industry. From time to time it has been alleged that the extent of foreign control of industry in Canada is harmful. To discuss this issue per se would, of course, not be within the scope of the present study. It may be of some interest, however, to look at the role which American capital has played in the Canadian aluminum industry.

Until 1928, Alcan was a fully owned subsidiary of the Aluminum Company of America. Shares of the former company were not readily available to Canadian investors. When Aluminium Limited was formed, 100 per cent of its shares were turned over to the shareholders of Alcoa, almost all of whom were Americans. Since then, however, Canadian holdings in Aluminium Limited have increased steadily. As of December 31, 1955, 26 per cent of Aluminium Limited's common stock was owned by

Canadians, 72 per cent were owned by Americans.[1] At that date the Canadian participation was worth more than $250 millions at then prevailing market prices. This is believed to be a larger Canadian equity holding than that at risk by Canadians in any other Canadian manufacturing enterprise.[2] While it is interesting to note that the Canadian equity has increased from practically nothing to 25 per cent, this does not by itself make it a Canadian company. In fact, it would seem that any particular percentage of shares held in Canada or in the United States has little influence on whether the company should be considered truly Canadian. A very large share of the company's output is at present sold in the United States, and this dependence on the American market may even increase in the future. Yet the fact that almost three quarters of the business is owned by Americans has in no way enhanced the company's position in that market. The American industrial community considers Alcan as a foreign company irrespective of the predominance of American ownership, and the company has little choice in the matter.

Quite apart from its marketing aspects, there seems little doubt that Alcan is a Canadian company forming an integral part of the Canadian economy. Its production facilities are located in this country, it directly employs some 22,000 residents of Canada, it uses one of the main natural resources and the Company's product is one of Canada's major exports. With this in mind, the company's contribution to Canadian

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1 Alcan Submission to Gordon Commission, op. cit., p. 17.

2 Alcan, ibid., p. 17a.

economic development is unquestioned.[1]

Aluminium Limited, on the other hand, is more international than its main operating subsidiary. Before the war, Aluminium Limited was probably not much more than a sales agency trying to place Alcan's metal. Since the war, its function of financing investment projects has become more prominent. Most of it has served so far to supplement Alcan's smelting operations.[2] In the future, participations in aluminum smelter schemes can be expected to increase. Although the latter may be labelled more properly International rather than Canadian, they do have a profound significance for Canada.

It will be remembered that the Canadian aluminum industry came to life as a result of the inflow of foreign capital. Some of the funds for current expansion still come from abroad, mostly the United States. The fact stands out, however, that the industry becomes less and less dependent on these sources as time goes on. First, stock or bond issues are subscribed to in Canada to an increasing extent. Second, a significant portion of the funds required for expansion comes from internal cash generation. Thus, even if all capital issues were still floated abroad, which they are not, the dependence on foreign capital would be lessening. In as much as Aluminium Limited uses cash

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1 This refers to the Aluminum Company of Canada as distinct from Aluminium Limited. The latter was discussed at some length in Chapter Fifteen. Alcan, on the other hand, is more predominantly Canadian also with respect to top level management. Its president lives and works in Montreal, and of its directors and senior officers Canadians outnumber Americans 9 to 5. Also, Alcan's entire executive personnel resides in Canada.

2 These developments have been brought about not only by the increased scale of operations but also by a change in the location of alumina plants. In the past, they were located in Canada, as for instance in Arvida. Now, however, they tend to be built near the ore mines to effect a dual saving in transport and labor cost.

generated for investment projects in other parts of the world, it contributes to Canada becoming gradually more of an exporter and less of an importer of capital than it has been in the past.

As an industry based on one of Canada's abundant natural resources and exporting most of its product, the aluminum industry is of course not unique. At first glance it may seem comparable to the nickel industry. Although both are owned to a large extent by American investors, both are independent from parent companies in the United States. In both cases this greater degree of corporate independence is in some measure the result of United States anti-trust action. According to O. Main,[1] it has been suggested that International Nickel, which was first an American company with headquarters in New Jersey, was made a Canadian company to remove it from the jurisdiction of American antitrust action. Aluminium Limited was probably not formed primarily for the purpose of avoiding United States anti-trust action. However, a recent anti-trust decision forcing the separation of ownership between Alcoa and Aluminium Limited had the effect of making the two companies independent from each other even though they had acted independently for some years prior to the court decision.[2] This is about all the two industry-firms in the base metal field really have in common. A comparison between the two is of interest not so much for the similarities between the two, but rather for their differences.

