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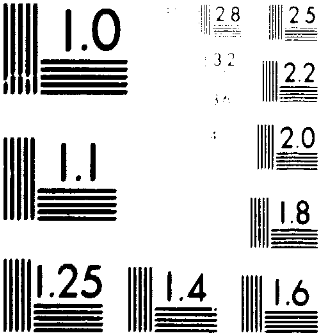
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FINAL REPORT

11420

Establishment of an Aluminium Industry in Mozambique.

S. Fülöp

United Nations Industrial Development Organization
Vienna

11420

FINAL REPORT

ASSISTANCE TO THE ESTABLISHMENT OF AN ALUMINIUM INDUSTRY IN MOZAMBIQUE

DP/MOZ/80/022
MOZAMBIQUE

Technical report: Establishment of an Aluminium Industry in Mozambique

Prepared for the Government of the People's Republic of Mozambique by the United Nations Industrial Development Organization, executing agency for the United Nations Development Programme

Based on the work of the advisors'team of ALUTERV-FKI, Budapest /S.Fülöp, W.Harrach, dr.Z.Oláh, dr.I.Varga/

United Nations Industrial Development Organization
Vienna

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EXPLANATORY NOTES

A full stop /./ is used to indicate decimals.

A comma /,/ is used to distinguish thousands and millions.

A stroke-line "/" is used to indicate "per", for example t/a = tonnes per annum.

A stroke-line between dates /for example 1979/80/ indicates an academic, crop or fiscal year.

A dash between dates /for example, 1970-1979/ indicates the full period, including the beginning and end years.

References to dollars /$/ are to United States dollars unless otherwise stated.

References to meticais /MT/ are to Mozambiquen meticais. In October 1981 the value of the metica in relation to the dollar was $1 = MT36.

The word billion means 1,000 million.

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The following notes apply to tables:
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A dash /-/ indicates that the amount is nil or negligible.

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Totals may not add precisely because of rounding.

The investment costs and suggested capacities in this study are estimated values.

Mention of firm names and commercial products does not imply the endorsement of UNIDO.

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I. AIM OF THE STUDY

The study is to contribute to the development of the aluminium industry in Mozambique based on available hydro-electric power and other natural resources. The immediate objectives are to assist the National Energy Direction's Cabinet of Aluminium, and the National Planning Commission in the pre-investment stage of establishing aluminium product-manufacturing industry for the local market and consumption, and for export to the regional and overseas markets.

With respect to this, the study deals with the investment possibilities, with the forms of products which can potentially be manufactured domestically, and highlights the principal investment aspects of a possible industrial proposition. It provides, however, more information than a usual project realization study.

When we elaborated this study, another feasibility-study was prepared for the development of the metallurgy of aluminium. We presumed, therefore, that the aluminium base material would be available in the country for manufacturing semis and finished goods. In addition, we took notice of the fact that the National Planning Commission's Project Department concluded an agreement with the New Hunter S.p.A. company for a feasibility-study to establish an aluminium smelter and a processing plant. Consequently, development of finished goods production has been primarily highlighted and necessity of development of semis production has been outlined in our study.

Beside general development concepts considering production of semis and finished goods, the aim of the project is to enable the official organizations dealing with the development of the aluminium industry in Mozambique:

- to decrease the period preceding investment activity,
- to reduce expenditures,

- to specify precisely the inquiry for offers concerning the establishment of particular plants,
- to evaluate offers,
- to make prompt decisions.

II. GENERAL OUTLINES

The report prepared on the techno-economic aspects of aluminium semis and finished goods production in Mozambique for local use and for export purposes, can serve as a guideline document to the Project Department of the National Planning Commission and to the Aluminium Cabinet of National Energy Direction.

The report gives a concise analysis of the world's aluminium production and consumption and forecasts them till the year of 2000. It deals with the possibilities of establishing the aluminium industry in general, and in particular in the People's Republic of Mozambique. In addition, it shows possible modes of increasing consumption of aluminium, modes of proper and economic applications of aluminium, factors influencing the end-users' decisions, and methods influencing the customers' decisions.

Having examined the techno-economic background in Mozambique, we collected data of the existing consumers of aluminium semis and forecast the expected ones until the year of 2000.

During the elaboration of this study we had to reckon with the fact that relatively scarce data were available within the country. The grouped questions, risen during local data collection and sent to several official organizations, are attached in Appendix I.

Though we took into account informations of officials of the Statistical Office, government offices, and other authorities as well, that of managers, and heads of the companies, dealing with manufacture and foreign trade, we had to collate and considerably supplement them with the tendencies prevailing in other countries or with our own collected experiences. The shortage of data supply refers not only to the recent period but also to the existing development targets and to middle- and long-term plans.

On the bases of local experiences, existing data, international tendencies and common practices, the study forecasts the aluminium consumption in Mozambique as per product assortment and provides a long-term development plan until the year of 2000. The product-assortment includes products and finished goods made of aluminium and used in electrical, packaging, mechanical, and building industries, as well as in transportation, material handling, storage and in other fields, of the economy.

In the study, aluminium-semis requirement of finished good manufacturing is grouped as follows: rolled products, extruded-drawn products, wires, cast and forged products.

This study is a short-term /5 years/ development program /customarily named as middle-term one/ and includes the technology of the proposed semi- and finished product-manufacturing plants, the list of equipment together with their minimum and maximum capacities. It summarizes the feasible, profitable capacities, the dimensions of the plants, the plants' specific requirements concerning raw materials, power, water, manpower as well as the estimated capital- and operating-costs, etc. The study also recommends a time schedule and provides the costs and sources of technology and know-how. It provides the material balance, the foreseen export possibilities of basic materials, the foreseen export and import possibilities of semis and finished goods. In addition, it analyzes the possibilities of exports and imports to and from Europe, India and the neighbouring countries.

Measures are also recommended to promote product-developing activity including technical advice and research to boost economic aluminium consumption. Special emphasis is laid on the organization of the development that should provide technical advice on proper application, training, marketing, and standardization. The recommendations are summarized.

III. GENERAL ASSESSMENT

A. Analysis of the world's aluminium production and consumption

Development of usage and production of aluminium on a world scale can be assessed by the comparison of the successive periods of the 20th century. Analysis of the periods differing from one another in nature helps to value the present situation in its reality. The present situation can be characterized - after a long, undiminished development - by only a short halt which is the result of the so called energy crisis, although the ever-growing tendency is unchanged.

..e 1

Trend of the world consumption of primary aluminium in quantity, per annum

Years	Consumption,
1900	5.7
1910	44.4
1920	131.0
1930	209.0
1940	820.0
1950	1,585.0
1960	4,166.3

Years	Comsumption, 1,000 tons
1961	4,496.0
1962	4,969.5
1963	5,443.3
1964	6,009.4
1965	6,605.2
1966	7,535.4
1967	7,759.4
1968	8,844.2
1969	9,633.3
1970	10,028.0
1971	10,741.5
1972	11,816.1
1973	13,627.0
1974	13,847.4
1975	11,676.0
1976	13,312.6
1977	14,248.5
1978	15,231.4
1979	15,923,3
1980	16,500.0

The annual quantity of metal production was tenfolded three times between the beginning of this century and 1964. Especially striking is that the production had centuplicated between 1913 and 1964, in spite of the World War II, and the great economic crisis of the 1930s. /A similar centuplication can be seen for the past 50-year period between 1923-1974./

In the history of aluminium production, up to 1974, thus, practically till the measurable consequence of the energy crisis the following periods can be differentiated:

four boom periods coming one after the other and three declining or rather restoration periods:

- The first increasing period lasted till 1918, to the end of the World War I.
- The decline following World War I reached its lowest level in 1921. The level of 1918 was reached again only in 1925. There were 4-year interruptions in the development.
- The second boom period lasted from 1924 till 1929.
- The lowest point of the production was in 1933, because of the general economic crisis and in 1935 it was again close to the level of 1929.
- A dynamic upward tendency of the production was again observed in the period between 1935-1943, in which the powerful rearmament had an obvious role.
- There was a nadir again in 1945, after which the production reached the level of 1943 in the year 1952. This was the longest restoration period.
- The fourth boom period was undiminished till 1974, apart from smaller fluctuations.

The data representing the use and production of aluminium differ from each other, of course. Domestic consumption of aluminium of a country consists of:

- domestic consumption of primary aluminium
- domestic consumption of secondary aluminium
- domestic consumption of import semi-products.

The production of secondary aluminium has to be considered, too, beside that of the primary one, when speaking of the world's consumption of aluminium. Storage and trade can be disregarded.

Application of secondary aluminium has become more and more important lately.

Table 2

Production capacity of secondary aluminium
/1,000 mt/

Year	World total
1974	2,795
1975	2,534
1976	3,014
1977	3,172
1978	3,246
1979	3,300
1980	3,500

Share of scrap metal's processing is continually increasing so, that it may reach 35-40 % of the primary production by 2,000.

The form of availability of the aluminium's quantity for application is highly important.

Table 3

Distribution of the consumption according to the types of semi-products

Semi products	%
sheet and strip	43.2
circle and slug	2.5
foil	7.1
welded tube	1.2
rolled products total	54.0

Semi-products	%
extruded profile	2.9
shape	15.4
tube	1.4
drawn tube	0.7
extruded products total	20.4
wire and cable	7.7
forgings	1.2
pigment	1.2
mould castings	15.5

Requirements of finished products' manufacturers created the horizontal split-up of the vertical structure of semis'-production as it is nowadays. Variety of semi--products - available in different countries - has a certain reaction on the finished products' manufacturing. The prime factors, however, are the requirements, changing only slightly during a short period. Application according to consuming branches varies considerably in the different countries even in the same period.

Table 4

Consumption of some countries according to branches, %

	FRG	Switzer-land	Italy	Spain	India	Hungary
Vehicle production	28.3	5.88	31.14	23.76	12	8.63
Machine industry	8.2	15.63	7.78	4.77	-	7.38
Electrical engineering	6.8	9.74	5.45	13.61	52	30.77
Building and construction industry	19.5	21.14	20.58	23.83	6	13.01
Chemical industry, food processing, agriculture	1.1	0.92	2.44	3.82	1	2.48
Packaging	10.3	23.16	9.69	10.88	4	7.00
Pots and pans /utensiles/	8.4	3.68	13.42	10.88	15	3.50
Powder, deoxidation agents	6.6	0.55	4.17	0.88	1	5.00
Mass products	4.8	11.3	1.33	3.57	5	17.56
Miscellaneous	6.0	8.0	4.0	4.0	4	4.67

B. Per capita consumption in some selected countries

There are great differences in the structure of consumption in various countries even if they are on nearly the same level of development. The difference among the countries for different technical vel is far greater not only in the distribution of applications according to the branches. but also in the consuming capacities and in the per capita consumptions.

There is a very close relationship between the aluminium per capita consumption and the GDP/Gross Domestic Products/. This is figured in the Table 5.

Table 5

GDP per capita in relation to aluminium consumption

GDP $ per capita	Aluminium consumption kgs per capita	Aluminium consumption kgs/1,000 $ GDP
300	0.50	1.66
500	1.00	1.00
1,000	2.60	2.60
2,000	6.75	3.38
4,000	17.50	4.38

Aluminium consumption is growing regularly to a greater extent than GDP. 1 % growth in GDP implies in average 1.43 % consumption of aluminium. Data of the Table 5 are derived from the trend line of the Fig.1.

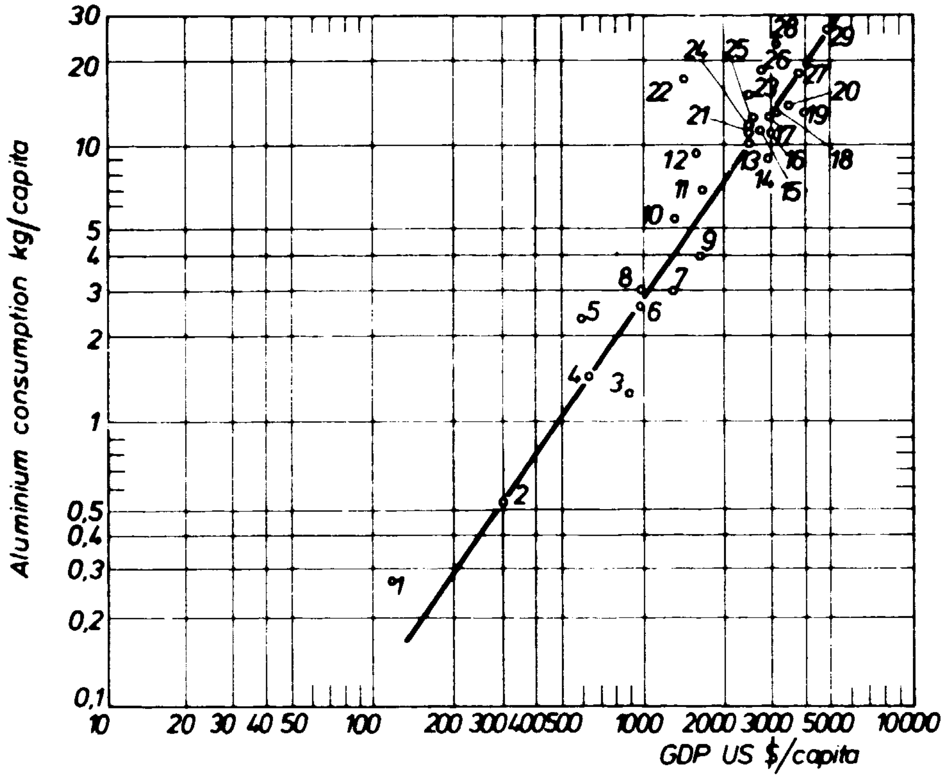


Fig.1. Per capita aluminium consumption plotted against per capita GDP in 1976

Legend

1. India
2. Egypt
3. Portugal
4. Mexico
5. Brazil
6. South Africa
7. Argentina
8. Greece
9. Ireland
10. Spain
11. Israel
12. Italy
13. Austria
14. New Zealand
15. Belgium
16. Denmark
17. United Kingdom
18. Netherland
19. Canada
20. Australia
21. France
22. Hungary
23. Japan
24. Finland
25. Switzerland
26. German Federal Republic
27. Sweden
28. Norway
29. United States of America

C. Production and consumption forecast until the year of 2000

To determine the present and future feasibilities of the various products more and more analyses were being done. The progressive, the linear and the degressive stages of development are generally differentiated. For raw materials, such as aluminium, an analysis cannot be carried out because the life-span of its application may last as long as many decades, perhaps even centuries, and the consumption is influenced by the technical development and numerous environmental processes as well.

The following diagram /Fig.2/ shows the logarithmic layout of the world's aluminium production.

Points of the annual consumption - as can be seer - are spread around a well-defined trend-line. /Angle of inclination of the trend-line shows the current annual growth./ By simple mathematical means the equation of the trend-line can be defined, i.e. the probable value of the production's logarithm which is $y = -0.00016\ x^2 + 0.05397\ x + 0.95584$, where x = a calendar year - 1900, the varying time factor of the trend analysis.

Mean error of the trend is $\pm$ 15,862 which denotes the upper and lower limits of the spreading zone, characteristic of the whole period investigated. Characteristic mean error of the past 30 years is $\pm$ 0.04206. The diagram shows the narrower spreading zone, too, which implies the stabilization of the consumption in the post-World War II period.

Preciseness of the trend is highly great: 98.7 %. On the basis of the trend-line the strict mathematical estimation of the world's primary aluminium production is shown on the Table 6.

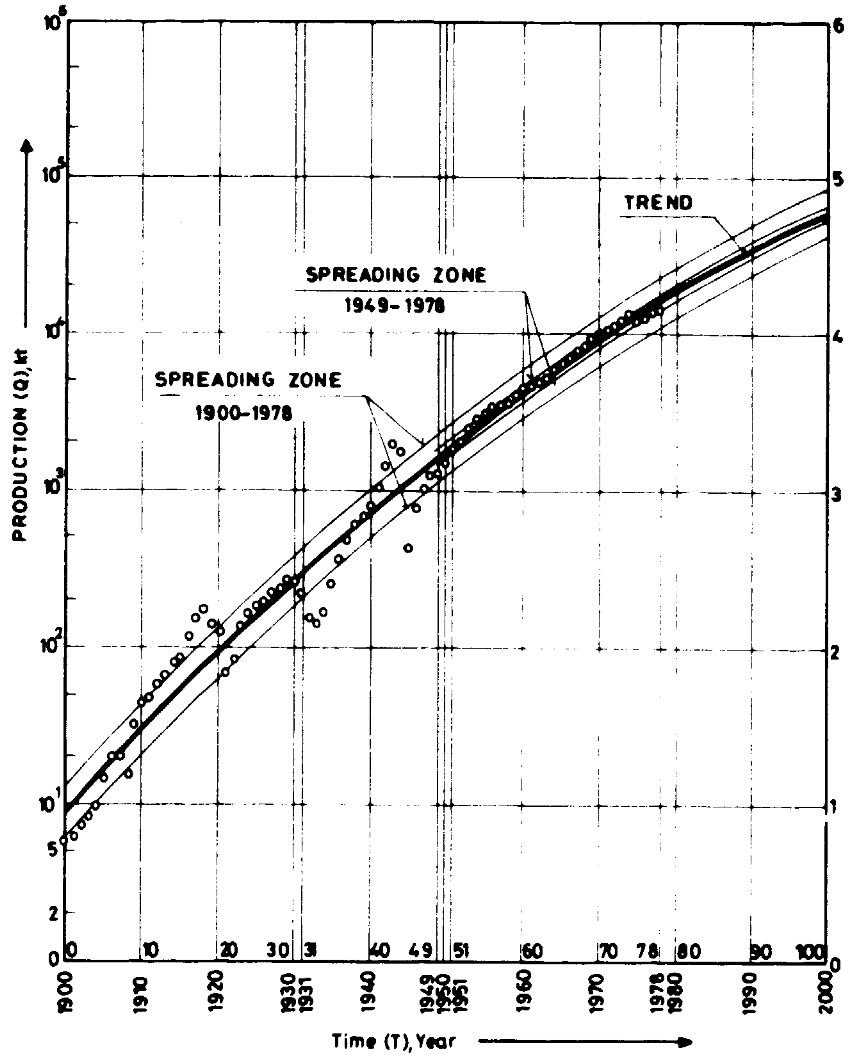


Fig.1 Trend of the World's primary aluminium production

Table 6

World's foreseen production of primary aluminium

Year	Production in 1,000 mt
1985	24,320
1990	32,880
2000	56,620

During the years the trend of the world's aluminium production has exceeded the values extrapolated from the trends of previous preiods this fact showing even in itself the progression of the development.

Aluminium consumption = production + recovery. For consumption of primary aluminium together with scrap recovery UNIDO and Metall Statistik had given a somewhat more conservative estimate /Table 7/.

Table 7

Foreseen consumption of primary aluminium with scrap recovery

Year	Consumption in 1,000 mt
1985	28,000
1990	36,000
2000	58,000

D. Price trends of aluminium and other structural materials

Trend of the aluminium consumption is mostly affected - beside the current metal quantities available - by the technical and economic competition of the structural material /see IV.B/.

The change of the world market price of steel and aluminium in the past 8 years is shown in the Table 8 /prices 1972 = 100/.

Table 8

The world market price of steel and aluminium

Year	Aluminium	Alloyed steel	Commercial steel
1972	100.0	100.0	100.0
1973	96.2	96.6	104.0
1974	129.7	124.3	123.3
1975	151.3	118.9	145.6
1976	169.6	133.6	157.8
1977	196.2	155.9	173.3
1978	207.6	156.6	200.0
1979	232.3	168.6	222.0

/Metals and Materials, August, 1980/

There is a relatively lower rise in alloyed steel's price if compared to aluminium and commercial steel. Further trend in the prices is influenced - beside the demands - by the trends of the costs. Presumable rise of the prices of raw materials, energy and wages per annum are as in the Table 9.

Table 9

Estimated annual mean growth of some costs factors

	1981-86 %	1986-91 %
Iron ore	1.3	2.0
Bauxite	0.65	1.0
Electric power	2.2	1.4
Coke	2.0	1.4
Natural gas	2.0	3.5
Wages-salaries	4.3	4.0

No sudden change can be predicted in the present price--rations. Aluminium is going to have a somewhat more beneficial position against the products of the iron industry.

Price ratios of other structural materials compared to aluminium and converted into weight have changed in the previous years as seen from the Table 10. /The aluminium price has also cahnged in the meantime./

Table 10

Relative pricing of some structural materials by volume

	1950	1975	1976	1977
Aluminium	100	100	100	100
Copper	127	140	142	117
Lead	81	48	46	56
Zinc	57	86	73	53
Tin	600	799	782	975
Synthetics	60	76	58	54
Cement	2	2.3	2.3	2.2

There were no drastic changes, not even in the past quarter of the century. The continuous increase in prices of the tin /and tinned sheet/ can be observed as a tendency. A decrease of prices of synthetical materials as compared to that of aluminium is to be expected.

Considering the history of aluminium consumption until now, and the various aluminium consuming branches, the undermentioned main, not numerical trends, tendencies are to be expected:

- As a result of energy saving in the industrialized countries aluminium consumption will expectedly be growing in vehicle production, electrical engineering /in form of heat exchangers, cylinders, components of the machine industry/, whereas there will be a decrease of consumption in the building industry and in the packaging.
- The decisive importance in the first period in the developing countries is the electrical engineering, production of household utensils, agricultural appliances and aluminium consumption of fabricated construction of the building industry.

IV. THE POSSIBILITIES OF ESTABLISHING AN ALUMINIUM INDUSTRY

A. Possibility of increasing the aluminium consumption

Industrial-scale production of aluminium has been conducted for about 100 years. During this relatively short period aluminium consumption has greatly and widely increased which - compared to other metals - is unprecedented, on one hand due to the advantageous properties of aluminium, on the other due to the fact that until now the price of aluminium has greatly risen much slower compared to that of other metals and structural materials.

Consumption estimate of aluminium in Mozambique can be based upon the following facts:

- the use of its relatively inexpensive electric power resources
- the more advantageous physical properties of aluminium compared to other structural materials - in proper fields of applications
- the economic efficiency of proper application of aluminium
- the expected quantity of available basic aluminium material.

The main conditions of increase in aluminium consumption are as follows:

- availability of aluminium in the required form
- user's demand capable of absorbing the available quantities of semis.

The problem of increasing the aluminium consumption is approached from two aspects: production and consumption.

Demand and consumption is, in general, devided according to International Nomenclature:

- vehicle-producing industry
- machine industry
- electrical industry
- agriculture, chemical and food industry
- packaging industry
- household utensils and goods
- iron and steel industry
- mass production
- miscellaneous fields.

Demand for semis is grouped according to the above nomenclature, or globally as per the following breakdown:

- rolled semis
- extruded-drawn semis
- castings.

To increase the aluminium consumption considerably, the availability of large quantities of aluminium semis in proper assortment alone, is not sufficient but increasing the consumption should be advantageous for the end users, too. /In general, aluminium consumption of a country is not taken as the consumption of end users but that of the aluminium-consuming industries./

Neither the development concepts for increasing the production nor the estimations for increased consumption answer generally the following problems:

- criteria of increasing the aluminium consumption in customary fields of application
- new fields of effective aluminium application.

B. The proper and economical use and application of aluminium

1. Factors determining the end users' decision

During manufacturing of a product the manufacturer has to choose among structural materials that can be applied for the same purpose. Choice is influenced by both technical and economic considerations. To apply the use of aluminium, the following aspects are to be considered:

- advantageous properties of aluminium in respect of the final utilization
- user's habits, application techniques
- price of aluminium compared to that of other structural materials
- additional economic advantages in application arising from the properties of aluminium
- availability of the different materials
- state interference, preferences.

Consequently, the end users' aspects have also to be considered.

The advantegous properties of aluminium are as follows:

It is light, its specific weight is one-third of that of the steel. Strength of its particular alloys reaches to that of the steel. In addition, they can be formed to various shapes. Aluminium is corrosion-resistant, weather-proof without surface treatment, and it is good electrical and heat conductor. Aluminium structures require little maintenance, and are fire-proof.

Aluminium has also disadvantageous properties compared to steel which are as follows:

- lower modulus of elasticity
- the welding needs special apparatus
- higher sensibility for fatigue.

The price of aluminium affects the user's decision in connection with the price sequence of the structural materials which can replace each other.

Comparison of prices as per weight and volume does not supply adequate information. The figures do not indicate all the economic advantages of aluminium such as for example that painting is not required as in case of steel, higher life-span compared to that of wood and plastics neither its disadvantages such as lower conductivity and lower capacity of heat transmission compared to copper.

Taking the peresent commodity prices into account an aluminium structure will probably be more compared to a steel structure in many cases. In some cases the price difference between the load-bearing aluminium structure and the steel structure should be compensated by the more advantegous properties of aluminium compared to that of steel. In other case simple and cheap workability, low maintenance requirement, eliminating of surface treatment, high life--span, high scrap price, low transport and operating costs owing to weight decrease, etc. can compensate the price differences.

To forecast user's decisions it is imperative to take the additional secondary economic advantages into account. In a country where there are no ingrained habits and extensive experiences as in Mozambique, users' habits do not play an important role. Application technique plays, however, an important role the creation of which may be essential in the first phase of the establishment of an aluminium industry /this study will return twice to this fact/.

2. Method for forecasting the user's decisions

Considering the primary costs only, aluminium structures are in most cases more expensive than steel or wood structures used for the same purpose but they are cheaper than structures of plastics and non-ferrous metals. Where non-ferrous metals can be replaced by aluminium, there the application of aluminium considerably increases /cable production, cooking utensil production/. The possibilities for replacement are now nearly fully exhausted worldwide.

Comparison between the purchase prices of products made of different materials for the same purpose does not base decision for purchase and application. Beside the prices most of the users consider the advantageous properties of aluminium especially if proper convincing informations are available. It can be proved that certain advantageous properties can moderate producing and applying transportation, moving parts and accessories.

Efforts are made worldwide to decrease vehicle's dead weight owing to the considerable rise in the price of energy sources. Essential view-point is to decrease maintenance in the building industry and agriculture.

Calculating method for user's decisions endeavours to take all the effects into account.

The essence of the calculation is that all the costs calculated for a desired life-span /purchase price + erection costs + transport costs + operating costs + maintenance and other costs - returns arising from scrape sale - cost-decreasing factors/ of the product made of material to be replaced should be reduced by the time-varying costs /operating costs + maintenance and other costs - cost-decreasing factors/ summarized for the same period of the product made of aluminium. The difference gained has to cover the cost of the product made of aluminium.

If this coverage is higher than the fix /or non-recurring/ cost /purchase price or production cost + erection cost + transport cost - returns, deriving from scrap sale/ of product made of aluminium the resulting cost difference constitutes savings i.e. profit owing to the use of aluminium. /Cost used to be discounted in the beginning of the period./

It is not worthy to enforce aluminium application in those fields where end user does not benefit economically from the application of it. If we know the user's requirement concerning the base material of the product we can affect his purchase even in case if the purchase price of the relevant product is temporarily higher than that of the other product. If he has money for it, if he can get it, etc. These influencing factors, however, cannot be followed by calculating methods.

Manufacturers of aluminium semis are generally not in connection with the end-users but with the manufacturers of finished goods. In spite of this fact aluminium industry is interested in convincing the users to get known their needs in the variety and quality of finished goods, to fulfil their requirements on the side of semiproduction. Besides several essential aspects this fact confirms also the efforts that finished goods-manufacturing industry should be integral part of the aluminium verticum.

Ranking of aluminium application fields and the aluminium finished goods in the aspect of useful ness can be effected unambigously on the basis of economic advantages of end-users. Possibly demand will grow parallel to the covering of costs compared to the costs. It is advisable to compare savings and expenditures.

In some countries of centrally planned economies this index is calculated:

$$\frac{\text{savings}}{\text{expenditures}} \%$$

This index gives a sequence which helps the management of economy in the price policy and taxation of finished products.

Consequently, savings by using of different products can be brought to a common denominator if divided with the quantity of used aluminium semiproduct and with the desired life-span. This index gives an other sequence which is important for the manufacturer of semis in the forming of marketing policy.

Sequences given by these indices do not unambigously follow each other. In case of Mozambique, at present, any of ranking cannot be calculated but in case of development of an aluminium industry it is advisable to prepare both of these indices at a very early stage.

Such a sequence can be modified owing to the change in prices, wages as well as other costs and expenses. Its most essential element is the estimation of the desired life-span, which is not at all exact, and can independently change. In addition, the various users estimate it in different ways. Extraordinarily long life-time may impede even progress.

In all cases the aim of the basic material industry of aluminium is to create a dynamic balance between production. Realization of dynamic balance in a long period is possible in the frame of long-term development concepts, which take common interests of national economy, aluminium industry and users into consideration.

To promote proportionate progress it is imperative to influence the users' decisions as means of maintaining dynamic balance.

3. Proper selection of materials

The range of mechanical properties of various kinds of aluminium is essentially wider than that of different kinds of steel. For example: the strength of tempered plate of AlMgSi 1 composition is 4.3-fold of that of soft plate of Al 99.5 composition. Its usual price is, however, higher by 13 to 15 % only. Prices of alloyed plates are generally higher by 5 to 10 % than that of unalloyed plates throughout the world. Price of semi-hardened plate is higher by 1 to 2 % than that of hard ones; soft plates are generally cheaper than semi-hardened ones but they are more expensive than hard ones. The specific price of 0.5 mm thick sheet is higher by about 40 % than that of a 5 mm thick plate.

Price of rolled semis is mainly influenced by size, lesser influenced by quality and hardly influenced by state. Prices change to a considerably lesser extent than mechanical properties which are indicated in the following table /Table 11/.

Table 11

Relation of price and mechanical strenght of some rolled semiproducts

Quality	S t a t e	Equivalent thickness in respect of same strength	Price ration of surfaces of the same size
Al 99.5	Soft	3.2	2.66
	Semi-hardened	2.2	2.85
	Hard	1.7	1.45
AlMg 3	Soft	1.2	1.23
	Semi-hardened	1.0	1.07
AlMgSi 1	Soft	1.7	1.62
	Annealed	1.0	1.03
	Hard	1.0	1.0
	Tempered	0.75	0.90
	Tempered and additionally rolled	0.70	0.87

The Table shows which are the equivalent plates as regards thickness, quality and state to the 1 mm thick hard plate of AlMgSi 1 quality and how many-fold is the price of a plate of the same size compared to the plate of the selected size and quality.

While selecting the material not only the strength alone is essential, but ductility, possibility of surface treatment and weldability, etc. as well, which necessitate a search for an optimal techno-economic solution.

This problem is slightly more complicated in case of rods, tubes and shapes.

If the constructor intends to apply tube, he has possibility to select among different tubes such as extruded, drawn of strip welded tubes. Here he will encounter the variety of sizes, qualitities and states.In case of extruded tubes, rods and shapes the price differences are 20 to 25 % owing to the quality differences. Difference among prices of products of different state but of the same quality ranges between 10 and 15 %. Price of product of minimal cross-section is higher by 30 to 40 % than that of products of maximal cross section if quality and state are unchanged. /Between the two limits there is a minimal price, too./ The price of drawn products is higher by 20 to 25 % only than that of extruded products of the same quality and cross section. Price difference is lower than strength difference, thus application of drawn tube is generally more advantageous for the user than the extruded, because in case of same diameter tube of thinner wall can be used for a lower specific price.

Welded tube is even cheaper than drawn one. In general, it is advisable to use strip rolled profile too, because rolled profile of thinner wall and smaller cross section may be equivalent to extruded profile.

A guideline such as "the most expensive is the best" may lead to a false selection of aluminium semis. Selection of the proper semis is always a search, applying mainly but not alone strength and price, for the optimal product. High tensile strength is recommended if it will result in saving of materials but it is not recommended if it is higher than required by the structure or by the finished good.

In the competition of various structural materials the position of aluminium can be strengthened by selecting of so called "special purpose alloys" as well as of highly manufactured and properly finished semis.

C. Organization for establishing an aluminium industry

Organization for establishing and developing an aluminium industry has to include a department which later manages production, operation and sale, etc. from the beginning. In the aluminium industry verticality is more dominating as in other industries, expecially in case of producing basic materials. In the production process of the aluminium, primary /basic/ raw-material is the bauxite alone, intermedier is alumina alone, ultimate product is aluminium ingot produced from alumina.

Bauxite, alumina and aluminium are interdependent, their ratios of production are determined by physical and chemical relations. Prices of the three products can move in conformity to each other during a long term and they are finally determined by the demand fcr aluminium.

Verticum of aluminium industry branches off to the following phases in semis manufacturing: rolling, extrusion and casting, etc. Its final phase of manufacturing of finished goods is characterized by the very large number of different kinds of products.

At present one of the world's most concentrated industry is the aluminium industry. Decisive part of the world's aluminium industry is possessed by a few mammoth companies. Among the independent companies not belonging to these multinational corporations more and more companies are partly or totally nationalized.

Such kind of unified organization operates efficiently owing to the following facts:

- The verticum is comprehended by one economic unit the activity of which ranges from bauxite prospecting to finished good manufacturing.
- The unified economic organization concentrates resources, coordinates and organizes development targets and other complex activities.
- The verticum may possess comprehensive innovation base.
- Products of the verticum have good markets because the unified economic organization performs a trade policy which permanently follows the world market changes.

By this unified organizational structure the higher profit /asset proportionate or even weight proportionate/ that is realizable on the higher level of the verticum, can be the base of the further, proportionate development of the whole verticum. It decreases the operating costs by eliminating the stock surplus among the manufacturing phases /this suplus in case of production for external market cannot be eliminated/, and resulting in a decrease of current assets and a possible cessation of cash flow. At home the organization has to concentrate on one market only and the end users' requirements have to be collated with the manufacturing possibilities of the domestic aluminium industry.

We have already emphasized the importance of this collating activity. In para.XI. we will return to it. Activities of a department dealing with application technique can be grouped as follows:

- technical consultancy and assistance in solving users' problems such as modern aluminium-processing techniques
- economic consultancy and public relation activities /convincing users about advantageous aluminium applications/.

In general, it is advisable to start with a section of the development department dealing with the marketing and techno-economic consulting services which will be available both for the development department and for the users.

The base of the development organization exists in Mozambique at the National Directorate of Electricity, as an "Aluminium Cabinet". This organization needs a definite enlargement with a staff giving technical and economic advices to the customers and to the management of the industry.

This consulting group should include at least the following staff:

- metallurgist
- mechanical engineer
- electrical engineer
- engineer specialist in construction, buildings and civil works
- economist.

It is an advantage when one person has two or more professions in this group being able for a complex activity.

Just at the beginning the development organization should involve the work of those future managers of the foreseen factories and plants who will start the production later in them.

Any hesitation of selecting and training these personals would cause a long delay in fulfilment of the development program and would lessen the efficiency of investition and the future production and of marketing of the products.

V. TECHNO-ECONOMIC BACKGROUND IN MOZAMBIQUE

After 10 years of war against Portuguese colonists, Mozambique became independent on 25 June, 1975 and from that time it has suffered serious development constraints. The pressing shortage of skilled manpower resulted in an extensive backlog of maintenance of economic infrastructure as well as drastic decline in industrial production. With the restoration of peace, Mozambique started the economic recovery, and a tendency has begun for continuos growth.

The total area of the country is 799,388 sq.km, the estimated population amounts to nearly 12 million. The annual growth rate of the population is 2.5 percent; approximately 90 percent of the population live in rural areas.

The economic recovery can be observed in export and import figures, too:

Table 12

Export-import of the People's Republic of Mozambique
/in 1,000 conto MT/

	1978	1979
export	5,344	8,311
import	17,199	18,575
export/import	0.31	0.48

The Government's budget deficit has been reduced from US$ 126 million to US$ 14.6 million in 1979, and probably will come to equilibrium by the end of 1980.

The role of the public sector is ever growing in the economic life. For example, US$ 320 million /70 %/ was invested by the state from the total investment cost amounted to $ 462 million according to the investment program in 1978/1979.

In 1981, 81 % of the investments is covered by the budget. In the National Investment Program in 1981, 28,663 million MT is allocated for the following purposes thereof

- 23,626 million MT for economic development
- 720 million MT for social establishments
- 4,337 million MT for other investments.

The sum earmarked to economic development is devided as follows:

- 4,508 million MT for agricultural development
- 6,556 million MT for development of industry and energy supply
- 4,668 million MT for transportation and telecommunication
- 3,374 million MT for development of building industry.

In 1980, the industrial production grew by 10 %, the planned growth rate in 1981 is indicated as follows:

- electric industry 14 %
- mining industry 50 %
- metallurgy 88 %
- mechanical industry 70 %

The National Plan is an instrument in the hands of the scientific organizations for conquering underdevelopment. According to the Constitution: "The People's Republic of Mozambique, taking agriculture as the base, and industry as the propelling and decisive factor, directs its economic policy towards wiping out underdevelopment and creating conditions for raising the living standards of the working people".

A. <u>The national economy at present and until the year of 2000 in the view of the development of an aluminium industry</u>

In the World Bank's report in 1980 concerning the progress in the world, the distribution of gross domestic products in Mozambique was in 1978 as follows:

- agriculture 45 %
- industry 16 %
- semis 39 %

From the data of this report, the per capita GDP can be calculated only; it totalled to some more than US$ 300 in 1978. 10 % of the GDP was assigned for investment which amount is considered too low even among the countries where the national revue is low. It is, however, a hopeful sign that imports of the investment goods between 1978 and 1979 generally grew, compared to the previous recession /Statistic Annual 1980, Mozambique/.

Table 13

Imports of machinery

	1978	1979
Electric machine, 1,000 conto MT	633	692
Import of other machinery and equipment, 1,000 conto MT	1,539	2,489

Aluminium semis can also be taken as investment goods. Their import was about 700 t in the previous year. At present the per capita aluminium consumption is 0.06 kg which amount is extraordinary low not only in respect of world relation but even in Africa. The per capita GDP would justify about 0.5 kg/person consumption of aluminium. In the countries of low revenue such as Mozambique, the yearly average growth-rate in GDP was 3.8 % between 1960 and 1970, while between 1970 and 1977 it grew to 4 % /Statistical Review of the World Industrial Situation, 1980 published by UNIDO/.

According to restricted estimations the growth-rate in the 1980s and in the 1990s will be 4.3 % and 4.8 % respectively. The following Table indicates forecast of growth in the GDP on the basis of 1978 prices, without knowledge of long-term plans.

Table 14

Forecast of growth in GDP

Year	1985	1990	1995	2000
GDP in million $	4,050	4,950	6,250	7,900

The growth rate of population between 1980 and 1985 will probably be 2.5 %, as at present, between 1985 and 1990 it will presumably decrease to 2.3 % and then to 3 %. The following Table shows the expected figures on population, GDP, and per capita and total aluminium consumption:

Table 15

Estimation of expected aluminium consumption in Mozambique

	1980	1990	1995	2000
Population, million	13.5	15.2	16.7	18.5
Per capita, GDP, $	300.0	328.0	374.0	427.0
Per capita aluminium consumption, kgs	0.5	0.6	0.7	0.9
Total aluminium consumption, 1,000 tons	6.75	9.12	11.7	17.0

The smelter to be established, for which a feasibility study has been elaborated and an other one for which the elaboration of an other study is in progress, will expectably produce considerably larger quantity of primary aluminium than required by indigenous consumers. It is obvious therefore that primary aluminium, semis, and finished goods, produced in Mozambique will greatly contribute as export goods to the balance of payments of the country. With products of the aluminium industry not only the cheap electric energy can be used at a favourable price but also the manpower. From the population of the country, the expected active manpower in Mozambique is estimated as follows:

Table 16

Estimation of expected manpower in Mozambique in 1,000 persons

	1980	1985	1990	1995	2000
Agriculture	2,060	2,300	2,500	2,700	2,900
Industry	500	600	950	1,200	1,400
Service industry	500	560	650	700	770
Total:	3,060	3,460	4,100	4,600	5,070

Rate of employment in the agriculture, that is, the share of the agricultural manpower from the total population will decrease relatively. The share of manpower to be employed in the service-industry such as trade, hotel and catering trade, transportation, telecommunication, banking, insurance, state administration, etc. will not change, while the share of manpower to be employed in the industry will dynamically increase. This fact justifies that the verticum of the aluminium industry should be developed.

At present, the system of wages and salaries in Mozambique is extraordinary simple:

Table 17

Wages and salaries in 1981

Quality of employment	Wage or salary
Industrial worker	3,500-7,000 MT/month
Administrative employee	4,500-10,000 MT/month
Technical employee	10,000-13,000 MT/month
Manager	12,000-15,000 MT/month

To increase the efficiency of the work, it is presumed that the wages and salaries will be differentiated according to the quality and quantity of the performed work and according to its usefulness for the community.

It is obvious that personal incomes will rise together with the growth in the GDP. It will, however,not be proportionate with the growth of this owing to the trend that the present share of the accumulation should be increased for the sake of economic advance.

B. The existing domestic consumers of aluminium semi-products

The business activity regarding aluminium base materials, semis and finished goods is organized and conducted by a newly established foreign trade company /Intermetal Edime, EE/.

In 1981 considerable part of semis has been imported by this company; the assortment and the planned quantity are as follows:

Rolled products, total	339 tons
thereof:	
- plates, circles and discs for manufacturing household utensils and autobus bodies	270 tons
- plates for ship building and repair	50 tons
- patterned plates	8 tons
- strips	11 tons
Extruded product, total	26 tons
thereof:	
- flat profiles	2 tons
- L-shaped profiles	4 tons
- profiles, used in the building and vehicle industry	20 tons
Slugs for collapsible tubes	60 tons

In Mozambique semis are sold to the state sector with 10 % wholesale price margin and to the private sector with 27 % retail price margin. In this latter case the retail company pays the 17 % difference as tax.

Trading companies pay 3 %, manufacturing-selling companies 1.5 % circulation tax. The tax, payable by companies dealing with manufacturing only, ranges between 1 anu 5 %. Companies owned by one or more persons pay 20 % tax on their profit.

Considerable quantity of processed metal is imported in Mozambique. Additional quantity is supplied by LIMETAL /Ligas Metalica, Maputo/ dealing with scrap collecting for remelting. Monthly 3 to 4 tons of scrap are remelted in oil heated furnaces. The molten metal is cast without alloying material. According to our estimation the domestic use of scrap will be about 100 tons/year. Those quantities not collected by LIMETAL are used by 10 to 20 small foundries /casting shops/.

1. Plant for manufacturing household utensils and mass products

Name of the plant: Aluminios de Mozambique /ALUMOC, Matola/. The plant produces household utensils, pressure--cookers, filters, cutlery /table-ware/ trays, tea kettles and boxes for small and large kitchens.

Main technology of the plant is metal shaping. The majority of its products, including the 300 liter household and hospital utensils, are produced on metal-shaping benches, while the thick wall utensils are produced by deep-drawing presses. According to the assortment of products, the general-purpose installations of the plant produce many different kinds of products in small quantities. The plant has the following equipments: manual metal-shaping benches, eccentric presses, 3 deep-drawing presses, ball presses, manual edge benders, plate shears,riveting machines, lathes, abrasive drums, casting crucibles, manual moulds, anodizing bathes.

For producing cast spare parts, the plant uses its own scrap without alloying material. The unused scrap is cast to rough plates of 20x300x400 mm and then rolled to thick plates by a small reversing roll stand.

Capacity of the plant: 300 t/y. In 1981, the plant has had 150 tons of basic material. The plant produces 57,000 pcs/month of various products; return from sales is 5,603,000 MT /September, 1981/. The unit price of the used semis: 120 MT/kg. The specific price of sold products: 448 MT/kg.
/producers' price/

The plant's products are not exportable their quality do not meet the export requirements.

The plant's management does not have concepts for development of the plant.

Manpower: 150 workers. The plant operates in 1 shift/day. The produced quantity of aluminium: 1 t/year/person, the gross return from sales: 448,000 MT/person/year. Production value compared to wages: 14 MT/MT.