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1 Op. cit., p. 105.

2 Evidence regarding the degree of collaboration between Alcoa and Aluminium Limited just after the latter's formation remains inconclusive. At the time when two brothers were presidents of the two companies it would have been rather unusual if they had not communicated with each other at all. However, Judge Learned Hand acknowledged that for some years prior to his decision in 1950 there was no evidence of collaboration.

Nickel is an additive metal, used mostly in the production of steel. The demand for nickel can be assumed to be in close correlation to the demand for certain steel alloys, a factor which makes the demand for nickel somewhat inelastic. Aluminum, interestingly enough, also started out as an additive ingredient in steel production. This application, however, ceased to be of importance at a very early stage. Today, by far the largest part of aluminum output goes toward end uses where the metal is in direct competition with other metals, ferrous and non-ferrous, as well as non-metallic substances. In a large number of these applications, aluminum is used only because of a relative price advantage. Should the ratio of prices of competitive materials change to the disadvantage of aluminum, important sectors of demand may switch to alternative materials.

The two metals are different on the supply side as well. Nickel production is feasible only to those who own or control deposits of sufficiently high quality, and these are not in abundant supply. Bauxite, on the other hand, is not a scarce commodity. Presently known deposits of high grade commercial ore are far too large to be controlled by any one company. Power is somewhat less abundant, but even here the element of rigidity of supply, which can be observed with nickel ore deposits, is lacking.

The International Nickel Company and Alcan are both monopolists in the text book sense. Yet neither behaves like a text book monopolist should. In his study of the Canadian Nickel industry, O. Main comes to the following conclusion:[1]

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[1] Ibid., p. 125.

"... (T)here is considerable evidence to support the belief that, in the nickel industry at least, monopoly control does not necessarily lead to stagnation. The concept that monopoly control means stagnation, waste, and inefficiency is based on the assumption that the monopolist has an assured position through time and that he faces known market conditions. It will be argued, however, that the large corporation, in a dynamic situation, faces many uncertainties of both market conditions and control over the market. Under conditions of uncertainty, the action of the monopolist may be far different from those expected by an examination of the limiting case of the pure monopolist faced with static and known market conditions. Anti-monopoly campaigns based upon the concept of pure competition under static conditions usually fail to appreciate the considerable difference that uncertainty can make in the behaviour of entrepreneurs and the consequent use of resources."

There exist some rather interesting parallels between nickel and aluminum. Both failed to pursue a traditional monopoly policy, although for different reasons. Nickel displayed a market behavior approximating that of socially useful competition because of the uncertainties of the future. Aluminum did so, not so much because of the uncertainties of the future, but because of the confidence that the demand curve would continue to shift rapidly to the right. The motive in the two instances may have been different, the results are essentially the same. Neither producer has been a good illustration of the Robinson and Chamberlin models.

Aluminum is in many ways also similar to the Pulp and Paper industry. Like aluminum, pulp and paper is one of Canada's major export commodities based on a raw material which is in chronic short supply in the receiving countries. Commodities, like aluminum, pulp and paper and nickel, will continue to be an integral part of United States-Canadian trade relations. These industries, which were developed mostly by

American capital, tend to strengthen Canada's position vis-a-vis the United States. At a time when there is much talk about diverting trade from the United States to the United Kingdom it may seem incongruous to speak of the increasing interdependence of United States-Canadian economic relations. However, once the discussion has been removed from the arena of political controversy, it may well turn out that Canada will ultimately be drawn more rather than less closely into the network of North American trade. Should this come to pass, Canada may find it increasingly difficult to share equally in the fruits to be gained from closer integration. In this context it is reassuring to see that Canada, on the basis of its resource industries, would be able to bargain from a position of strength.

APPENDIX A

Canadian Exports of Primary

Aluminum to Major Market Areas

1905 - 1955

CANADIAN EXPORTS OF PRIMARY ALUMINUM

1905 - 1915

(in thousands of dollars)

Period Ending March 31st	United Kingdom	United States	Other Markets	Total Exports
1905	92	108	197	397
1906	99	69	241	409
1907	193	211	632	1,036
1908	444	108	484	1,036
1909	180	18	133	331
1910	283	1,300	303	1,886
1911	324	477	106	907
1912	257	934	166	1,357
1913	459	845	327	1,631
1914	606	821	458	1,885
1915	810	1,264	245	2,319

Source: Dominion Bureau of Statistics, Trade of Canada, Volume II, Exports.