2. Collapsible aluminium tube-manufacturing plant

Name of the plant: Empresa Metallurgica de Mozambique, Maputo.

The plant consists of the following properly separated plant units:

1. Wire cloth manufacturing plant
2. Binding element manufacturing plant
3. Collapsible tube manufacturing plant

This latter plant produces collapsible tubes of 19 mm dia. without inner lacquering and with outer lithography only for tooth-paste.

The collapsible tube manufacturing line includes impact extrusion press, thread-cutting machine for joining caps as well as lacquering and lithographing machines.

These machine units /4 pieces/ are not interconnected, so each machine are separately handled. Consequently, the number of operators is 12/shift.

Production of the plant:

- in 1979 849,000 pieces
- in 1980 1,559,000 pieces
- in 1981 1,188,000 pieces

In this year recession is caused by the shortage of basic materials and slugs. For the time being, the machines are overhauled /September, 1981/.

Capacity of the plant is 30 t/year/shift, that is 5 million collapsible tubes/year/shift.

In the previous years collapsible tubes of 22-25-30 mm dimensions and of inner lacquering were also produced. The die requirement of the plant is satisfied by the maintenance shop.

The binding element manufacturing plant is also suitable for producing aluminium nails, rivets and screws. Aluminium rivets were already produced in the plant, so production of other binding elements can be properly effected owing to the previous practice.

3. Autobus-body manufacturing plant

Name of the plant: Industrias de Carroceria /Matola/.

This plant produces and repaires autobus bodies. The manufacturing is based mainly on manual work. Capacity of the plant: 80 autobus bodies/month. The plant uses 1,000 plates of 2 to 4x1,250x3,000 mm dimensions yearly /cca 30 tons/year/ and approximately 150 different kinds of extruded profiles such as decorative mouldings, window frames, joint-covering mouldings, handle, etc. in little quantities.

The plant struggles with continuous shortages of materials and spare parts, so the output of the plant amounts to only about 20 autobus bodies/month.

4. Cable-manufacturing plant

Name of the plant: Celmoque /Beira, Manga/

This plant belongs to the company Electromoc, which has a radio receiver plant with service network.

In the cable factory, aluminium cables have not been produced till now. Capacity of the plant: 1,000 t/year copper cable for max. 11 kV. The copper wire and the PVC material are imported. Manpower: 100 persons.

The plant, partly owned by the English, has been nationalized in 1977. The installation of new extruders, just under way of that time, was abandoned; this has been completed by 4 engineers of the company KWO, GDR in October, 1981.

Start-up of the installation is now going on.

Introduction of technology is planned for manufacturing aluminium cables in two steps:

1. The first step is to expand the plant capacity with aluminium cable-manufacturing including wire drawing /for the drawing machine, offers are invited from companies SKET German Democratic Republic and Electroimpex, Hungary/.
2. The second step is to expand the capacity for export up to 20,000 t/year after 1987, as the raw material will be procured from the newly established smelter, and the PVC material will also be available in Mozambique owing to the gas program.

It can be stated that the plant is suitable for manufacturing aluminium cables as regards installations and skilled manpower.

VI. WORLD WIDE LONG-TERM PROGRESS FOR MANUFACTURING FINISHED ALUMINIUM PRODUCTS

Production of finished aluminium goods means processes by which semis get their final state ready to be used.

Most of the aluminium semis are getting into the processing industry through smaller firms which are able to adapt to the various and rapidly changing requirements of the consumers. Production of finished goods fits only partly into the verticum of producing and processing aluminium. The big aluminium companies of the world process only a smaller part of their semis to finished products. Th' rest is sold to the processing industry. It is their aim, however, to expand their activities also for producing finished goods either in a direct or an indirect way. Among the many reasons the following are the most important:

- The technology of finished goods' production is highly aluminium-oriented which means that manufacturing of good-quality final products requires the use of knowledge accumulated in the aluminium industry.
- Production of finished goods needs cooperation with the manufacturers of raw materials and semis.
- Aluminium has a good market in its finished form, the price margin of sales between semis and finished goods is higher than the expenses arising from turning the semis into fully finished goods.
- Finished products of great quantities, and finished products requiring certain semis can be produced by using the technology similar to that of the semis /e.g. roofing material, facade, etc./.

- A considerable benefit may be attained if the scrap originating in large quantities from the finished products' manufacturing processes is rapidly returned to the processing cycle.

A. The possible product mix

1. Electrical industry

The electrical industry uses aluminium for structures which conduct or do not conduct current. Nowadays the electrical industry applies 15 % of all the aluminium consumption. This amount may increase to 20 % by the Millenium since development possibilites are very notable both in the industrialized and in the developing countries.

Table 18

Per capita aluminium consumption in some countries in the electrical industry

Country	Consumption /kg per capita/
USA	3.7
Hungary	3.5
Western European countries, average	1.4
Brazil	1.2
Union of South Africa	1.0
India	0.15

In case of current-conducting structures, application of aluminium is justified by the following main aspects:

- Low production cost having a decreasing tendency even for longer term compared to copper.
- Economical application due to its good conductivity and simple maintenance.
- Its applications are reliable.

The main fields of application are:

- Open lines and airlier cables
- High voltage power transmission lines
- Airlier cables /low-voltage distributing grids/
- Armatures
- Telecommunications systems
- Subterrain cables
- Telephone cables
- Internal power lines /building electricity/
- Insulated aluminium wires
- Busbars
- Transformers
- Condensers
- Electrical machine windings
- Open air switch gear.

The most important aluminium structures not conducting current are as follows:

- Poles of power transmission lines
- Lamp-columns, columns' arms
- Busbar channels, cable channels
- Lighting fixtures
- Aluminium covered switchgears and safety equipment
- Measuring and distribution boxes.

2. Packaging industry

This field of application of aluminium consists of production and use of cans, boxes, lids, bottle closures, collapsible tubes,packaging foils, hard-foil trays, sterilizable cups, small containers, barrels, and drums.

75 % of the package materials are utilized by the food processing, so the demands of this branch are of determining character in the consumption as well as in forming the development purposes. There are two ways of technologies for making aluminium cans:

- They are made of slugs by impact extrusion then lacquered and lithographed.
- They are produced from lacquered, lithographed sheet by deep-drawing.

The method mentioned first requires much material and is of low productivity. The second method is productive and inexpensive, but the height of the sides is, however, limited to 2.5-fold of the bottom radius.

Basic material of the deep-drawn cans is a semi hardened, anodized, lacquered strip of 0.22 to 0.3 thickness. The sides are often ribbed to improve stiffness.

The dimensions of cans produced by the modern technology of side-weakening deep-drawing are more favourable. This technology is mostly applied when producing beverage--cans. Share of using this technology compared to other ones has been increasing by 15 % yearly.

Covers used for cans are generally tearable. For food-preserving jars the lock caps OMNIA or PANO are used. These are made of alloyed aluminium strip lithographed on the one side and lacquered on the other.

Bottles for valuable beverages which are closed and opened several times have screwed caps of the type PILFER-PROOF, TOP-SIDE, etc. Its basic material is a strip of 0.15 to 0.25 mm thickness. The inner side is lacquered. Basic material of the lacquer is epoxy resin. The outer side of the strip is lacquered with inscriptions on it.

The technology of impact extrusion is characteristic of producing collapsible tubes. These tubes are used in the food industry /with closed orifice/ and in the package of cosmetics and drugs /with opened orifice/.

To reduce the transportation costs conical tubes sliding in each other are also made recently, and usage of aluminium-plastic combined tubes is spreading, as well. Material of the latter is polyethylene-foil-polyethylene coil in hose-form, welded on their sides.

Aluminium foil has become one of the most general basic materials employed in the food industry for packaging. Its usage as basic material is growing quantitatively the best of all. Growth rate of the world's foil production exceeds significantly the general growth rate of aluminium application. Application fields of the various foil-products are shown in the table below:

Table 19

Application of aluminium foil by the food industry

Description of the foil	Field of application
Blank foil	sweets industry, household foil, prepared food trays
Foil, patterned, with coloured or transparent lacquer coating	sweets industry: chocolate, desserts, bonbons wrapping of wine bottle-necks
Foil with coloured or transparent hot-melt lacquer coating	dairy industry: cheese wrapping
Hard foil with hot-melt lacquer coating,printed	canning industry: lids of jam and marmalade jars
Soft foil with hot-melt lacquer coating,printed	dairy industry: milk and dairy product cup closures
Aluminium foil/vellum paper combination, wet laminated, printed	tobacco industry: cigarette wrapping; coffee and spice bags
Aluminium foil/vellum paper combination, wax-laminated	dairy industry: butter, cottage cheese wrapping vegetable oil industry: margarine wrapping

cont'd

Description of the foil	Field of application
Aluminium foil/paper combination, wet-laminated, with hotmelt coating, printed	sweets industry: filled wafers, biscuits
Aluminium foil/paper/polyethylene film combination, dry and wet-laminated, printed	soup-powder bags, seasoning bags
Aluminium foil/single or double plastics film combination, dry laminated, printed	canning industry: fruit jucies

There is a certain material, similar to foil that is used to produce thin-walled, sterilizable cans and boxes with hot-melt inside coating. Its thickness is maximum 0.18 mm laminated with polyethylene. It is primarily used by the meat industry, but is also good to pack jam, fruit--creams, honey, cheese, etc.

Trays drawn from hard foil and low but wide boxes produced by the same technology are used first of all to pack processed food.

Another large group of aluminium products used in packaging industry is mainly for non-consuming usage. These are boxes, cases, commercial small containers, drums, pallets.

Dimensions of large boxes and small cases generally follow the sizes of normal pallets, but their forms and dimensions are, however, exceedingly various. They are mainly applied as reusable packing materials, for postal purposes, retail transportation of liquid-, piece-, and bulk goods. Types of cases are:

- collecting cases,
- transporting cases /collapsible and non-collapsible/,
- cooling cases.

Aluminium pallets, though being more expensive than the traditional ones, are spreading widely in Europe mainly in internal transportation. Small containers are also used for shop supply: there are also special purpose containers such as air-containers, thermos-containers, etc.

The marketed aluminium drums are as follows:

- drums for chemical agent
- drums for food industry
- beer barrels.

Among small barrels of 25 to 100 litres, aluminium drums have mostly dominated the market owing to their simple maintenance.

3. Machine industry

It is a general industrial effort to improve the yield or rather to reduce the material consumption that determines the price of the products.

The specific material consumption of the machine industry is estimated to be 89 % to 95 % of the present one in Anno 2,000 provided that production is of the same volume and structure. The proportion of steel machine parts will decrease from 86 % to 67-77 %, while the proportion of light metals and plastics will increase from 4.7 % to 13 % according to the prognosis.

The application of aluminium parts in the machine industry is limited owing to the extremely rapid development of plastics on one hand, and to the remarkable fall in the world market prices of alloyed steel in the last years on the other hand. The present situation is figured by the Table 20.

Table 20

Share of the machine industry in the total aluminium consumption

Countries	Share of machine industry /without the vehicle industry/ '000 tons	%
Great Britain, FRG, France and Italy together	595	17
USA	364	16
Japan	714	30
Hungary	51	27

Casting and forgings give the biggest part of aluminium consumption in the machine industry. In the countries where the vehicle producing industry is highly developed, foundries generally supply parts for road transportation. Share of other products of the machine industry within the whole consumption is relatively smaller in these countries - as it appears from the table - than in Hungary, where the road vehicle industry has a relatively smaller importance.

Accordingly, attention had to be paid to some other possibilities concerning aluminium application in the machine industry. Consequently, it can be seen that there is a remarkable reserve in aluminium applications within the machine industry where its share in the whole consumption is relatively low. Electric motors, heat-exchangers and miscellaneous mass products are the main users in this category in Hungary /only the castings of electric motors are counted here, the conductors are not/.

The possibilities for aluminium application in Mozambique are first of all:

- heat exchangers, engine coolers
- cast components.

The weight of aluminium heat-exchangers of the same capacity is much less than those of steel or copper. Thermal efficiency of copper calculated for one unit weight is 40 %, that of steel 15 % taking aluminium as 100 %.

Sizes of the aluminium heat-exchangers of the same thermal output are smaller than that of steel ones. They are spreading widely both in heating and cooling equipment.

The market for aluminium heaters is very restricted in Mozambique and in the neighbouring countries, however, it can be taken into account as finished product's export. Heat-exchangers used in air-conditioners and refrigerators could have a good market in Mozambique. The air-side flow--resistance of the equipment due to its ribbed structure is greater but its efficiency is higher. Their most common industrial application is being the cooling component of the air condensation system of thermal power plants. This system enables the setting up of power plants in arid areas. Their aluminium consumption is shown in the Table 21.

Table 21

Aluminium consumption of cooling components

Capacity of the power plant, MW	Aluminium consumption of the cooling component in tons
1,000	2,280
2,000	4,500
3,000	6,800

The application of aluminium is useful in the cooling technique to evaporate and air-cooling condensers of refrigerators. It is a common practice to combine aluminium with steel or copper so that the cooling element on the air side is made of aluminium strip and the material of the primary side is steel- or copper pipe. Metallic contact is provided for soldered connection. The thermal conduction is perfect and the stability of the whole structure is satisfactory, too.

Specific aluminium consumption of heat-exchangers of the refrigerating industry is 0.3 kg/m^2. Evaporators of refrigerators and refrigerating counters are made exclusively of aluminium, of roll bond sheets. Their average aluminium consumption is 1.1 kgs/piece.

Another typical ever developing application field of aluminium is its use in the water- and oil cooling systems of vehicles. If the ribs alone are made of aluminium and the tubes of copper, 0.1 kg/m^2 consumption of aluminium can be reckoned with.

Perspectively, material of sheet collectors utilizing solar energy will also be aluminium. Solar energy can be employed to heat and cool. This way of utilizing energy sources in our days seems to be the most economic because of the increasing energy prices. The structure of collectors is in many respects similar to the roll bond sheets used in the cooling industry. Their surface is black /without pigment/ anodized.

Another large field of the machine industry is the application of cast parts. The rapid upswing in the usage of aluminium castings is justified by both technical and economic conditions. Aluminium castings of great accuracy, requiring no considerable additional working after casting and being easily replaceable, can be produced by mechanized to some extent. The capital costs to establish a light metal foundry is considerably lower than that of an iron- and steel foundry.

For different quantities the most economical technologies are:

- sand casting up to 1,000 pieces
- gravity die casting from 1,000 to 10,000 pieces
- different pressure die casting for larger series

A break-up of the principal casting technologies are illustrated in the Table 22.

Table 22

Break-up of casting technologies

	Sand casting	Manual gravity die casting	Mechanized casting
Industrialized West-European countries	20	40	40
Developing countries	45	50	5

4. Transportation, storage

This field of application of aluminium means the production of the passenger and freight cars,caravans, buses, ships, vehicle accessories, silos, tanks, transport containers, gas-cylinders, etc.

Application of aluminium in the vehicle- and machine industry cannot always be separated. Castings, also discussed in the preceding chapter are mostly employed by the vehicle industry. Of the 2.5 million tons castings, produced annually worldwide, some 1.2 million tons are used as components of cars and motor bikes.

In the passenger cars' production these aluminium castings are to replace first of all iron and steel, and to a lesser degree copper and zinc. Share of some structural materials used in a passenger car is summed up in the Table 23.

Table 23

Share of structural materials in passenger car manufacture

	1980		1990*	
	kgs	%	kgs	%
Steel, iron castings	830	67.0	614.0	56.0
Aluminium alloys	107	8.6	390.0	35.0
Plastics	95	7.6	127.0	11.5
Copper alloys	11	0.9	7.0	0.6
Zinc alloys	5	0.4	3.6	0.3

*estimated

In spite of the high specific cost of aluminium there is a tendency to increase the aluminium consumption in the vehicle production. The reason for this is the effort to reduce the weight of motorcars to fulfil the following requirements:

- planning of energy-saving constructions
- regulations of environmental protections
- personal safety's prescriptions.

It is experimentally proved that a 100 kgs reduction in dead weight has the result of saving 0.7 litre petrol in 100 kilometres. During the whole required endurance period which can be taken as 150,000 kilometres it corresponds to 600 US$. The selling price of a car can be increased only by 25 % of this sum.

It must be stated, however, that application of aluminium leads to the increase of costs. It is the treble of that of cast iron and two to three and a half fold of that of steel. Neverthless,a saving of 75 % can be attained compared to stainless steel.

Building in generally 1 kg aluminium in a car has generally the result of reducing its weight by 1 kg, max. by 1.5 kg.

It is to be expected that the regulations concerning the environmental protection will be obligatory in Europe, too. /Maximum permitted consumption in 1980 was 11.8 litres/100 kilometres and it will be 8.5 litres/100 kilometres in the USA in 1985./ This prescription will promote reduction in the dead-weight, of the cars.

The application of castings will remain but the appearence of forged components has also to be taken into consideration. Application of body plates has shown a notable upward tendency from the mid eighties and usage of extruded profiles /fenders, decorating strips/ will be growing, too.

Considering that plasticity of aluminium plates assuring proper stability is behind that of steel that can be deep-drawn, changes in body construction become necessary. The time needed to such changes is estimated to five years or so.

These tendencies will dominate practically in lorries, buses and service vehicles, too. Though being fewer in number than passenger cars, they require more material per piece because of their bigger weight.

Economic efficiency of aluminium construction applied to superstructures of lorries and buses is secured not only by reducing the weight but also by the favourable maintenance costs and endurance. An interesting development is the exchange of steel/wood combined superstructures for aluminium ones. The aluminium bodywork consists of extruded aluminium section to be pushed into one another and be fixed by a latch giving remarkable manpower saving. The production cost will practically be the same as that of steel/wood combination with the extra benefit of not needing skilled manpower.

Application of aluminium in railway cars and carriages is - besides the already known inside equipment /luggage--grids, handholds, window-frames, handlers/ and outside appliances such as roofs, mobile separation walls like railway car doors, door covering for bulk transports - constantly the question of the day. If the chassis and carcases are made of extruded, alloyed profiles, not only the weight can be reduced but also saving in production and maintenance costs can be achieved. Weight reduction has the favour of causing reduced wear in running-gear and trackage and in the case of a collision and or a spotting trip, i.e. the shock absorption of aluminium is good. Among vehicles rolling on rail these advantages are proved in serial production of the underground train carriages.

It is the reduced weight, the corrosion resistance and the simple maintenance that are good reasons supporting the application of aluminium usage for vehicles and transportation facilities alike.

Processing technology of tanks, carrying liquids, and bulk goods are practically the same as that of stable tanks, silos, etc. It is their dimension and wall-thickness that are different first of all. Pressure tanks and tanks of static loads are made of aluminium. The main consumers of such tanks are the chemical industries, industry of synthetics, food processing and the agricultural industries.

Aluminium tanks are employed by breweries not only for storage, fermentation and transportation, but also for saturation of beer with carbon dioxide. Boiling vessels are also made of aluminium replacing tinned copper.

The outer hull of the double-walled equipment in dairy industry is made of aluminium and their inner body - being in direct contact with milk - is made of stainless steel.

The prospects to produce tanks, bottles, cylinders, suitable for transporting liquid gas /PB-Gas/ are very good. Experiences and professional knowledge in this field are available from Hungary.

The so called big containers /larger than 5 m^3/ are not so widespread due to the strict ISO requirements. There are only two firms producing these all over the world. They produce 20 feet long containers.

5. Building-industry

Constructions and finished products of building-industry are of many kinds regarding both requirements and structural appearance.

Application fields in building and construction where aluminium semis can advantageously be employed due to their light weight, corrosion resistance, and good ability to block humidity and favourable refelctivity, include:

- inside and outside cladding
- aluminium foil to preserve against humidity
- framed constructions
- doors, window frames, bars
- cooling components.

The share of the aluminium consumption in building industry from the total consumption of aluminium in the industrialized countries in the last years, in percentage:

FRG	19 %
Belgium	32 %
Austria	21 %
Switzerland	21 %
Japan	34 %
USA	23 %

The volume of aluminium consumption in building industry of a country depends mainly on the national income.

The correlation is not too strict. Conventional building methods are no longer able to meet growing demands concerning both quantity and quality.

Table 24

Relationship between national income and aluminium consumption in the building-industry

National income per capita $	Consumption per capita $
<800	-0.7
800-1,000	0.7-2.0
>1,000	2-6

This calls for a thorough revision of conventional architectural thinking throughout the world, with more sophisticated building techniques, prefabrication and light constructions.

General advantages of these methods are the following possibilities:

- Prefabrication can be sited in areas where a more advanced stage of industrialization and the necessary infrastructure alread exist.
- Bult-in volumes of material may be reduced by about one tenth.
- Assembly and installation work on the spot require fewer skilled labour.
- Completion of projects may be short-cut.

Greater part of semis produced by so called high-finish are made for the purposes of building industry:

- various patterned sheets
- lacquered sheets
- corrugated sheets
- perforated sheets
- profiles bent from strip
- heat isolated panels.

Aluminium industry itself is often also the producer of certain constructions like, for example:

- windows, doors
- air grids, refuse sheets, rain gutters,
- roofings
- suspended ceiling /element systems/, separating walls,
- garages, stores,
- room elements /container buildings/,
- complete buildings, deep-feezing storage houses.

Prime contracting is the highest activity phase of the aluminium industry in building and construction, it covers the whole feasibility of complete industrial, agricultural and public buildings. Two systems are used at present:

- The so called mobile homes, a sort of dwelling containers. These are completely prefabricated and so delivered to the site of setting up.

- The module system enabling the mounting of pre-fabricated framing, roofing, side panels, window frames and doors on site.

The former method requires minimal work when assembling but combination possibilities are restricted, but it is important still at buildings to be moved to another place if required.

6. Apparatus manufacture

According to the International Nomenclature, radiators, heat-exchangers, air-conditioners belong to the mechanical engineering industry and exhausters to the building industry. Irrigation systems, greenhouses in agriculture are classed among chemical engineering - food processing, though being of different character. It is expedient, therefore, to discuss this field separately.

Because of the usual rough handling and unfavourable local conditions, quality standards of aluminium items used by agriculture are in most cases high and exacting. Aluminium can fulfil these norms in many cases.