CANADIAN EXPORTS OF PRIMARY ALUMINUM

1916 - 1935

(in thousands of short tons)

Period Ending March 31st	United Kingdom	United States	Other Markets	Total Exports
1916	5	2	-	7
1917	9	-	-	9
1918	4	2	3	9
1919	4	3	3	10
1920	3	6	1	10
1921	2	5	-	7
1922	-	2	1	3
1923	-	6	1	7
1924	1	4	3	8
1925	2	4	5	11
1926	2	7	3	12
1927	-	10	2	12
1928	2	20	5	27
1929	4	11	7	22
1930	6	15	18	39
1931	3	5	8	16
1932	5	1	4	10
1933	4	1	4	9
1934	11	1	5	17
1935	14	2	7	23

Source: Dominion Bureau of Statistics, Trade of Canada, Volume II, Exports.

CANADIAN EXPORTS OF PRIMARY ALUMINUM

1936 - 1955

(in thousands of short tons)

Period Ending March 31st	United Kingdom	United States	Other Markets	Total Exports
1936	17	2	9	28
1937	21	4	9	34
1938	29	10	16	55
1939	36	2	34	72
Period Ending Dec. 31st				
1940	56	16	15	87
1941	170	13	9	192
1942	160	110	44	314
1943	235	126	14	375
1944	160	107	28	295
1945	25	328	29	382
1946	88	42	58	188
1947	109	16	88	213
1948	160	78	89	327
1949	172	70	55	297
1950	139	161	36	336
1951	191	105	58	354
1952	256	116	40	412
1953	189	233	37	459
1954	211	198	59	468
1955	259	194	58	511

Source: Dominion Bureau of Statistics, Trade of Canada, Volume II, Exports.

APPENDIX B

Corporate Data

Aluminium Limited

and

Aluminum Company of Canada

TOTAL ASSETS BEFORE RESERVES

(in millions of dollars)

	Aluminium Limited	Aluminum Company of Canada
1945	480	411
1946	490	415
1947	514	445
1948	587	434
1949	612	452
1950	698	506
1951	809	571
1952	972	750
1953	1,124	863
1954	1,180 *	917 *
1955	1,310	1,004
1956	1,472	1,110

* Change from diminishing balance to straight line depreciation.

Source: Financial Statements, Aluminium Limited,
Aluminum Company of Canada Ltd.

SALES AND OPERATING REVENUES

(in millions of dollars)

	Aluminium Limited	Aluminum Company of Canada
1945	114	n.a.
1946	111	n.a.
1947	153	n.a.
1948	209	n.a.
1949	199	n.a.
1950	227	n.a.
1951	284	204
1952	333	243
1953	336	258
1954	328 *	236 *
1955	412	275
1956	483	309

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* Change from diminishing balance to straight line depreciation.

n.a. stands for not available.

Source: Financial Statements, Aluminium Limited,
Aluminum Company of Canada Ltd.

NET INCOME AFTER TAXES

(in millions of dollars)

	Aluminium Limited	Aluminum Company of Canada
1945	12	12
1946	12	12
1947	16	18
1948	27	24
1949	27	24
1950	33	31
1951	29	25
1952	22	19
1953	19	21
1954	35 *	33 *
1955	48	41
1956	56	45

* Change from diminishing balance to straight line depreciation.

Source: Financial Statements, Aluminium Limited,
Aluminum Company of Canada Ltd.

ALUMINIUM LIMITED

	Number of (1) Common Shares (in millions)	per Common Share: Capital Stock and surplus (in dollars)	per Common Share: Net Income (in dollars)	per Common Share: Cash Dividends (in dollars)
1945	7.4	13	1.55	.80
1946	7.4	14	1.61	.90
1947	7.4	15	2.15	1.00
1948	7.4	17	3.67	1.32½
1949	7.4	18	3.63	1.30
1950	7.4	22	4.67	1.72½ (2)
1951	8.2	26	4.54	1.77½ (2)
1952	8.2	28	4.31	2.00 (2)
1953	9.0	31	4.24	2.00 (2)
1954	9.0	33	3.87	2.00 (2)
1955	10.0	37	4.83	2.15 (2)
1956	10.0	40	5.56	2.35 (2)

(1) Outstanding at end of each year, adjusted for stock dividend in 1939 and stock splits in 1948 and 1952.

(2) Dividend payments in U.S. dollars after 5th September 1950, including U.S. $0.75 in 1950.

Source: Aluminium Limited, Annual Report 1956.

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