Irrigation systems in agriculture are of different character according to whether they are used in gardening or on arable land. Their design also depends on whether they are employed as rainers, sprinklers or as subsoil irrigation systems.

Aluminium pipelines are usually used in largest quantities on arable land for rainees. They may be re--siteable, self-propelling or trailable, but their common feature must be: mobility.

Aluminium has only a complementary role beside plastics in subsoil and sprinkler irrigation systems.

Greenhouses in gardening can be very favourably used they being independent of weather and an optimate climate is so secured for the plants. This means heating, keeping of optimal moisture and carbon dioxide content in continental climates while in torrid zone cooling is the most important. There is a possibility - with help of these greenhouses - to grow such plants, that would not grow otherwise in the given climate.

The cheapest way of making such greenhouses is using a framework clad by two plastic foils so that sprinkling of water between the foils can assure heating, or cooling. Frameworks employed in greenhouses are made of welded or extruded drawn aluminium pipes.

In large-scale production of viniculture the vine--yard grape-poles, and supports are also made of welded pipes or profiles bent from strips of agricultural aluminium frameworks, too.

7. Household appliances

This group includes the production of

pots and pans
pressure cookers
autosyphons
office and camping furnitures.

Considering the history of aluminium consumption and finished good manufacture, we can state that production of pots and pans preceeded the production other finished goods everywhere. This is the case in Mozambique, too.

Conventional aluminium utensils, though having been used already for some decades, are on the market even today, and presumably will find a market in the future, too. The producers provide it with continuous development.

The various utensils: coloured, anodized, enamelled and plastic clad ones enlarge the collection beside those having natural colour. Pressure cookers are next in line.

Sodasyphons, for example, cannot be imagined to be manufactured of anything else, but aluminium. Similar technology is used when manufacturing whipped-cream in so called cream-syphons with a certain combination of plastics.

Aluminium framework of office furnitures include wooden or plastic sheets, doors, drawers. The usual combination for camping furniture is aluminium, textile and plastic.

B. Substitution of copper, tin-plated and/or zinc-coated steel

Contention among the various structural materials has already been discussed in para IV.

Development work in the past 40 years tended to produce goods, substituting those made of conventional structural materials. This process notably contributed to looking of aluminium as a sort of "substitute" but this definition has a pejorative meaning. But it is not really the case because the simple substitution possibilities are mostly over in the industrialized countries. To enlarge the consumption of new products, entirely new application fields are needed.

Development work in order to find substitute materials has considerable possibilities in the countries where there are technical sources available and the market is not overstocked. The tendencies are influenced chiefly by the reserves of raw materials, degree of supply of structural materials and the industrial and economic structure.

In electrical engineering aluminium is very good for replacing copper, in many fields of packaging tin and tin-plated-steel are substituted by it, and aluminium can be used instead of zinc and zinc-coated steel in the building industry too. In our days it is the vehicle industry, where aluminium becomes used in large quantities instead of steel and cast iron.

Aluminium is more expensive than steel, therefore its usage is somewhat hindered, whereas it being relatively cheaper than copper, aluminium could replace it with success in many branches of the industry. Whether aluminium can take the place of copper, is nowadays practically a question of technique.

Resistance and price of 1 kg conductor, e.g. cadmium bronze, is 2.28 fold and 1.4 to 2.- fold respectively, compared to that of aluminium. These indices make application of aluminium conductor quite obvious. Electrical conductor manufacture is now strongly aluminium oriented.

This can be stated from the fact, that share of the aluminium conductors manufactured in many countries is about 50 %. Comparing the heat-transfer of ribbed plates in heat-exchangers made of various metal sheets, application of aluminium proved to be substantiated:

commercial aluminium sheet	3,400 kcal/h.kg
aluminium alloy sheet	3,000 kcal/h.kg
copper sheet	1,250 kcal/h.kg
commercial steel sheet	500 kcal/h.kg

Tinned-steel sheet may be replaced primarily in food processing industries /cans, glass jar tops/. There is a tin shortage in the world market and so it is getting more and more expensive. Money spent on up-to-date package material and constructions often exceeds the value of the packaged goods itself, so might development of packaging, result in reduction of production cost.

For example:

Weight of one can of 240 ml volume

made of tinned steel sheet	77 grams
made of aluminium	27 grams
made of aluminium foil	15 grams

It is not a mere chance that aluminium used for can and box production was subject to a fivefold rise in the last 10 years, while tin-plate had only a 1.5-fold growth. Counted in pieces, the growth is much greater according to weight ratios.

Using 1 ton aluminium in building industry means a saving of averagely 2.4 to 2.6 tons steel sheet and [illegible] 0.25 ton zinc. Aluminium structures /roofs, side-walls, rain gutters/ are generally more expensive regarding production cost. It must be stated that durability of aluminium sheet is much longer than that of zinc-coated steel, and zinc coated steel has to be surface-treated /painted/, too.

In contention - between aluminium and zinc-coated steel plate - application of aluminium is more favourable in all cases when the required life-span of the construction is expected to be more than 4 years.

Aluminium is no more regarded as a "substitute" material concerning the application fields mentioned above. On the contrary, it is the proper material and this is reflected by the large fields of its application.

C. <u>The assortment of semis for manufacturing recommended product mix</u>

Base information is, that 150,000 tons aluminium ingot will be available by 1987 and a further 50,000 tons will be supplied by indigenous smelters between 1995 and 2000; that makes altogether 200,000 tons of aluminium [illegible] got,which will probably be available in Mozambique at Anno 2000. It is presumable that an agreement for cooperation will be concluded according to which aluminium ingot can be supplied in ecxhange for the imported alumina. The price of alumina amounts to 1/7 to 1/9 of that of the aluminium metal, so in Mozambique the expected usable quantitv of aluminium will range from 105,000 to 115,000 tons in 1990-1995; and from 140,000 to 155,000 tons in 2000. Until Mozambique does not have indigenous basic material, domestic finished good-manufacturing has to be provided with imported semis. Semis requirement of the short-term developing program till 1985 /see the following para/ can be fulfilled by import alone.

As it can be seen from point V.B., the expected domestic consumption of aluminium will be as follows:

Year	1985	1990	1995	2000
Consumption in 1,000 tons	6.75	9.12	11.7	17.0

This indigenous consumption of aluminium will be probably divided among branches of the industries according to Table 25. On the basis of these expected domestic consumptions alone, the creation of semis-manufacturing capacities is nearly impossible.

It may happen that during long-term economic development - not known till now - certain important special-purpose programs, such a programs concerning electrification, gas supply, flat building, etc. will advance particular branches to the detriment of other ones. These factors can not be taken into account in our prognosis.

As the semis-manufacturing capacities definitely exceed the maximum domestic consumption, so the available metal reserve will also exceed the requirement of the semis production after 1987. Sufficient amount of ingot and semis will remain for export allowing a flexible adaptation to the world market situations. At the same time capacity of some semis-manufacturing plants will exceed unavoidably the doméstic requirements because of the realizable sizes of these plants. We propose a long--term developing plan according to the program indicated in Table 26.

The Table shows the groups of products and their output collated with the semis-manufacturing capacities /recommendation are given in para VIII.B/.

Table 25

Domestic consumption of aluminium products

Unit: 1,000 tons Use of product groups	Rolled products				Extruded-drawn semiproducts				Properzi-wire				Castings and Forgings				Total			
	1985	1990	1995	2000	1985	1990	1995	2000	1985	1990	1995	2000	1985	1990	1995	2000	1985	1990	1995	2000
Electrical industry	0,7	0,7	0,7	1	1,25	2,2	0,3	0,3	-	-	2	1,8	0,05	0,1	0,1	0,2	2,0	3	3,1	3,3
Packaging industry	0,3	0,6	0,8	1,7	-	-	-	-	-	-	-	-	-	-	-	-	0,3	0,6	0,8	1,7
Machine industry	0,05	0,15	0,3	0,4	0,1	0,2	0,3	0,4	-	0,05	0,05	0,1	0,15	0,3	0,35	0,8	0,3	0,7	1,0	1,7
Transportation, storage	0,4	0,8	1,6	2,7	-	0,07	0,45	1	-	-	-	0,1	0,05	0,1	0,25	0,5	0,45	0,97	2,3	4,3
Building industry	1,4	1,4	1,8	2,5	0,3	0,3	0,45	0,6	-	-	0,05	0,1	-	0,1	0,1	0,2	1,7	1,8	2,4	3,4
Apparatus manufacture	0,1	0,2	0,3	0,6	0,2	0,1	0,15	0,4	-	-	-	-	-	0,15	0,15	0,2	0,3	0,45	0,6	1,2
Household appliances	0,7	0,6	0,6	0,6	0,7	0,7	0,6	0,5	-	-	-	-	0,3	0,3	0,3	0,3	1,7	1,6	1,5	1,4
Total domestic consumption	3,65	4,45	6,1	9,5	2,55	3,57	2,25	3,2	-	0,05	2,1	2,1	0,55	1,05	1,25	2,2	6,75	9,12	11,7	17

Primary metal stock:	0	105	115	155
Recycling:	0,2	1	5	10

Table 26 **Proposed capacities for end-products**

Unit: 1,000 tons Output of product groups	Rolled products				Extruded-drawn semiproducts				Propersi-wire				Castings and Forgings				Total			
	1985	1990	1995	2000	1985	1990	1995	2000	1985	1990	1995	2000	1985	1990	1995	2000	1985	1990	1995	2000
Electrical industry	0,5	0,5	1,0	2,0	6,2	6,5	7	7	-	-	20	20	0,1	0,2	0,2	0,4	6,8	7,2	28,2	29,4
Packaging industry	0,3	0,6	0,8	1,7	-	-	-	-	-	-	-	-	-	-	-	-	0,3	0,6	0,8	1,7
Machine industry	0,5	1,5	1,5	1,5	0,1	0,2	0,5	1	-	1	1	1	0,2	0,4	2	4	0,8	3,1	5	7,5
Transportation, storage	3,5	3,5	4,0	4,0	0,3	0,3	0,5	2	-	-	-	0,5	0,2	0,2	0,5	3	4,0	4,0	5,0	9,5
Building industry	1,4	1,4	3,0	5,3	1,5	1,5	2,5	4	-	-	1	1,5	-	0,3	0,4	2	2,9	3,2	6,9	12,8
Apparatus manufacture	0,3	0,6	1,0	1,8	0,5	0,5	0,8	2	-	-	-	-	-	0,4	0,5	1	0,8	1,5	2,3	4,8
Household appliances	0,7	0,7	0,7	0,7	0,4	0,7	0,7	0,7	-	-	-	-	0,3	0,3	1	2	1,4	1,7	2,4	3,4
Total capacity	7,2	8,8	12	17	9	9,7	12	16,7	-	1	22	23	0,8	1,8	4,6	12,4	17	21,3	50,6	69,1
Semiproducts' output	0	20	55	70	9	10	20	30	0	20	40	40	1	2	5	15	10	52	120	155

VII. A SHORT-TERM PROGRAM FOR MANUFACTURING ALUMINIUM FINISHED PRODUCTS

Establishing a verticum in the aluminium industry is a long-term procedure. There are two possibilities of doing so:

1. Starting from bauxite mining, through alumina production and aluminium smelting, to semis manufacturing.
2. Starting from finished goods manufacturing to semis manufacturing and aluminium smelting.

Aluminium metallurgy is the biggest energy-consuming and most device-intensive phase of the verticum, it requires, however, the least manpower. Finished goods manufacturing is the least device-intensive but has the largest manpower requirement in the verticum.

If we consider the volume of the market activitiy, aluminium basic-products require the least marketing activity but the world market price fluctuations have immediate effects. It could be considerably profitable by maintaining proper and advantageous ratio among manufacturing, stockpiling and selling; but both businessmen and manufacturers can suffer, however, considerable losses working in the free market. If finished aluminium goods manufacturing plants, running not entirely independently of each other, have a sufficient wide range of product assortment and can smoothly change their profiles, manufacturing of finished goods implies smaller risk. Selling of finished goods requires considerable marketing activity owing to the wide range of assortment and the small quantity of a given kind of products.

In our opinion, it is not advisable to postpone development of finished goods manufacturing till it can be fully provided with indigenous raw materials. In addition, satisfying the finished goods' requirements fully from import is uneconomic, too.

We wish to propose to establish aluminium goods manufacturing plants by which indigenous manufacturing can be started, and which are appropriate to make the fundament to the aluminium industry.

A. The recommended products and workshops in particular

1. Small plant for manufacturing aluminium household utensils

Aluminium household utensils listed below or any other products requiring the same technology can be produced in the plant.

Name	Size /cm/	Pieces/year
Pot	14, 18, 22	50,000
Pouched pan	14, 18, 22	50,000
Lid	14, 18, 22	10,000
Frying pan	18, 20, 22	30,000
Tea-kettle	14, 16, 18	40,000
Dinner-carrier /with 2, 3 and 4 bowls/	14, 16, 18	30,000
Bowl		50,000
Tourist pan	16	40,000
		370,000

Material requirements:

Aluminium circle	105 t
Steel /sheet, strip, wire/	33 t
Auxiliary materials	
paint	5 t
caustic soda	3 t
nitrous acid	1,5 t
abrasive paste	10 t

Total weight of finished goods: 135 t

Operations of manufacturing technology are as follows:

a/ Cold working without machining

a/1 Straightening, cutting to size
- straightening and cutting of wires, coils and straight materials

a/2 Strip forming to pipe, cutting to size
- strip forming and cutting to size of tea-kettle clips and utensils' iron handles

a/3 Cutting by band saw

a/4 Deep drawing
- drawing operations on hydraulic extrusion presses: bowl and lid drawing

a/5 Cutting by circle shears
- cutting of drawn parts by circle shears

a/6 Cutting by eccentric press
- cutting, bending, flattering, striking, blanking, punching

a/7 Metal shaping, cutting, flanging
- shaping operations from circle with or without prestressing on metal-shaping machines by hand tools

a/8 Smoothing, planishing
- smoothing, planishing of prestressed work-pieces by planing machine

b/ Machining

Drilling, counterdrilling, thread drilling, milling /tea-kettle spout milling/, grinding, deburring.

c/ Chemical processes

Acid and basic production operations for the technology of:
- degreasing
- pickling
- phosphate coating

d/ Surface finishing

d/1 Finishing
Surface treatment by finishing machines of horizontal or vertical shaft by means of abrasive cloth /inner and outer finishing/

d/2 Polishing
Polishing by polishing machine of two rag buffing wheels /at each end of shaft/

d/3 Abrasive tumbling

e/ Casting
Casting of tea-kettle spouts from pot metal using scrap.

f/ Assembling
Assembling of two or more parts:
- soldering /tea-kettle spout/
- riveting
- other manual assembling steps

g/ Painting
Surface protecting and finishing processes
- varnishing
- burning-in

h/ Cleaning
Cleaning the surface of product from manufacturing impurities.

i/ Packaging according to requirements.

Table 27

List of machines and equipment of a household utensils manufacturing plant

Item No.	Name	Pieces	Built-in power, kW	Mass kgs
1.	Extrusion press for deep-drawing /PYE 100S/1/	2	30.0	7,200
2.	Eccentric press /DKS-40A/	5	20.0	12,500
3.	Planing machine /E 400 M/	1	5.5	2,600
4.	Metal-shaping press	1	5.5	2,600
5.	Circle shears	1	2.0	150
6.	Universal machine /E 400 M/	1	5.5	260
7.	Pickling+phosphate coating bath line	1	108.0	1,200
8.	Finishing machine with horizontal shaft	1	2.0	150
9.	Finishing machine with horizontal shaft	1	2.0	150
10.	Finishing-polishing machine with double shaft	2	16.0	1,000
11.	Special air puncher	1	-	200
12.	Special riveting machine	3	4.5	600
13.	Soldering equipment	1	-	100
14.	Casting ladle TCAL 50	1	21.0	1,740
15.	Band saw	1	1.5	200
16.	Aggregate for tea-kettle spout milling	1	2.5	150
17.	Grinding machine with double shaft /K-301/ /deburring/	1	1.1	140
18.	Drilling machine /F 013/	1	0.55	150
19.	Strip forming /to pipe/ machine	1	3.5	300
20.	Abrasive drum	1	1.5	150
21.	Straightening-cutting machine	1	2.0	100
22.	Dip painting equipment with burning-in box	-	-	200

con'd

Item No.	N a m e	Pieces	Built-in power, kW	Mass kgs
23.	Burning-in kiln	2	64.0	6,000
24.	Paint spraying box	1	2.0	260
25.	Cutting machine /to rectangular size/	1	3.0	400
26.	Special flanging machine	1	3.0	400
27.	Straightening-cutting machine	1	2.0	100
28.	Exhaust fan	5	16.0	500
1-28.		41	325.0	41,840

Total price of installation: US$ 412,000.-

The total area required for the plant including casting shop, chemical and finishing plant's units requiring separation as well as storage area among various operations:

cca 950 m^2.

Power requirement of the plant

Electric power /built-in/: 325 kW

Note: If heat energy for chemical operations /bath heating/ is available in form of steam, built-in electric power requirement: 217 kW

and steam requirement: 1 t/h

Compressed air 15 m^3/h

Water 3 m^3/h

Tooling cost requirement /non-recurring cost/ US$ 172,000.-

Productive manpower requirement

Metal pressing skilled workers	2 persons
Finishing skilled workers	3 persons
Semi-skilled machine workers	14 persons
Other semi-skilled workers	7 persons
Totally	26 persons

If buildings and infrastructure are available or they can be constructed on the spot from local materials, cost of plant is the following:

Machine and equipment		US$	412,000.-
Tooling		US$	172,000.-
Know-how		US$	46,000.-
	Total	US$	630,000.-

Workers' training costs are added to this value /as in para X/. Costs can be decreased if main parts such as bodies of pots, pans and kettles as well as lids are manufactured only, while smaller parts such as handles, handle--supports, tea-kettle spouts are produced by a subcontractor or from the company supplying the know-how, under a long-term cooperation agreement. In this case the equipment and built-in power requirement decreases as follows:

Item No.	Name	Pieces	Built-in power kW	Mass kgs
1.	Extrusion press for deep--drawing /PYE 100S/1	1	15.0	3,600
2.	Eccentric press /DKS-40 A/	1	4.0	2,500
3.	Planing machine /E 400 M/	1	5.5	2,600
4.	Metal-shaping press /E 400 M/	1	5.5	2,600
5.	Circle shears	1	2.0	150
6.	Universal machine /E 400 M/	1	5.5	1,600
7.	Pickling+phosphate coating bath line	1	108.0	1,200
8.	Finishing machine with horizontal shaft	1	2.0	150
9.	Finishing machine with vertical shaft	1	2.0	150
10.	Finishing-polishing machine with double shaft	2	16.0	1,000
11.	Special air puncher	1	-	200

con'd

Item No.	Name	Pieces	Built-in power kW	Mass kgs
12.	Riveting machine	2	3.0	400
13.	Soldering equipment	1	-	100
14.	Exhaust fan	4	13.0	400
1-14.		19	181.5	17,650

Consequently the cost of machines and equipment	US$	177,000.-
tooling	US$	94,000.-
know-how	US$	29,000.-
Total	US$	300,000.-

2. Small plant to manufacture transport milk-cans of aluminium

Transport milk-cans of 25 litres and 40 litres or any other products requiring the same technology can be produced in the plant.

Operations of manufacturing technology are as follows:

a/ Cold working without machining

a/1 Deep-drawing
Drawing operations by crank and hydraulic extrusion presses

a/2 Cutting by circular saw

a/3 Cutting of drawn parts by circle shears or by special cutting machine

a/4 Press forming
Shaping operations on pre-stressed workpieces by special neck-forming machine

b/ **Machining**

Turning, drilling, milling, deburring

c/ Chemical surface treatment /pickling/

Acid and basic manufacturing operations

d/ Casting

The milk-can manufacturing plant does not have a casting shop. Consequently, the cast parts /neck ring, bottom ring, closing clip, lid base/ are to be provided for.

e/ Assembling

Assembling of two or more parts by

- welding
- riveting
- other manual assembling method

Table 28

Equipment and built-in power requirement and water consumption of a milk-can manufacturing plant

Item No.	Name	Type	Pieces necessary for production of 25,000 units	100,000 units	Power kW	Water m^3/h
1.	Extrusion press for deep-drawing	HZPU 200 hydraulic press	1	1	74	1
2.	Extrusion press for deep-drawing	160 t Shuller	2	2	60	-
3.	Extrusion press for deep-drawing	PYE 100 t	1	1	15	-
4.	Lathe	RT 40	2	5	11 /27/	-
5.	Upright drilling machine	FO-13	1	3	0.55 /1.7/	-
6.	Pickling bath line	consisting of 5 wooden baths	1	1	80	2.5
7.	Oil press	special oil press	1	2	5 /10/	-
8.	Welding apparatus	T.I.G.	1	1	-	-
9.	Finishing machine	K-352	1	3	3.6 /10.8/	-
10.	Circular saw	plastic disc circular saw MTD-300	1	1	2.7	-
11.	Cutting machine	special cutting machine	1	1	2.5	-
12.	Low-frequency annealing furnace	special annealing furnace	1	1	50	-
13.	Neck-shaping machine	special shaping machine	1	3	4 /12/	-
14.	Lathe	EE 500-0.1	1	1	13	-
15.	Eccentric press	DKS-25/a	1	1	3	-
16.	Milling machine	special milling machine	1	1	0.5	-
17.	Milling machine	special milling machine	1	1	0.5	-
18.	Circle shears	special circle shears	1	1	0.5	-
	Total		20	30	326 /61.[illegible]/	3.[illegible]

It can be seen from the Table that utilization of some machines and equipment is not adequate in case of manufacturing small quantities. If 25,000 pieces of milk-cans are manufactured yearly, in one shift, there are considerable unutilized machine capacities. If 100,000 milk-cans are manufactured yearly, utilization factor of machines is improved.

Large household utensils up to 90 litres can also be advantageously manufactured by this manufacturing line. In addition, the remaining capacity can be utilized to manufacture utensils of normal sizes.

Area requirement of the plant including chemical plant unit requiring separation and storage area among the various technical operations/

Table 29

Operational conditions of a milk-can manufacturing plant

	Capacity 25,000 pieces	Capacity 100,000 pieces
Area, m^2	850	1,000
Electric power /built-in, kW/	326	388
Water-consumption	3.7 m^3/h	
Natural gas	4.0 m^3/h /if hot steam can be used for chemical operations and bath heating, 1 t/h steam substitutes 80 kW electric power/	
Productive manpower requirement:		
semi-skilled machine workers	6 persons	/20 persons/
other semi-skilled workers	6 persons	/20 persons/

If the number of workpieces increases 4-fold the manpower requirement will be 3.3-fold only.

Table 30

Aluminium requirement for milk-can producing plants of different capacities

Capacity /number of pieces/	25 lit milk-can	40 lit milk-can
25,000	150 t	225 t
100,000	600 t	900 t

Cost of machinery, first tooling and know-how:

US$ 1,300,000.-

Thereof:

machinery	US$	970,000.-
tooling	US$	100,000.-
know-how	US$	80,000.-
setting and start-up operation	US$	150,000.-

3. Plant for manufacturing aluminium cylinders for P.B.-gas

Gas cylinders of capacities between 16.2 litres and 50 litres and car gas bottles of 60 litres can be produced in the plant.

Technologies are as follows:

- cold working /drawing, bending, inscription text stamping/
- machining /turning, milling/
- welding
- heat treatment /hardening/
- surface treatment /pickling/
- laboratory quality tests /pressure test/

Table 31

Sequence of operations of cylinder manufacturing technologies

Base material: disc

	Operation	Machine - equipment
1.	Drawing - cutting - opening-annealing - opening-reducing	1300 MN SNG manufacturing line
2.	Opening turning	Special lathe
3.	Pickling	pickling line
4.	Welding of the fittings /neck ring, bottom ring protective basket/	AGA-Miller welding machine
5.	Pressure test	Special equipment
6.	Heat treatment /hardening/	KGYV electric pusher type furnace
7.	Heat treatment /ageing/	KGYV electric pusher type furnace
8.	Pickling	Pickling line
9.	Final acceptance tests	Special line for acceptance test
10.	Painting /marking stripe/	Painting equipment

Table 32

Sequence of operations of neck-ring manufacturing technologies

Base material: forged semi-product

Operation	Machine - equipment
1. Text stamping /in case of 50 lit gas bottle/	2500 MN PYE hydraulic press
2. Machining I	1314 capstan lathe
3. Machining II	1314 capstan lathe
4. Thread milling	GFU-16 MECANA thread-milling machine
5. Pickling	Pickling line
6. Assembling /welding to the bottle/	AGA-Miller welding machine

Table 33

Sequence of operations of bottom ring manufacturing technologies

Base material: extruded semi-product

Operation	Machine - equipment
1. Cutting, punching, preliminary bending	350 MN eccentric press
2. Final grinding	Stand grinder
3. Rounding	Special rounding machine
4. Welding	AWI welding apparatus
5. Calibration	350 MN eccentric press
6. Pickling	Pickling line
7. Assembling /welding to the bottle	AGA-Miller welding machine

Table 34

Sequence of operations of protective basket manufacturing technologies

Base material: extruded semi-product

	Operation	Machine - equipment
1.	Cutting	Circular saw
2.	Text stamping	2500 MN PYE hydraulic press
3.	Window punching	350 MN eccentric press
4.	Preliminary bending	350 MN eccentric press
5.	Rounding	630 MN hydraulic press
6.	Punching	350 MN eccentric press
7.	Final embossing /two/	350 MN eccentric press
8.	Deburring	Stand grinder
9.	Pickling	Pickling line
10.	Assembling /welding to the bottle/	AGA-Miller welding machine

Manufacturing technology of 60 lit. car gas cylinder is the same as applied for manufacturing the above gas cylinder without bottom ring and protective basket but supplemented with:

Table 35

Sequence of operations of looking cap manufacturing technologies

Base material: circle

	Operation	Machine - equipment
1.	Drawing	2500 MN PYE extrusion press
2.	Cutting to size	Special lathe
3.	Pickling	Pickling line
4.	Assembling	AGA-Miller welding machine

Table 36

Sequence of operations of connecting end manufacturing technologies

Base material: slab

Operation		Machine - equipment
1.	Turning	1314 capstan lathe
2.	Drilling	Table drilling machine
3.	Thread drilling	Table thread-drilling machine
4.	Pickling	Pickling line
5.	Assembling	Special AGA-Miller welding machine

Table 37

Summarized list of machines and equipment for manufacturing PB-gas cylinders

Item No.	Name	Pcs.	Source of procurement
1.	1300 MN SMG drawing line	1	FRG
2.	KGYV electric pusher type furnace	2	Hungary
3.	AGA-Miller welding machine	6	Sweden
4.	Pickling line	2	Hungary
5.	Testing line	1	Hungary
6.	1314 capstan lathe	2	USSR
7.	GFU-MECANA thread milling machine	2	Switzerland
8.	350 MN eccetric press	6	Hungary
9.	2500 MN PYE hydraulic press	1	GDR
10.	630 MN hydraulic press	1	FRG
11.	AWI welding apparatus	1	Sweden
12.	Stand grinder	2	Hungary
13.	Special painting machine	1	Hungary
14.	Cutting machine with circular saw	1	Hungary
15.	Special lathe for opening turning	1	Hungary
16.	Special rounding machine	1	Czechoslovakia
17.	Material-handling equipment		
	- conveyor belt	3	
	- manual and mechanized trolley trucks	6	
	- crane /above SMG drawing line/	1	
18.	Exhaust fan and air conditioning		Hungary
19.	Laboratory test equipment		Hungary
	- to measure hardness	1	
	- to tear and bend	1-1	
	- X-ray equipment	1	
	- to tear	1	
20.	Other equipment		Hungary

Estimated total price of equipment: US$ 3,940,000.-

Additional equipment to manufacture car gas cylinders:

21.	2500 MN PYE hydraulic press	1	GDR
22.	AGA-Miller special welding machine	1	Sweden
23.	Table drilling machine	1	Hungary
24.	Table thread-drilling machine	1	Hungary
25.	Lathe /cutting to size/	1	Hungary

Cost of the above additional equipment:	US$	214,000.-
Cost of first tooling:	US$	470,000.-
Cost of know-how:	US$	370,000.-
Cost of establishing the plant without infrastructure:	US$	4,994,000.-

Area requirement of the plant: 3,500 m^2 /recommended length and width 70x50 m/

Power requirement:	electric /built-in/	1,500 kW
	heat - steam /technological/	4 m^3/h
	water	15 m^3/h
	air 6 to 10 att.	25 m^3/h

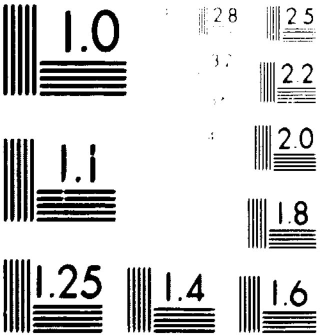
If pickling baths are not heated by steam built-in electric power requirement is: 1,750 kW.

Productive manpower requirement: directly engaged 60 persons/shift

indirect /other/ 12 persons/shift

In case of 2 shifts capacity of the plant is 250,000 pcs/year. By installing some additional machines capacity can be easily increased to 400,000 pcs/year.

Aluminium-consuming requirement can range between 2,000 and 8,000 tons/year depending on the assortment and volume of the products.


1.0
2.8
2.5
2.2
1.1
2.0
1.8
1.25
1.4
1.6

4. <u>Small plant to manufacture aluminium beer barrels</u>

Reviewing the lists of equipment of plants manufacturing household utensils, transport milk-cans and gas cylinders it can be seen that the equipment required for plants manufacturing different products overlap.

Base machinery such as drawing extrusion presses, drawbenches, eccentric presses facilitate cold working. Bodies of utensils can be manufactured in the milk-can manufacturing plant, too; milk-cans and utensils can be manufactured in the gas cylinder manufacturing plant, as well. If several products are manufactured parallelly, the capacity of the plant decreases considerably. If a gas cylinder manufacturing plant produces utensils as finished products, the machinery indicated in para VII.1 but not included in Para VII.3 is also required. In case of such parallel manufacturing the total capacity of this machinery will not be utilized.

Beer casks are also manufactured by cold working. The characters of the equipments are similar to that of gas cylinders manufacturing plant. For example, beer barrels /casks/ consisting of two parts are also welded by an automatic welding machine. A special equipment is required to varnish the inside wall of the cask.

Summed up cost of a small plant manufacturing 40,000 beer casks/year is, including main machinery, first tooling and know-how, without the detailed description of technology and equipment:

US$ 1,563,000.-

Barrels /casks/ of 50 litres and 100 litres can be produced in the plant.

Material requirement:	400 tpy	for 50 lit.casks
	950 tpy	for 100 lit.casks

5. Small plant to manufacture aluminium soda water syphons

1 litre soda water syphons and 0.5 litre cream syphons for cream or fruit cream can be manufactured in the plant. To use the syphons, cartridges containing CO_2 and N_2O are needed.

The bottles and heads are made from aluminium and plastics respectively. Surfaces are polished, sand blasted and anodized.

There are two manufacturing technologies: deep drawing or cold working. Base material for the latter is slug cut from extruded aluminium rods. Cold working extrusion presses are similar to extrusion presses used in the munitions industry for making cartridge cases.

Capacity of the proposed plant:

500,000 pcs/year /250,000 pcs soda water syphons +
+250,000 pcs cream syphons/

Material requirements:

aluminium	350 t/y
plastics	55 t/y

Cost of machinery including tooling and know-how:

bottle manufacturing	US$ 2,200.000.-
head manufacturing	US$ 250,000.-

Manufacturing costs in case of deep drawing are higher than those of the cold working. Consequently, home price as well as export price of the product will be higher, too. Despite greater unit prices, marketability, volume of the mass production, return on sales and magnitude of profit will decrease.

Adaptation of deep drawing technology is only justifiable in the period of introducing the product at the market, when the hardware or gas bottle's plant is already operating at fractional load; the manufacturer accepts responsibilities for marketing at a lower price till start up of the syphon plant in order to gain the market.

6. Aluminium heat-exchangers' manufacture

In this plant, small ribbed /finned surface/ heat exchangers and radiators can be produced from extruded aluminium shapes and strips.

Capacity of the plant:	200,000 m^2/y
Material requirement:	750 t/y
Estimated price of main machinery including tooling and know-how: US$	780 000.-

Manufacturing technology:

- cold forming /strip cutting, rib forming /finning//,
- machining /turning, thread cutting/
- welding
- finishing /pickling, painting/.

Finned surfaces are preferably used at aluminium heat exchangers and cooling elements in the power generation industry. This allows building power plants everywhere, even at arid sites, because cooling the water of the steam turbine condensers can be accomplished with forced circulation in cooling elements as a closed cycle.

Finned cooling surfaces can be used for any kind of industrial cooling as well, e.g. for compressor stations of gas- and oil pipe-lines, or or coolers in chemical industry.

Finned surfaces are also used at aluminium radiators.

7. Plant for manufacturing aluminium lamp posts and lamp arms

St pped diameter roadside aluminium lamp posts with or without arms can be produced in the plant for public lighting and other purposes /e.g. posts for supporting low, and middle voltage network and traffic lights, etc./.

We propose to produce the lamp posts according to the following percentage break-down:

Table 38

Percentage break-down of lamp-post manufacturing plant

Item No.	Name	Length m	%	Remark
1.	Lamp-posts of single stepped diameter	3.1	20	for traffic lights
2.	Lamp-posts of single stepped diameter	4.2	20	for floodlight witn arms
3.	Lamp-posts of single stepped diameter	5.1	6	lamp to be mounted on top of the post
4.	Lamp-posts of single stepped diameter	6.5	6	lamp to be mounted on top of the post
5.	Lamp-posts of double stepped diameter	7.8	8	lamp to be mounted on top of the post
6.	Lamp-posts of double stepped diameter	9.6	40	single- or double arm mounted on top of the lamp post

Base material: aluminium tubes.

Dimensions of some aluminium tubes:

- diameter 160 mm, wall thickness 6 mm
- diameter 180 mm, wall thickness 6 mm
- diameter 90 mm, wall thickness 6 mm

For lamp-posts of 180 mm diameter at its bottom, additional elements such as casting tube and extruded door profile are required.

Material quality: Al Mg Si Cu mild.

The plant should be operated in 2 or 3 shifts. Accordingly the expected capacity of the plant would be 20,000 and 35,000 pcs/y respectively.

Manufacturing technology:

- push-pointing
- drawing
- hardening
- stretch-forming
- blanking /sizing/
- tempering
- finishing
- pickling

Some remarks to the above technological stages:

- push-pointing: preparatory to clamping;
- drawing: step-forming on the longitudinal section of the tube diameter;
- hardening: heating and quenching /in water/;
- stretch-forming: straightening;
- blanking: sizing of the finished product;
- tempering: holding at the requisite temperature for strength-improving purposes;
- finishing operations:
  - door blanking,
  - casing tube welding,
  - shaping the seat of mounting plate,
  - door lock welding,
  - bottom welding,
  - preparation of arms,
  - arm fixing onto the post, etc.
- pickling: degreasing, cleaning.

List of machinery: Table 39

Machines of lamp-post manufacturing plant

Item No.	N a m e
1.	Push-pointing machine
2.	Drawbench unifilar, 15 t, up to dia. 180 mm, lenght 12 m
	2.1 gang saw /hand tilting/
	2.2 drill press
	2.3 table with rollers, length: 12 m
	2.4 swing crane, rate: 1 ton
3.	Hardening furnace, 15 m, max.temperature 550 °C
4.	Stretching bench, 250 t, max. dia. 280 mm
5.	Large diameter gang saw with hold-drawn clamp
6.	Tempering furnace, max.temperature 200 °C, 15 m
7.	Eccentric press, 250 t
	7.1 door blanking tool
8.	Plate shears, 2,000 mm
9.	Welding machine /4 nos/ 400 A, with automatic feeder
10.	Band saw
11.	Gang saw with adjustable table /2 nos/
12.	Vibrating shears /5 nos/, hand-operated
13.	Drill press /5 nos/
14.	Milling machine
15.	Drill press
16.	Edge bending machines, 1,000 mm, with hand lever
17.	Pickling bath /4 nos/, length: 14 m, width: 0,8 m, depth: 1.5 m with exhauster
	17.1 travelling crab type DEMAG
18.	Truck
19.	2 off cranes: rate: 5 tons each

If the above list is completed with a 30 t drawing bench for tubes of 280 mm diameter, low- and middle voltage /20 kV/ lamp-posts can also be produced in the plant.

Price of machines and equipment:	US$	2,900,000.-
Cost of design and engineering:	US$	180,000.-
Cost of know-how:	US$	100,000.-

8. Plant to manufacture aluminium overhead /aerial/ cables and low-frequency insulated cables

Sequence of the manufacturing technology: wire-drawing, heat treatment, stranding, insulation and packaging.

Two types of uninsulated overhead /aerial/ cables are recommended for manufacturing:

- Alloyed aluminium overhead cable as per quality of Aldrey's and Almelec's cables.
- Alumoweld type overhead cable.

The above cables have good market all over the world; they can be properly used as high-frequency cables.

Minimal installed capacity of the plant: 6,000 t/year.

Base material: cast-rolled rough wire of 10 to 14 mm diameter.For Alumoweld type overhead cable additional steel wire /abt. 25 % in weight/ coated with aluminium layer is required /e.g.: the wire produced by Copperweld Steel Int. Co./.

Main machinery:
- 3 collecting and slipping type drawing lines
- 1 heat treating furnace
- 1 stranding machine
- 4 strand-welding machines

Price of main machinery: US$ 600,000.-

Additional equipment for manufacturing low-frequency insulated cables:

- 2 extruders for plastics
- 1 stranding machine

Price of the above additional equipment: US$ 320,000.-

Productive manpower requirement for manufacturing overhead cable:

8 skilled workers/shift
8 semi-skilled and unskilled workers/shift
4 workers for presetting and maintenance

20 workers/shift

Additional 12 persons are required for manufacturing insulated cables.

Cost of buildings and infrastructure depends on the location of the plant.

9. Plant to manufacture aluminium rain gutters of supported and hanging forms

Rain gutters and their accessories such as shapes, fall tubes and clamps can be produced in the plant.

Capacity of the plant:	800,000 m of gutter/year
Material requirement:	800 t.p.y. rolled aluminium strip
Price of main machinery:	US$ 940,000.-
Area requirement of the plant:	500 m^2
Manpower requirement:	34 persons/shift

10. Fitter's shop to manufacture aluminium ladders, scaffolds and furniture skeletons

Equipment requirement of the shop, fulfilling demands by proper adaptability, will be minimal.

Material requirement /i.e. the processing capacity of the shop/ 800 t/year.

Price of small machines and equipment: US$ 50,000.-
The required area of the shop: 300 m^2
Productive manpower requirement:

18 skilled workers
20 semi-skilled and unskilled workers

38 workers

11. Fitter's shop to manufacture aluminium inner room-forming elements, facades, portal frames and pavilons

Few general-purpose machinery such as cutting machines, welding apparatus, eccentric presses, etc. are required in the shop as in shops where special products are constructed.

Proposed capacity of the shop: 250,000 m^2/year surface
Material requirement: 1,000 t/year
Cost of machinery: US$ 95,000.-
Productive manpower requirement: 43 persons
The required area of the shop: 1,000 m^2

12. Plant to manufacture containers, tanks and bunkers

Containers, tanks and bunkers of diameter ranging from 1.4 to 2.6 m and of volume ranging from 3 to 41 m^3 can be produced in the plant for the food and chemical industries.

Capacity of the plant: 36,000 m^3/year
Material requirement: 1,200 t/year aluminium plate
400 t/year carbon steel

Price of main machinery depends on capacity.

The required area of the plant with service crane: 4,000 m^2
Manpower requirement: 120 persons /fitter, welder, painter and unskilled worker/

13. Plant to manufacture aluminium corrugated sheets

Proposed capacity of the plant: 400,000 m^2/year

Basic material requirement: 1,400 t strip of 0.8 to 1.2 mm thickness and of 1,500 mm width /roll weight: max. 8 t/

The corrugating line includes hydraulic roll-lifting device as well as machines for unrolling, pattern making, shaping, cutting and depositing.

Price of manufacturing line: US$ 1,200,000.-

Price of first tooling as per types: US$ 95,000.-

Tooling requirements can be fully satisfied by four different types.

Electric power:

- built into machines 75 kW
- for other purposes 15 kW

Cooling water: 2,400 lit/h

Compressed air: 100 lit/h

Area requirement of the plant:

- covered hall with crane 800 m^2
- storage /for rolls/ 400 m^2

Finished goods can be stored packed in open air.

Manpower requirement: 4 skilled workers/shift
6 unskilled workers/shift.

14. Plant to manufacture sandwich panels for the building industries

There are two possibilities for locating the plant: connected to the sheet-manufacturing plant or apart from it.

Proposed capacity of the plant: 200,000 m^2/year

Material requirement: 1,400 t aluminium corrugated sheet
320 t polyurethane

Manufacturing technology: surface treatment, frame producing, cutting, cleaning, packaging.

List of machinery:	1 pc	surface preparing machine
	1 pc	sheet turning machine
	1 pc	foam producing machine
	6 pcs	holding frames
	1 pc	drawing device
	6 pcs	rolling tables
	1 pc	cutting-off saw
	1 pc	foam-storage

Price of machinery: US$ 650,000.-

Required area of the plant:

for machines	1,200 m^2
for foam-storage	100 m^2

Electric power:

built into machines:	110 kW
other:	20 kW

Compressed air: 1,840 lit/h

There is no tooling cost.

Manpower requirement: 2 skilled workers
10 semi-skilled and unskilled workers.

B. Summary of the minimal capacities of the suggested factories, raw materials, power and water consumptions, staff requirements, estimated investments and operation costs

Table 40

The minimal output figures of different products

Para	Name of the product	Unit	Quantity per year
VII.A 1	Household utensils	1,000 pcs	370
2	Milk-cans	1,000 pcs	25
3	Gas cylinders	1,000 pcs	250
4	Beer casks /barrels/	1,000 pcs	40
5	Soda-water syphons	1,000 pcs	500
6	Radiators	1,000 m^2	200
7	Lamp-posts	1,000 pcs	20
8	Cables	1,000 t	6
9	Rain gutters	1,000 m	800
10	Ladders, scaffolds and furniture skeletons	1,000 t	800
11	Facades, portal frames, etc.	1,000 m^2	250
12	Containers, tanks, bunkers	1,000 m^3	36
13	Corrugated sheets	1,000 m^2	400
14	Sandwich panels	1,000 m^2	100

Table 41

The material consumption in tons

Para	Aluminium rolled products	Extruded pressed products	Castings and forgings	Steel	Synthetics /plastics/
VII.A 1	103	-	2	33	-
2	180	-	45	-	-
3	1,600	250	150	-	-
4	380	-	20	-	-
5	-	350	-	1	56
6	250	500	-	-	-
7	17	1,200	3	1	4
8	400	4,000	-	100	500
9	800	-	-	-	-
10	40	750	10	10	20
11	200	750	50	10	20
12	1,200	-	-	400	-
13	1,400	-	-	-	-
14	700*	-	-	-	160
Total	6,570	7,800	280	555	760

*Included the quantity of corrugated sheet.

The total material consumption is 14,650 tpy /after establishing the suggested capacity in 1986/.

Table 42

Required area for production in m^2

Para	Workshop area	
	with crane	without crane
VII.A 1	-	950
2	-	850
3	-	3,500
4	-	1,800
5	-	2,000
6	-	1,000
7	-	1,200
8	-	7,000
9	-	500
10	-	300
11	-	1,000
12	4,000	-
13	800	400
14	-	1,200
Total area requirement	4,800 m^2	21,700 m^2

The total requirement of the producing area /excl. offices, storages, social investments/ is: 26,500 m^2.

Table 43

Power- and water demands

Para	Electric power installed in the equipment kW	Other energy kW	Water-demand m^3/hour
VII.A 1	325	110	3
2	325	150	4
3	1,500	1,800	15
4	900	300	6
5	800	200	10
6	300	150	5
7	600	800	8
8	4,000	180	10
9	100	5	1
10	60	10	1
11	60	10	1
12	1,200	300	3
13	75	15	1
14	110	20	2
Total	10,355	4,050	72

In the column of "Other energy" are given energies convertible more or less with the electric energy, i.e.: fuel oil, coal, gas, in electric energy equivalent.

Table 44

Manpower requirements

Para	Productive unskilled	Productive skilled	Others	Total
VII.A 1	63	15	22	100
2	18	18	14	50
3	150	66	74	290
4	40	35	25	100
5	80	30	45	155
6	60	15	20	95
7	42	10	13	65
8	24	72	34	130
9	82	20	28	130
10	60	54	36	150
11	90	39	51	180
12	240	120	30	390
13	18	12	20	50
14	30	6	14	50
Total	997	512	426	1,935

Table 45

Estimated investment costs, in 1,000 US$

Para	Price of main eqpmt fco Maputo unclared	Building construct. setting + siting machinery	Tooling, know-how start-up of the plant	Infra-structure, etc.	Total
VII.A 1	412	308	218	22	960
2	970	286	180	19	1,455
3	4,994	1,278	840	78	7,190
4	1,183	518	380	40	2,121
5	1,660	611	790	45	3,106
6	640	287	140	22	1,089
7	2,900	557	280	27	3,764
8	1,120	279	230	17	1,646
9	940	205	160	11	1,316
10	50	72	150	7	279
11	95	231	305	22	653
12	2,400	1,240	380	100	4,120
13	1,200	409	530	29	2,168
14	650	330	80	28	1,090
Total	19,214	6,613	4,663	467	30,957

The buildings and infrastructure are calculated from MT.

The investments, supposedly, aim at the extension of the public sector, thus at the import of the equipments the duty is not imposed on the central, national investment fund.

Table 46

Estimated operation costs, in 1,000 US$

Para	Direct materials	Direct manpower	Factory overheads	Administ. overheads	Sales costs	Operating costs per year
VII.A 1	330	140	980	25	25	1,500
2	652	80	480	15	3	1,230
3	5,875	429	2,100	80	6	8,490
4	1,190	160	955	30	5	2,340
5	1,013	226	1,100	40	11	2,390
6	2,150	133	670	22	5	2,980
7	3,423	91	400	16	10	3,940
8	12,465	230	1,400	50	5	14,150
9	2,400	184	1,000	36	20	3,640
10	2,264	241	1,000	45	20	3,570
11	2,844	266	1,100	50	20	4,280
12	3,800	590	2,400	120	5	6,915
13	4,200	75	200	15	5	4,495
14	3,212	53	100	10	5	3,380
Total						63,300

C. Suggested time schedule for the realization

Estimate based on increase of population and per capita GDP of the People's Republic of Mozambique show that aluminium consumption will be 6,75 thousand tons in 1985. Consumption of existing and later extendable finished goods' plants as well as of facilities outside aluminium industry /e.g. tin manufacturers of canning factories, accessories' workshops of metal working plants/ will take up 1.5 thousand tons of this amount. Surplus production may either be exported or exchanged for other goods to diversify and equalize collection of goods as shown earlier /see Chapter IX/.

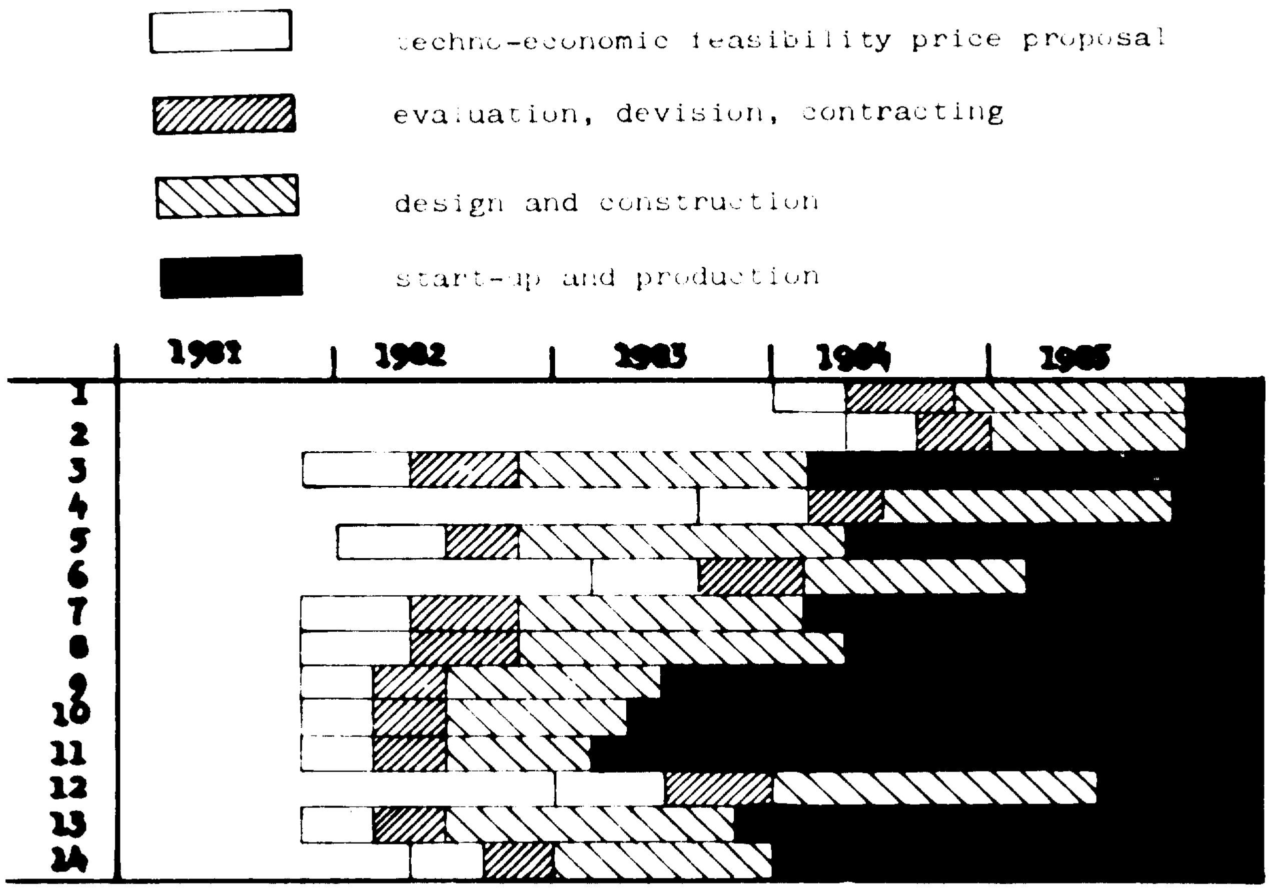
To motivate suggested time schedule /Fig. 3/ the following stands for reason.

It is reasonable to start developing process with plants, that

- require low investment, few equipment or building;
- require relatively great but unskilled work force whose training can be accomplished during normal operation;
- are suitable to quick product-changes, product-expansions or restrictions as demands require;
- require relatively small amounts of raw materials so that manufacturing could go untroubled even before Mozambique's own basic material resources will be available.

Consequently, the program might be started with ladders, furniture skeletons, sandwich panels, window frames, doors, portal frames, facades, building panels manufacturing plants, according to points VII.A 10 and 11. The rain gutters' plant, as it is relatively simple, might belong to this category, too.

Fig.3. Time schedule for the realization of development program for manufacturing aluminium finished products



1 - Household utensils
2 - Milk cans
3 - Gas cylinders
4 - beer casks
5 - Soda-water syphons
6 - Radiators
7 - Lamp posts
8 - Cables
9 - Rain gutters
10 - Ladders
11 - Portals
12 - Containers
13 - Corrugated sheets
14 - Panels

The second category consists of plants that

- require greater investment;
- require semi-skilled work force;
- are producing goods primarily necessary for developing the country's economy

these are plants producing corrugated sheets, panels, lamp posts and columns according to points VII.A.13 and 14. Corrugated sheets can be used for roofing and cladding industrial as well as agricultural buildings /workshops, halls, warehouses, sheds, stables, corn silos/ because of their inherent advantages, e.g. easy transportability, quick assembly, long life, beside being practically maintenance free. They are also suitable for manufacturing thermo-insulated building panels.

Lamp posts, columns are necessary for the country's electrification program and - last but not least - have excellent chances for exporting.

The third category is made up from plants with more complex technologies, such as gas cylinder or cable plants. Some of the gas cylinder manufacturing equipment can be used for fabrication of other hardware, milk cans, beer casks but certainly not at optimum capacities and only if the original products remain unchanged or export demands require neither start up of an independent milk can, beer cask plant, nor expansion of existing hardware production facilities.

The rest of the proposed plants is mainly export oriented; these are the syphon plant according to point VII.A.5 and the heat exchanger plant according to point VII.A.6.

The four phases of developing process shall lastly be justified by the fact that know-how owners can be asked to provide detailed cost estimates for the plants and may make feasibility of the plants easy to decide for experts at the National Planning Committee or at the advisory service of the Industrial Ministries by saving costs for feasibility studies.

Investment and operational costs, prices estimated now are apt to changes; production costs, sales revenues are changing, too, so that break even point should only be determined in the evaluation, decision making phase, shortly before concluding agreements for construction.

Estimated profit of the suggested finished goods' plants at full capacities shall be US$ 18 million. This means a capital recovery period of 2 years on investments. Taken usual and normally longer running-in periods into account, recovery on investment can be safely estimated as 4.5 years.

VIII. MANUFACTURE OF SEMIPRODUCTS IN MOZAMBIQUE

1. Proposed technologies

The basic material for aluminium semi-production is, in general, primary ingot, however, to a less, but continuously growing extent the molten aluminium coming directly from the smelter is also applied.

The mass of aluminium pigs is in general, about 10-25 kgs but in order to facilitate the handling, so called "T"-ingots, too, with the mass of max. 1,000 kgs, are cast.

The way of processing can be devided into two, large groups. These are: the cold and the hot ductile formation. The die casting represents a separate group.

The relationship between main operations and products of the semis' manufacture is represented in Fig.4.

Over 80 % of the world's primary aluminium production constitutes the semis manufactured by ductile formation; within this group are dominating the rolled and extruded products /Table 47/. The products of die casting are mainly fabricated from collected scrap /secondary metal/. For the pigment manufacture exclusively only operation scrap is used.

In the industrially developed countries, either, cannot be found all the technologies indicated in Fig.4, because it is not necessary that each country should possess manufacturing of total product scale. Some products can be made by different technologies. Technology to be applied is determined, mainly, by the quantity to be produced but the choice is influenced also by an existing or planned technological base.

Technologies of aluminium processing **SMELTER** **Figure 4**

/primary aluminium/

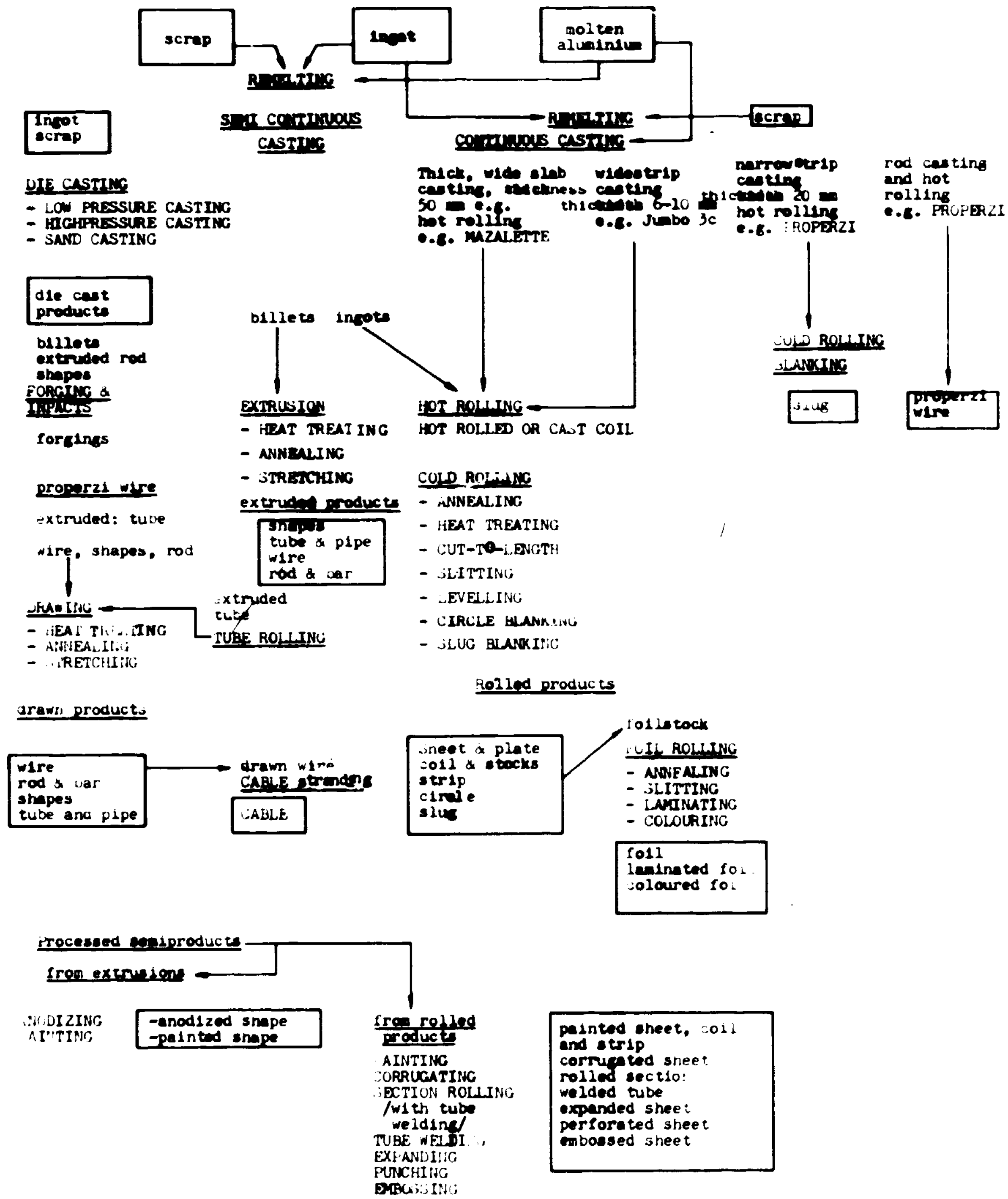


Table 47

Distribution of the world's primary aluminium production according to products range

/1975-1980/

Product	Rate, %
Sheets and strips	43.2
Circles and slugs	2.5
Foils	7.1
Extruded rods	2.9
Extruded profiles	15.4
Extruded tubes	1.4
Drawn tubes	0.7
Welded tubes	1.2
Wires and cables	7.7
Forgings	1.2
Products made by ductile formation, total	83.3
Pigments	1.2
Die castings	15.5

The technologies for semiproduction in connection with the development of aluminium industry in Mozambique till the year 2000, according to products are as follows:

Table 48 gives a recommendation about the rate of application for the semis for various purposes.

For the erection of a semi-production plant the following points of view must be taken into consideration:

Table 48

Assortiment of semis for the production of the recommended finished products mix

Assortment by markets /all types of producers/	Rate, %
Building and construction	20
Transportation	25
Consumer durables	7
Electrical industry	10
Machinery and equipment	6
Containers and packing	25
Others	7
Total	100 %

Aluminium mill product mi by type of producer

P r o d u c t	Rate, %
Sheets and Plates, Coils, Circles, Slugs	55
Foils	7
Wires and Cables, Rods, Bars /excluding extruded/	10
Extruded products /including rods and bars, pipes and tubes, shapes, drawn tubes/	24
All others /welded tubes, powder and paste, forging and impacts/	4
Total	100 %

- plants with continuous casting process /i.e. casting of wire rods and strips have to be erected close to the smelter because in this way they can work directly with the molten metal insert;

- it is reasonable to establish the extrusion plant, the rolling mill and the cast workshop in one factory, because the scraps, arising from the various phase of manufacture, can be processed in this way with the less waste and cost.

1.1 Rolled products

The rolled products are: plates, sheets, shaped sheets, circles, foils, welded tubes, bended profiles and slugs.

The technologies of rolling mills differ from each other in the manufacture of the master strips with the thickness of 3-10 mm. The master product is made by the traditional and the most frequently employed technology, form ingot of 4-12 t mass with 300x500x1000-2000 mm section, by hot rolling.

The various continuous strip-casting or cast-rolling procedures are, however, more and more spreading.

The advantages of the continuous procedures are already indisputable in very many fields:

- production output /recovery, yield/ of the hot rolled strips is 75-80 %, that of cast-rolled is 90 %;
- for manufacture of cast-rolled strips the energy consumption is by 30-35 % less than for the hot rolled ones.

An up-to-date cast-rolling equipment has a capacity of 10-15 thousand t/y that means, the project can be realized in smaller units, too. In case of hot rolling the smallest, up-to-date and economical unit has a capacity of 100 thousand tons/y at present.

Taking into account the above mentioned facts and planned consumption of the finished products, it seems practicable to lay the basis of rolled products manufacture in the cast-rolling process.

The projected mill consists of two parts, as:

- continuous strip-casting plant with a capacity of 27,000 t/y,
- cold strip- and foil-rolling plant with a capacity of 20,000 t/y.

1.2 Foundry shop, including continuous strip casting machines /total capacity: 27,000 t/y/

By this method the strip is produced on a rotary system casting machine. The feeding with molten metal is done from a holding furnace by means of a trough and tun-dish. A contact float operating on the surface of metal feed regulates the level in the trough. The casting rolls are cooled by inner water circulation and supply a strip 6 mm to 10 mm thick.

Production program

Al 99.5 - Al 99.0	17,000 tons
AlMg, AlMn	9,000 tons
AlMg 4.5 Mn	1,000 tons

List of the main equipment and their costs /including installation cost/:

	Equipment		Cost in 1,000 US$
1.	Gas melting furnaces	2 pcs	1,400.-
2.	Electrical holding and casting furnaces	2 pcs	1,200.-
3.	Continuous strip casting machines	2 pcs	7,400.-
	Total cost of the main equipments		10,000.-

	Additional equipment		Cost in 1,000 US$
4.	Feeders with rotary heads	2 pcs	320.-
5.	Trucks and cranes for handling		300.-
6.	Small machines, controlling and qualifying equipments		200.-
7.	Tool-manufacture, maintenance		300.-
8.	Hall, social and communal establishments /8000 m^2/		4,000.-
9.	Infrastructure /water, gas, steam, compressed air, electric inputs, connections/		800.-
10.	Environmental protection		300.-
Total /4-10/			6,220.-
Total cost of the installation			16,220.-

Energy requirements:

Electric energy	2,300 MWh/y
Gas /with a calorific value: 36 MJ/m^3/	4.8 million m^3/y
Cooling water /at least with ten--times recirculation/	1.3 billion m^3/y
Compressed air /6 bar/	6 billion m^3/y

Manpower reqirement:

Metallurgical engineer	2 persons
Other engineers	2 persons
Technician /metallurgical, mechanical, electrical/	11 persons
Skilled worker	35 persons
Unskilled worker	60 persons
Total	110 persons

1.3 Continuously cast and cold rolled products

Table 49

Continuous casting shop and cold rolling mill for production of rolled goods

/Total capacity: 20,000 tpy. of rolled products mix/

Product/utilization	Quantity tons		Rate %	
Sheets and Plates				50
Building /sheets for anodizing/	2,000		10	
Building /lacquered sheets, flat or shaped/	4,600		23	
Van sheets, coach and waggon sheets	800		4	
Consumer durables	800		4	
Machinery and equipment	1,000		5	
Litho sheet	-		1	
Corrugated sheet, embossed sheet	-		3	
Coils		6,600		33
Foil stock	3,600		18	
Fin stock	600		3	
Lacquered /varnished/ foil for food packing	800		4	
Closure stock, can body stock	600		3	
For welded tubes, profiles	1,000		5	
Circles		2,800		14
Kitchen utensils	2,000		10	
Deep-drawn containers	800		4	
Slugs		300		3
Total /including foil-stock/	20,000		100	
Total /without foil-stock/	16,400			
Foil	3,000			

Table 50

Cold rolling mill including foil rolling

/Total capacity: 20,000 t.p.y./

List of the main equipment

	Equipment	Quantity	and specification	Capacity t.p.y.
1.	Cold rolling			
	Cold mill	1 pc	4-High non-reversing mill 500/1200x1800 mm 2000 kW, 600 m/min., max.10 tons coils	20,000*
2.	Annealing			28,000
	Annealing furnaces	2 pcs	Electric heated atmosphere controlled 25 tons/charge	
3.	Slitting			15,000
	2500 mm line	1 pc	200 m/min, 10 tons/coils	
	500 mm line	2 pcs	200 m/min, 3 tons/coils	
4.	Cut-to-length			8,000
	1500 mm line	1 pc	90 m/min	
5.	Tension levelling			8,000
	1500 mm tension leveller	1 pc	100 m/min	
6.	Circle /disc/ blanking			3,000
	Continuous circle blanking lines	2 pcs		
7.	Foil rolling			3,000
	Foil mill	1 pc	4-High non-reversing mill 200/800x1500 mm 300 kW, 800 m/min, max.3 tons coils	
8.	Foil finishing and heat-treating			3,000
	/slitters, pointers, mounting lines/			

*Including 3,000 tons foil stock and foil prerolling.

Table 51

Costs of the rolling mill

	Equipment		1,000 US$
1.	Cold mill	1 pc	17,000
2.	Annealing furnaces	2 pcs	3,300
3.	Slitting lines	2 pcs	2,000
4.	Cut-to-length line	1 pc	2,000
5.	Tension leveller	1 pc	4,200
6.	Circle blanking lines	2 pcs	700
7.	Foil rolling mill	1 pc	4,000
8.	Foil slitting, pointing, mounting lines	2 pcs	11,000
	Total cost of the main equipments		44,200
9.	Roll-grinder and tool-manufacture /building, installation		1,100
10.	Repair shop for electric and machinery equipment /building, installation/		3,100
11.	Material testing, quality control		500
12.	Energy supply system		2,000
13.	Communication		300
14.	Workshop with social and communal installations		19,500
	Total /9-14/		26,500
	Total investment costs		70,700

Energy requirements:

Electric energy	15,500	MWh/year
Gas /calorific value: 36 MJ/m^3/	1.5	million m^3/year
Cooling water /recirculated/	0.7	billion m^3/year
Compressed air /6 bar/	5.5	billion m^3/year

Manpower requirement:

Metallurgical engineers	2 persons
Mechanical engineers	3 persons
Electrical engineer	1 person
Technician	10 persons
Skilled workers	85 persons
Unskilled workers	90 persons
Total	201 persons

1.4 Extruded and drawn products

Extrusion billets are homogenized, then preheated in the extrusion shop to the proper extrusion temperature.

The extrusion lines are built together with the complete finishing equipment /quenching, stretcher, saw/, giving completely worked, cut, straightened products.

The products will then be cold-rolled into tubes and rods with consecutive quenching and annealing.

Table 52

Expected break-down of extruded and drawn product mix

Product		Quantity t.p.y.	Rate %	
Shapes		7,800		52
Building and structural industries	6,750		45	
Vehicles, traffic industries	300		2	
Consumer durables industries	450		3	
Engineering shapes industries	150		1	
Others	150		1	
Rods and rails		600		4
Press forging semis	300		2	
Engineering uses	150		1	
Others	150		1	
Wires and rods		4,950		33
Extruded tubes		1,350		9
Building	750		5	
Agriculture	300		2	
Vehicles, traffic	150		1	
Infrastructure purposes	150		1	
Drawn tubes and rods		300		2
Consumer durables	150		1	
Others	150		1	
Total		15,000		100

Table 53

Expected break-down of alloys used in the extrusion and drawing shop

Alloying rate	Uses	Rate %
Unalloyed	Shapes, semis for cable and wire production, extruded tubes	25
Low-alloyed	Shapes, semis for cable and wire production, rods and rails, extruded tubes, drawn rods and tubes	65
Highly alloyed	Rods and rails, extruded tubes, drawn rods and tubes, semis for wires' production	10

Table 54

List of equipment for a 15,000 t.p.y. capacity extrusion and drawing plant

	Equipment		Quantity	Characteristics	Capacity .p.y.
1.	Extrusion line with billet heating furnace, finishing equipment and tool--heating furnace				
	Presses:	35 MN	1 pc	with flat recipients	4,000
		25 MN	2 pcs	rod press, Ø 200 mm and 250 mm billets	6,000
		16 Mn	1 pc	rod press, Ø 150 mm and 200 mm billets	1,800
			1 pc	tube press, Ø 150 mm and 200 mm billets	1,800
		12 MN	1 pc	Ø 150 mm billets	1,400
2.	Annealing furnaces		3 pcs	moving hearth furnace, gas heated	8,000
3.	Quench furnace		2 pcs	vertical, electric heated	3,000
4.	Shape rolling machine		2 pcs	for max.100 mm shapes	-
5.	Tube and rod stretcher		1 pc	for max.Ø 120x8000 mm product	3,000
6.	Press straightener		1 pc	for max.OD 50x8000 product	1,000
7.	Press straightener		1 pc	hydraulic press	2,000
8.	Tube and rod drawing machine		1 pc	with 100 kN rated force	1,200
			1 pc	with 50 kN rated force	800
9.	Tapering machines		-	-	-
10.	Others /finishing, packing mashines/		-	-	-
11.	Transport and handling equipment		-	-	-

Table 55

Costs of a 15,000 t.p.y. capacity extrusion and drawing plant

	Equipment	Pcs	Price, 1,000 US$
1.	Extrusion lines with billet heating furnace, finishing equipment, tool heating furnace, complete	6	17,000
2.	Annealing furnaces	3	1,300
3.	Quenching furnaces	2	900
4.	Shape rolling machines	2	300
5.	Tube and rod stretchers	2	460
6.	Press straightener	1	60
7.	Tube and rod drawing machines	2	710
8.	Tapering machines		140
9.	Others /finishing, packing machines/		300
10.	Transport and handling equipment		1,000
	Auxiliary facilities		
1.	Tooling, maintenance /building and equipment/		2,000
2.	Electricals and machine shops /building and equipment/		1,500
3.	Material testing, quality control		400
4.	Power distribution system		1,300
5.	Communication system		200
	Production building with social and communal facilities		14,300
		Total:	41,870

Energy requirements:

Electric energy	12,600 MWh/year
Gas /calorific value: 36 MJ/m^3/	2,500 m^3/year
Cooling water /recirculated/	1.5 billion m^3/year
Compressed air /6 bar/	4 billion m^3/year

Manpower requirement:

Metallurgical engineers	2 persons
Mechanical engieneers	2 persons
Electrical engineer	1 person
Technicians	12 persons
Skilled workers	85 persons
Unskilled workers	88 persons
Total	190 persons

1.5 25,000 t.p.y. extrusion billet casting shop

Capacity of the connected extrusion plant: 15,000 t/y. The casting shop produces in 65 % low-alloyed, 25 % unalloyed and 10 % highly alloyed billets.

Sizes of billets vary from Ø 150 mm to Ø 350 mm, mostly in the size range of Ø 200 mm.

60-70 % of the billets leave the casting shop as threads, the remaining 40-30 % will be cut to length.

The highly alloyed billets are scalped.

Production of the billet quantity needed will be made in 5 duplex melting-casting units. Holding capacity of the melting furnaces is 26 t each, of the casting furnace 20 t each, while loadibility of the casting machines is 20 t each.

Table 56

Equipment and investment costs of a 25,000 t.p.y. semi continuous billet casting shop

/Main machinery including erection costs/

Name	Pcs	Cost 1,000 US$
Semi continuous billet-casting equipment with duplex furnaces /26/20 t/, purifying salt jets, launder preheating and continuous refining equipment	2	9,500
Homogenizing furnace	1	2,400
Saw	1	650
Billet scalping unit	1	100
Tool preheating furnace	1	180
Rotary charging devices	2	300
Transporting and handling equipment /cranes, trucks/		500
Others /labour saving devices, control and qualifying equipment/		300
Tooling, maintenance shop		680
Building, social and communal facilities		4,500
Utilities /water, gas, nitrogen, compressed air, environment protection equipment, chimney stacks, ducts/		2,100
Total		21,110

Energy requirements:

Electric energy	2,800 MWh/year
Gas /36 MJ/m^3 calorific value/	5 million m^3/year
Cooling water /min.10-times recycled/	1.1 billion m^3/year
Compressed air /6 bar/	2.2 billion m^3/year

Manpower requirement:

Metallurgical engineers	2 persons
Mechanical engineers	2 persons
Technicians	10 persons
Skilled workers	30 persons
Unskilled workers	50 persons
Total	94 persons

1.6 Manufacture of starting material for wire- and cable production

The master product of drawing mills, the preliminary wire-rod can be made in two ways, as: by extrusion and by continuously casting-hot-rolling procedure.

The smallest capacity which can be established for extrusion, is some thousands tons and considering that on the same extrusion press also wire-rods and extruded profiles can be manufactured, so capacity below onethousand t.p.y. can be built.

At the continuous casting-rolling procedures the capacity of one equipment is already up to 30,000 t.p.y. at present, but the machines, built 15-20 years earlier, have a capacity of 5-15 thousand tons per year.

The biggest equipment supplyers are as follows: Properzi, Secim, Southwire, A.Mann.

Continuous casting-rolling mill for wires and rods
/Capacity: 20,000 t.p.y.

The plant is working with liquid charge.
The material qualities which can be used, are:

EAl 99.5 /electrical/
EAlMgSi /electrical/

The wire-diameters which can be produced:		7.5-12 mm.
Sizes of coils:	external diameter	2.000 mm
	height	2.000 mm
	weight, max.	2 tons

Table 57

Parameters of the equipment and the investment costs of a 20,000 t.p.y. casting-rolling mill

/including the costs of erection/

	Name and capacity	Costs, 1,000 US$
1.	2 pcs equalizing furnaces, tiltable	1,500
2.	Continuous metal refiner, with Cl_2-N_2 gas mix, with two rotary heads	750
3.	Continuous casting-rolling machine with reeling device of capacity 5.5-7.5 tons per hour with auxiliary equipment	6,191
4.	Tool-preheating furnace	80
5.	Transporting and material handling equipment	200
6.	Other equipment, small machines, controlling devices	100
.	Tool manufacture, maintenance	200
8.	Workshops, social and communal establishments	850
9.	Civil works incl.environmental protection	1,200
	Total	10,621

Energy requirements:

Electric energy	2,340 MWh/year
Gas /calorific value: 36 MJ/m^3/	2 million m^3/year
Water /recirculated/	1.1 billion m^3/year
Compressed air /6 bars/	1.5 billion m^3/year

Manpower requirements:

Metallurgical engineer	1 person
Other engineers	2 persons
Technicians	7 persons
Skilled workers	30 persons
Unskilled workers	50 persons
Total	90 persons

1.7 Production of forgings

Forgings can be produced either from cast billets or from extruded bars of circular, square or multiangular cross-sections.

Break-down of the starting materials:

extruded bars	95 %
cast billets	5 %

Suggested product mix:
for the following fields:

- buildings
- vehicles
- transports
- consumer durables
- engineering /parts, assemblies/
- other miscellaneous usage.

Table 58

Investment of a 1,000 t.p.y. press-forging shop

/Capacity in 3 shifts: 1,500 t.p.y./

	Equipment	Pcs	Costs /incl.foundation and erection/ 1,000 US$
1.	a/ 400 t friction press b/ preheating chamber-furnace, with resistance heating, 2x60 kW	1	1,000
2.	a/ 800 t friction press b/ preheating chamber-furnace, with resistance heating, 2x80 kW	1	1,600
3.	a/ 1,200 t friction press b/ preheating chamber furnace, with resistance heating, 2x100 kW	1	2,900
4.	Tool preheating chamber-furnace, with resistance heating for the presses under 1 and 2	1	50
5.	Semis cutting semi automatic saw for: Ø 10- 90 mm Ø 60-120 mm	2	450
6.	Trimming press 63 t 100 t	2 1	100
7.	Quenching, ageing furnace with air circulation, resistance heating	4	550
8.	Pickling equipment	1	420
9.	Material handling equipment /overhead cranes, trucks/	-	300
10.	Building with utilities and energy distribution /water, gas, electricity and social facilities/	-	2,550
	Other miscellaneous equipment	-	550
	Total		9,470

1.8 Remelting facilities

Remelting of materials will be made usually in three cases:

- remelting of virgin aluminium ingots,
- remelting of classified quality scrap of the semis' shops,
- remelting of scrap coming from outside sources, such as disassembled equipment or gleaning.

Remelting of virgin aluminium can be made in a foundry connected to the extrusion shop. This can be avoided only when foundries are built together with or in the neighborhood of the smelter. This solution would cause another problem, i.e. extrusion, and rolled scraps should be transported to the smelter which again increases transporting costs.

Apart from electrotechnical use, classified scrap of semis' shops is equal in quality those of virgin aluminium, in some cases their application in the charge is even advantageous e.g. for alloys containing magnesium. When remelting shop scraps, foils and chips are to be handled separately; the latters have to be compacted before melting.

When remelting scrap coming from outside sources, 2,000 t.p.y.capacity proves to be economical for building new remelting facilities. Small moulding shops may utilize gleaned scrap directly. Ingot casting shops can also utilize scrap after double remelting and in a quantity of maximum 1,000 t.

Table 59

Investment costs of a 2,000 t.p.y. remelting facility

/No separate building was considered, it can be placed into the extrusion billet foundry/

Equipment	Investment costs, 1,000 US$
1. Scrap compacting equipment	25
2. Scrap remelting furnace, 3 t	140
Total	165

2. Long-term program and minimum realizable capacities of semi-product output

While planning future investments, the followings were taken into consideration:

- demand of finished products,
- metal sources available /smelter investment/,
- optimum, i.e. from a technological point of view, minimum of the realizable semi-production units,
- potential export possibilities into surrounding countries.

Development volume of semi-production is summarized in Table 60.

Table 60

Proposed semi-production development

/1,000 tons/

	Suggested development				Miniumum consumption and realizable imvestment			
	1985	1990	1995	2000	1985	1990	1995	2000
Rolled products								
Consumption of rolled finished products*	7.2	8.8	12.0	17.0	3.65	4.45	6.10	9.5
/1/ Cold rolling capacity	-	20.0	55.0	70.0	-	10.00	10.00	10.0
Continuously cost strip /to be de-processed by cold rolling mill	-	27.0	74.0	90.0	-	13.00	13.00	13.0
Extrusion								
Consumption of extruded finished products	9.0	9.7	12.0	16.7	2.55	2.55	2.55	3.2
/2/ Extruding capacity	9.0	10.0	20.0	30.0	3.00	3.00	3.00	5.0
Billet casting production for extrusion	-	-	30.0	45.0	purchased billets			
Wire-bars								
Wire and cable consumption	-	1.0	22.0	23.0	-	0.05	2.10	2.1
/3/ Wire-bars production	-	20.0	40.0	40.0	covered by extruded products			
Casting and forgings								
Consumption of finished castings and forgings	0.8	1.8	4.6	12.4	0.55	1.05	1.25	3.2
/4/ Semi-production	1.0	2.0	5.0	15.0	0.55	1.05	1.25	3.2
Total								
Finished products /from import and domest.production/	17.0	21.3	50.6	69.1	6.75	9.12	11.17	17.0
Semis /domestic production/ /1+2+3+4/	10.0	52.0	120.0	155.0	3.55	14.05	17.25	21.2
Scrap remelting /excl.scrap from semis' shops/	0.2	0.6	1.2	2.5	0.20	0.40	0.50	0.8

IX. EXPORT-IMPORT
THE BALANCE OF BASIC MATERIALS

In order to set up an aluminium industry in its completeness, there are some necessary conditions to be satisfied such as availability of bauxite, low cost electrical power and considerable capital resources that are, however, scarcely disposable simultaneously in the same country. Bauxite mines coincide geographically not always with alumina factories, and there are countries producing large quantities of alumina without having any bauxite at all, whereas countries extracting bauxite have no alumina production.

There are countries where the setting up of alumina production and elcetrolysis does not coincide and countries producing primary aluminium do not produce alumina at all.

Trade of bauxite and alumina is about 50 %; 25-30 % of the world's primary aluminium ingots get into foreign trade. Only 9-10 % of semis and a far smaller part of finished goods get into the world trade.

Bauxite and alumina cannot be represented on the world market despite all the above mentioned facts, because

- multi-national companies manage trade among their own firms,
- of trade of long-term delivery contracts between firms producing raw materials, and using this raw materials,
- "spot" deals are relatively scarce.

Aluminium is a real world market item to the contrary of bauxite and alumina.

In lower phases of aluminium industry's structure, the prices generally follow the world market prices but they are less changeable. Price of 1 ton bauxite is one tenth of the alumina price for the same quantity, or maximum 2 % of the ingot price, in general.

Price rates of alumina - aluminium fluctuate between one sixth - one ninth, depending on business cycles.

A. Basic materials

In spite of the disturbing circumstances, aluminium has a well defined real world market price. Ingot sale within the monopolies is still of remarkable importance but in the industrialized countries, there are a lot of aluminium consumers belonging not to the monopolies and, in addition, these are real buyers.

The aluminium market is strongly regulated. Metal, as it can be used for strategic purposes, has officially regulated market price in several countries, setting limits in this way to prices of imported aluminium. Strategic stockpiles controlled by the governments give sometimes opportunity to affect prices. Significance of the free market is not to be dismissed. Share of potential consumers on one hand and the possibility to affect prices by buying up stockpiles or throwing them on the market on the other, seem to be beneficial to the monopolies, too. Beside the direct extra profit, concerns influence their governments by price manipulations in order to lift inconvenient restrictions and to increase official prices; they influence development aims of contractors who have not too much experience in aluminium industry.

Foreign trade balance of ingot in some industrialized countries is shown in Table 61.

There are countries, which use - beyond their domestically produced aluminium - imported ingots too, to satisfy their growing demands. These are - among others - Austria, Belgium, Denmark, Italy, Finland, France, Japan, the FRG and the USA. Their imports show a growing tendency. Their common feature is that they do not have low cost electric power and the labour costs are relatively high. Ingot exporting countries like Canada, Norway, have inexpensive hydroelectric power but labour costs are high. All countries with low power+labour expenses lower than those of Norway and Canada may successfully rival with them on European market provided that the difference in delivery costs does not consume the difference on power+labour.

Table 61

Foreign trade balance of aluminium ingots

in 1,000 tons

Country	1975 exp.	1975 imp.	1976 exp.	1976 imp.	1977 exp.	1977 imp.	1978 exp.	1978 imp.	1979 exp.	1979 imp.
	balance		balance		balance		balance		balance	
Australia	76.6	-	64.0	-	77.5	-	79.9	-	72.7	-
Austria	-	9.5	-	12.5	-	10.6	-	3.2	-	20.4
Belgium	-	178.2	-	240.0	-	225.3	-	256.6	-	242.0
Canada	491.0	-	485.0	-	634.5	-	851.1	-	526.0	-
Denmark	-	0.3	-	6.2	-	6.0	-	7.2	-	11.1
Finland	-	18.7	-	23.3	-	25.3	-	19.0	-	23.6
France	-	54.0	-	102.2	-	109.5	-	124.7	-	157.7
Greece	82.2	-	85.3	-	73.0	-	84.9	-	54.8	-
FRG	-	287.4	-	417.2	-	241.3	-	162.4	-	263.5
Italy	-	77.8	-	188.3	-	171.2	-	121.2	-	213.3
Japan	-	294.8	-	360.4	-	434.1	-	685.6	-	739.2
Netherland	132.8	-	128.3	-	154.0	-	148.9	-	191.6	-
Norway	432.1	-	538.2	-	546.8	-	622.1	-	556.4	-
Spain	-	26.2	-	3.6	-	28.0	-	32.2	34.7	-
Switzerland	6.5	-	2.0	-	-	10.2	-	2.4	6.2	-
Sweden	-	35.7	-	33.4	-	10.9	4.3	-	-	17.1
USA	-	246.6	-	380.0	-	507.6	-	583.9	-	325.7
United Kingdom	-	95.7	-	96.5	-	52.6	-	26.0	22.6	-
Yugoslavia	39.7	-	49.1	-	20.3	-	17.1	-	1.0	-

European countries that may come into consideration for Mozambique to export aluminium ingots are: Italy, Belgium, France and the German Federal Republic. Foreign trade balance of these countries towards Mozambique is positive, i.e. they are selling more than they are buying. Or, inversely, Mozambique is importing more goods from them as compared to the quantity of goods these countries take over. This situation is represented by the figures in Table 62.

Table 62

Foreign trade of Mozambique with some European countries

1,000 conto Metica

	Import				Export			
	1975	1976	1977	1979	1975	1976	1977	1979
Italy	248	138	282	329	75	182	48	147
FRG	1116	1152	1575	903	111	92	121	187
Belgium	189	149	189	204	73	55	52	35
France	538	600	262	762	38	32	111	255

There is an actual possibility of balancing imports and exports between Mozambique and the above mentioned countries. All four countries take prominent part in Mozambique's foreign trade. Care should be taken that proper trade agreements are to be contracted in time, fixing quantity and value of goods simultaneously /with pro rata contingencies/. The main characteristics of the aluminium industry in these countries are shown in Table 63 with the latest figures.

Table 63

Main characteristics of the aluminium industries in four countries

1,000 tons

Semis	Production	Export	Import
BELGIUM, 1979.			
Rolled	157	149	43
Extruded	67	48	16
Wire, cable	37	30	4

FRG,	1979	1980
Production		
primary	742	730
secondary	425	400
Import	512	635
Export	242	230
Consumption		
primary	1.068	1.060
secondary	420	406

FRANCE,	1979
Semis	
export	165
import	119

ITALY,	1980
Production	272
import	211
export	7
Semi-production	
sheets, bands	180
discs	29
slugs	10
rods and shapes	210
tubes	18
wire, cable	18

India can be considered a steady market for aluminium ingot apart from Western Europe. India's aluminium ingot import shall be 130,000 tons in 1981, as estimated in 1980. It is almost impossible to satisfy this quantity. /Import in 1980 was only 85,820 tons./

Safety and costs of sea transport make India a more favourable partner than Western Europe.

Table 64

Aluminium production and import in India /semis and ingots/

1,000 tons

Y e a r	Production	Import
1977-1978	179	5.5
1978-1979	214	33.0
1979-1980	192	76.0
1980-1981	200	155.0

Built-in capacities 1,000 tons

Company	Capacity
HINDALCO	100
INDAL	96
BALCO	100
MALCO	25
Aluminium Co.of India	9
Total:	330

Future demands:	1984-1985	496,000 tons
	1989-1990	843,000 tons

India and some West-European countries have to face a remarkable metal shortage between 1985-1990 as estimates say /Predicast Inc., Cleveland, World non-ferrous metals to 1990', Industry Study/.

Table 65

Expected basic metal shortage of the same four countries

1,000 tons

Country	1985	1990
India	60	100
France	100	130
Italy	150	200
GFR	130	115

Aluminium production and a minimum consumption in Africa for the same period are shown in Table 66.

Table 66

Estimated aluminium production and consumption in Africa

1,000 tons

	1985		1990	
	Production	Consumption	Production	Consumption
South-African Union	115	85	145	115
Others	715	160	1,050	335

Selling Mozambique's surplus ingot in Africa will meet difficulties because of the keen competition, the production being far bigger than consumption in this area. Present situation in Africa is not encouraging. In 1980, the four aluminium smelters of the African Continent shall produce approximately 440,000 tons, which is about 40,000 tons more than in 1979. Existing capacities in

Ghana	200,000 tons
Egypt	133,000 tons
S.Africa	85,000 tons
Cameroon	79,000 tons

Africa consumes approximately 150,000 tons of primary aluminium /34 % of the primary production on the Contintent/, South-Africa 50,000 tons, Egypt 30,000 tons, and the remaining countries 70,000 tons.

Egypt continues its expansion to 166,000 t to be completed in 1981.

ALUSAF had started expanding capacity to 175,000 t.p.y. to be completed till 1982.

Projects still under discussion:

in Algeria	for	140,000 t.p.y.
in Libya	for	100,000 t.p.y.
in Zaire	for	155,000 t.p.y.

Vereinigte Metallwerke Ranshofen-Berndorf /Austria/ prepared a study for a rolling mill /capacity 10,000 t.p.y./ in Kenya.

In Guinea, the Government signed a Contract with Alusuisse and associated partners from Kuwait, Saudi-Arabia and the United Arab Emirates for a US$ 200 million investment, for an alumina-aluminium plant /1,2 mtpy alumina and 150,000 t.p.y. aluminium/.

It is impossible to forese which of these future plans will be realized. One thing is certain and these plans seem to accentuate it, i.e. Africa will not be a buyer's market for P.R.Mozambique.

In case of realization of the whole program, Mozambique's minimum ingot surplus can be estimated as follows /see Chapter VII./B/:

Year	1985	1990	1995	2000
Thousand tons	-9.5	+54	0	+10

Theoretical maximum /without any semis' and finished production/:

Year	1985	1990	1995	2000
Thousand tons	0.2	106	120	165

This last quantity is easily marketable but certainly with smaller profits than the semis and with even smaller profits than finished goods.

Ingot export of the industrialized West-European countries /the FRG, France, Italy, Netherland, United Kingdom, Ireland, Denmark/ was minimal to the surroundings of Mozambique in the last economic year. /Data collected from the Eurostar, Brussels, 1980's issue./

Table 67

Import-export from West-Europe to the surroundings of Mozambique

Country	tons	1,000 ECU value
Malgas	481	591
South-African Union	378	645

Neither Middle-East, nor the Gulf countries might be of interest in respect of a potencial export, for they decided to strongly develop their own metallurgical capacity. They are going to increase the present production of 280,000 tons to 1 million tons in the following twenty years. Semi-production output will be developed, too. /E.g. a 275,000 tons rolling project shall be put into operation is Saudi-Arabia in 1985/.

Mozambique will be able to sell its ingots surplus to India and to West-Europe in the next twenty years if the decision for developing aluminium smelting is made. Brazil can also be considered as a country of interest.

B. Semi-production

In the semi-production, notable expenses arising from the use of energy have to be added to the costs of aluminium ingot. Transport costs are not too high as compared to that of raw material. World market price is not a firm point in this case, because semi-production is being horizontally built up. Prices of traditional semis are 140-200 % higher that those of aluminium ingot. A mass-unit comparison would be of no use, as prices of semis as well as phase costs of manufacturing processes from ingot to semis do not depend directly on the ingot's price, fluctuation of prices as compared to aluminium appears only later in time. It is not a lucky practice to deliberatley misrepresent the price ratios of domestic semis in interest of the finished goods production because they do not reflect reality any more. This leads to causeless waste of aluminium which could easily be sold on the world market otherwise.

Exporting semis is advantageous only if the price margin between semis and ingot is greater than the production cost of the process from ingot to semis.

In case of an already existing semi-production plant, the price margin should cover the direct expenses that are quantity proportional.

The following table shows the foreign trade balance of aluminium semis in the industrialized countries discussed earlier.

Foreign trade balance of semis /in weight/ is considerably lower than that of base materials. Home trade among them enlarging the assortment is not shown in the Table.

Table 68

Trade balance of semis in developed countries

1,000 tons

Country	1975		1976		1977		1978		1979	
	exp. balance	imp. balance	exp. balance	imp. balance	exp. balance	imp. balance	exp. balance	imp. balance	exp. balance	imp. balance
Australia	-	1.6	-	3.1	-	0.6	1.1	-	7.9	-
Austria	18.5	-	31.4	-	24.2	-	33.3	-	32.3	-
Belgium	107.5	-	135.2	-	146.3	-	158.0	-	163.8	-
Canada	-	47.3	-	66.5	-	59.0	-	70.0	-	97.2
France	27.0	-	-	8.2	46.9	-	68.5	-	73.1	-
FRG	51.1	-	78.9	-	96.8	-	151.9	-	144.0	-
Italy	25.0	-	35.2	-	29.5	-	47.0	-	20.6	-
Japan	53.0	-	59.3	-	86.3	-	136.2	-	76.3	-
Norway	14.7	-	19.7	-	5.2	-	24.4	-	37.6	-
Switzerland	28.4	-	33.4	-	38.8	-	30.8	-	34.1	-
Sweden	-	27.3	-	23.5	-	13.0	-	1.9	-	7.7
United Kingdom	-	17.1	-	51.5	-	67.1	-	98.7	-	110.1
USA	142.4	-	155.6	-	164.3	-	12.6	-	102.6	-

The situation is reversed here: ingot iporting countries become semis exporting countries, so they do not constitute a market for Mozambique's eventual semi surplus. They may become partners on the other hand in enlarging the assortment either by change of semis or mutual delivery of ingot--semis.

Semis production of Mozambique should primarily be based on domestic market and consumption of finished goods. Surplus ingots marketing in the neighbouring countries being without semis production, should be aimed at. Mozambique could very likely take over the export of semis to some extent, which are coming now from West-Europe to the countries around Mozambique and to India. To estimate the quantity with responsibility for the next twenty years would be difficult. Last years' data are shown in Table 69.

Table 69

West-European export of semis to the surruoundings of Mozambique

Country	Extruded		Rolled		Foil	
	tons	1.000 ECU	tons	1.000 ECU	tons	1.000 ECU
Republic of Zambia	23	221	-	-	61	167
India	13493	15453	-	-	1026	3230
Republic of Kenya	146	236	514	923	-	-
South-African Union	160	426	2714	4151	438	1113
Zaire	46	181	74	148	-	-
Malgas	1456	1667	-	-	188	548
United Republic of Tanzania	21	228	-	-	148	337
Total	15345	18412	3302	5222	1861	5431

/Data for Zimbabwe, Malawi and others are not available./

The greatest part of the extruded products exported to India consits of wire-bar. A contract for a three years' period has been concluded with SURAL Co., Venezuela, importing 12,000 t.p.y. cast-rolled wire. Since India may be considered a potential buyer of ingot, it might be done in cast rolled wire bars. In long term planning, the quantity of such export may even reach 25,000 t.p.y.

For exporting purposes, Mozambique shall have the following semis' quantities if the program suggested earlier has been realized /1.000 tons/:

	1985	1990	1995	2000
	- 7	31	70	85
Detailed:				
rolled	- 7.2	11.2	43	53
extruded	-	0.3	8	13.3
Properzi-rod	-	19	18	17
billet	0.2	0.2	0.4	2.6

C. Finished goods

In the finished goods' production, labour has greater importance than in the metal production and also less processing equipment are used. Quantity and costs of auxiliary materials will rise, though.

Prices of finished goods are more apt to variations than the same of the semis. Simple mass products may cost twice as much, complicated ones 7-times as much as the ingots. Their prices are more affected by technical level, advantages as well as savings resulting in their use, etc. than by their production costs.

As compared to other aluminium products, monopolies of the aluminium industry have not too much word in the selling of finished goods. They insist on trying to extend their influence directly or indirectly on finished goods production, too, but it is not remarkable for the time being.

The market of finished goods appears to be subject to changes. Useful life ot the prducts is short, it is therefore very difficult to make an exact and well founded, specified proposal for longer periods regarding production, realization and particularly export. Trends, tendencies can be prognosticated on the other hand.

Smaller workshops with less automatized equipment but with a possibility of changing product structure in a relatively short period of 3-4 years surely operate more safely but with less profit.

It is especially true for enterprises or countries like Mozambique where there is no traditon in end-products, no traditional market of traditional goods with all its personal connections and objective conditions.

Goods producible in greater volumes and with modern technology at lower costs, i.e. those that are worth developing, can be chosen in the course of development.

Long range demands for aluminium end-products and export markets for longer periods cannot be estimated definitely. Starting point may be an estimate without consumption structure.

Average aluminium consumption of developing countries is 0.33 kgs per capita; in geographical breakdown:

Africa	0.14 kgs/capita
Asia	0.25 kgs/capita
Latin America	1.10 kgs/capita.

Production of finished goods in the aluminium industry is taking shape, but the developing process is slow and very likely will not include every sort of products. There is a possibility to specialize by dividing production, by cooperation, and mutual agreements shall evidently consider existing situations. The country, where intellectual and material bases regarding aluminium finished goods production are at high level, is in a more advantageous position in concluding agreements.

We assume that these considerations encourage the governing authorities of Mozambique to develop finished goods' production on time.

Turnover of Mozambique's foreign trade with countries in 1979 is shown on Table 70 with accent on the finished goods export.

Table 70

Turnover of Mozambique's foreign trade in 1979

1.000 conto Metica

Mozambique	Tanzania	Zambia	South-African Union	India
Imports	295	6.8	2665	20.7
Exports	35	0.16	397	0.3

The finished aluminium goods export can constitute means of balancing the turnover and of getting a positive balance.

Export return on sales of finished goods is not indifferent even in the industrialized countries. Some figures of finished aluminium goods export of the EEC-countries are shown in Table 71.

Table 71

Export of aluminium finished goods in the EEC countries

Group of products	tons	1,000 ECU
Insulated cables	15,509	22,646
Uninsulated cables	6,647	11,002
Household articles	20,929	88,673
Bolts, screws, nuts	2,475	12.119
Irrigation pipes	3.241	8,949
Milk cans and similar products	27,163	102,565
Gas cylinders	2,637	9,713
Architectural elements	30,900	123,337

For Mozambique, the important feature of these data is the export in the neighbouring countries.

Table /2

Export of finished aluminium goods of West-European countries to the surroundings of Mozambique

Group of products/countries	tons	1,000 ECU
Architectural elements		
South-African Union	197	1,607
Malgas	29	157
Republic of Kenya	20	103
Zaire	139	372
United Republic of Tanzania	136	1,788
Milk cans		
Republic of Kenya	34	127
United Republic of Tanzania	39	192
Malgas	12	116
South-African Union	33	178
India	99	912
Window frames, doors		
Malgas	116	798
United Republic of Tanzania	49	133
Republic of Uganda	36	205
Republic of Kenya	23	119
Irrigation pipes		
South-African Union	113	564
Household articles and mass products		
South-African Union	387	1,773
Malgas	14	126
Screws, nuts, bolts		
South-African Union	23	277
Total:	1,481	9.547

Industrialized West-Eurpean countries practically do not sell these articles in Mozambique's neighbouring countries yet, they are now establishing the market. Even if mass production will be low at the beginning, competitiveness can be reached by cheap labour and relatively low delivery costs within the country.

When reaching the suggested finished goods-production potential and considering domestic consumption, following export quantities might be reckoned with /Table 73/.

Table 73

Domestic consumption and export quantities of some aluminium finished goods

1,000 tons

	Domestic consumption				Export				Production			
	1985	1990	1995	2000	1985	1990	1995	2000	1985	1990	1995	2000
Goods for the electrical industry	2.0	3.0	3.1	3.3	4.8	4.2	25.1	16.1	6.8	7.2	18.2	29.4
Goods for packaging	0.3	0.6	0.8	1.7	-	-	-	-	0.3	0.6	0.8	1.7
Machineries	0.3	0.7	1.0	1.7	0.5	2.4	4.0	5.8	0.8	3.1	5.0	7.5
Traffic-storage-transport goods	0.45	0.97	2.3	4.3	3.55	3.03	2.7	5.2	4.0	4.0	5.0	9.5
Architectural elements	1.7	1.8	2.4	3.4	1.2	1.4	4.5	9.4	2.9	3.2	6.9	12.8
Apparatus manufacture	0.3	0.45	0.6	1.2	0.5	1.05	1.7	3.6	0.8	1.5	2.3	4.8
Household appliances, mass products	1.7	1.6	1.5	1.4	-0.3	0.1	0.9	2.0	1.4	1.7	2.4	3.4
Total:	6.75	9.12	11.7	17.0	10.25	12.18	38.9	52.1	17.0	21.3	50.6	69.1

X. SOURCES OF KNOW-HOW AND TECHNOLOGY

To accelerate self-development, the following foreign services are available:

- import of knowledge
- plus import of equipment
- plus import of a turn-key plant.

Buying a technology proved by a plant scale operation, its price is 100-times higher than the price of only the written knowledge. In general, the import of knowledge comprises the following services:

- supply of technology and technical descriptions,
- operation- and maintenance-instructions,
- testing- and qualification-prescriptions,
- models and prototypes,
- transfer of experiences,
- planning of plant organization,
- training of personnel,
- supervisions,
- commissioning,
- consultancy,
- continuous technical- and management-assistance.

Plant-import means the complex supply of equipment and isntallations. The project can be also implemented by a prime contracting organization as a turnkey plant.

A higher stage is to conclude a long-term agreement in the frame of a joint venture.

The price of knowledge is generally 3 to 10 % of the value of the plant established, depending on the supplier's participation in the realization.

In addition to this expenses, charges for Project Area Services of the Seller's employees as well as their accomodation and travelling costs and daily subsistance allowances are to be paid.

The fees and expenses /excl. daily subsistence allowances/ vary according to the following Table.

Table 74

Fees and expenses per day charged for technical assistance in some countries

Seller's country, or billing currency		Skilled worker	Technician	Engineer
England	£	62	78	97
France	FF	497	636	770
Japan	US$	108	140	165
FRG	DM	244	318	380
USA	US$	108	140	165
Hungary	US$	80	85	90

Daily subsistance allowances range from 23 to 50 $ and are paid to the employees on site.

Some sources of knowledge concerning various products and finished goods are shown in Table 75.
/In case of missing the adress of the firm, the country is indicated only./

Table 75

Sources of know-how of semis and finished aluminium goods manufacture

Product/technology	Source
Continuous casting	Alcan Research and Development Ltd., Canada Vereinigte Aluminiumwerke A.G., P.O.Box 100440 40480 Grevenbroich 1, FRG ALUSUISSE Feldeggstrasse 4 CH-8034, Zurich, Switzerland National Southwire Company /NSC/ Fertilla Street, P.O.Box 1000 Carrolton, Georgia 30117, USA
Aluminium casting, die casting	Mitsubishi Light Metal Ind.Corp. Japan Toshiba Machinery Corp., Japan Kaiser Aluminium and Chemical Corp. 300 Lakeside Drive, Oakland /Ca/ 94643, USA
Separation of aluminium from scrap	R.Fischer, FRG VEB Mansfeld-Kombinat Wilhelm Pieck, Freiberg, GDR
Recycling aluminium scrap	Vereinigte Aluminium Werke A.G. D-5300 Bonn, FRG
Aluminium extraction from scrap	Sharkey Metals Ltd., UK
Permanent mould castings	Fuso Light Alloys Co.Ltd., Japan
Low pressure die-casting	Reynolds Metals Co. One Union National Place Little Rock, Arkansas 72201, USA
Melting furnace design	Outokumpu Oy P.O.Box 27, SF-022201 Espo 20, Finland

cont'd

Product/technology	Source
Castable aluminium alloys	Nippon Light Metal Research Lab.Ltd. 7-3-5 Ginza, Chuoko, Tokyo, Japan
Wire drawing	Fujikura Cable Works Ltd., Japan ALUSUISSE Feldeggstrasse 4 CH-8043, Zurich, Switzerland National Southwire Co. Fertilla Street, P.O.Box 1000, Carrolton, Georgia 30117, USA Nippon Light Metal Research Lab.Ltd. 7-3-5 Ginza, Chuoko, Tokyo, Japan
Cold rolling	Sumitomo Metal Industries Ltd. Tokyo, Japan Norsk Hydro, Norway
Extrusion	Sumitomo Light Metal Ind.Ltd. Tokyo, Japan
Welding	ALCOA International Inc. Av.d'ouchy, CH-1006 Lousanne, Switzerland
Electric coloring, anodizing	Pechiney Ugine Kuhlmann, France Sumitomo Aluminium Corp., Japan ALCAN Research and Development Lab., Canada Nippon Light Metal Research Lab.Ltd. 7-3-5 Ginza, Chuoko, Tokyo, Japan
Building structures	Research, Engineering and Prime Contracting Centre of the Hungarian Aluminium Corporation /ALUTERV-FKI/ H-1133 Budapest, Pozsonyi ut 56. Hungary
Deep-Freezing storage houses	ALUSUISSE Feldeggstrasse 4, CH-8034 Zurich, Switzerland Energy Management Institute /EGI/ H-1027 Budapest, Bem rakpart 33-34. Hungary

cont'd

Product/technology	Source
Doors and windows	Factory of Metal Works /Fémmunkás Vállalat/ H-1394 Budapest, P.O.B. 380 Hungary
Container-type elements	Hungarian Aluminium Corporation /HAC/ H-1133 Budapest, Pozsonyi ut 56. Hungary
Hothouses /greenhouses/	Hungarian Aluminium Corporation /HAC/ H-1133 Budapest, Pozsonyi ut 56. Hungary
Automotive wheels	ALUSUISSE Feldeggstrasse 4, CH-8034 Zurich, Switzerland Ardal Og Sunndal Verk A.S. P.O.Box 2459 Solli, N-Oso 2, Norway
Aluminium truck frames	Reynolds Metals Co. One Union National Place Little Rock, Arkansas 72201, USA
Cooking utensils	Aluminium Ware Factory H-1142 Budapest, Erzsébet királyné utja 57-61. Hungary
Soda-water siphons, beer barrels, radiators	Refrigerator Works H-5100 Jászberény, P.O.Box 64, Hungary
Heat exchangers, radiators	"Lehel" Refrigerator Works H-5100 Jászberény, P.O.Box 64. Hungary
Sea-water desalting installations	Societe Egico, Paris, France Energy Management Institute /EGI/ H-1027 Budapest, Bem rakpart 33-34. Hungary
Mine props	Hungarian Aluminium Corporation /HAC/ H-1133 Budapest, Pozsonyi ut 56. Hungary

cont'd

Product/technology	Sources
Aluminium alloy conductor wire	**ALUSUISSE** **Feldeggstrasse 4,** **CH-8034 Zurich, Switzerland** **Sumitomo Electric Industries Ltd., Japan**
Raw material of aerial conductors and cables	**Hungarian Aluminium Corporation /HAC/** **H-1133 Budapest, Pozsonyi ut 56.** **Hungary** **Research Institute of Electr cal Engineering /VEIKI/** **H-1168 Budapest, P.O.B.233.** **Hungary**
Cables stranded from alumoweld wires	**Vereinigte Metallwerke Ranshofen-Berndorf** **Uraniastrasse 2,** **A-1010 Wien, Austria**
Stranded cables	**Hungarian Cable Works /MKM/** **H-1117 Budapest, Budafoki ut 60.** **Hungary**
Insulated conductors and cables	**Hungarian Cable Works /MKM/** **H-1117 Budapest, Budafoki ut 60.** **Hungary** **ALCAN Ltd.** **Dufourstrasse 43. Zurich** **Switzerland**
Electric assembly units	**Allgemeine Elektrizitäts-gesellschaft /AEG/** **Bebelstrasse 24. D-7 Stuttgart** **FRG** **Electric Equipment and Apparatus Works /VBKM-EKA/** **H-1457 Budapest, Füzér u.37-39.** **Hungary**
Telecommunication cables	**Southwire Company** **Fertilla Street** **P.O.B. 1000, Carrollton,** **Georgia 30117, USA**

cont'd

Product/technology	Source
Electric busbars, cable channels	Hungarian Aluminium Corporation /HAC/ H-1133 Budapest, Pozsonyi u. 56. Hungary
	Székesfehérvár Light Metal Works H-8001 Székesfehérvár, Adonyi u.64. Hungary
	Balassagyarmat Metalworking Enterprise H-2660 Balassagyarmat P.O.B.30. Hungary
	Electrical installation Enterprise /VIV/ H-1400 Budapest, Sip u.23. P.O.B. 67. Hungary
SF6 insulated switching equipment	BBC Aktiengesellschaft Brown-Bovery, Postfach 85, CH-5401 Baden, Switzerland
	Ganz Electrical Works H-1525 Budapest, Lövőház u.39. P.O.B.63. Hungary
Transformers	Csepel Transformer Factory H-1751 Budapest, P.O.B.72. Hungary
	Transformatoren Union, A.G. Katzwanger Strasse 150 Nürnberg, FRG
	Westinghouse Electrical Company Shargon, Pa. 16146, USA
Capacitors	Mechanical Works H-1502 Budapest, P.O.B.64. Hungary
	GIPROCVETMET, Moscow, USSR
Lighting fixtures	Electrical Equipment and Apparatus Works /VBKM-EKA/ H-1457 Budapest, Füzér u.37-39. Hungary
Deep-drawn light-weight containers	R.Rosch GmbH, FRG

cont'd

Product/technology	Source
Welded containers	VEB Transformatorenwerk, GDR
Collapsible tubes for toothpaste etc.	Sumitomo Aluminium Smelting Co.Ltd. 7-9-2 Chome, Nihonbashi, Chuo-ku, Tokyo, Japan
Containers with stamped base	Reynolds Metals Co. One Union National Place Little Rock, Arkansas 72201, USA
Beverage cans	Pechiney Ugine Kuhlmann, France
Gas cylinders	Aluminium Ware Factory H-1142 Budapes, Erzsébet királyné utja 57-61. Hungary
High-pressure tanks	Scanaluminium, Vika Oslo, 1. P.O.B. 1857. Norway
Storage and transport cans	"April 4" Machine Works /Április 4. Gépipari Müvek/ H-6100 Kiskunfélegyháza, Csáni ut 2., Hungary
Barrels, small containers, pallets	Hungarian Aluminium Corporation /HAC/ 1133 Budapest, Pozsonyi út 56. Hungary
Beer and drink boxes	Aluminium Co. of America 1501 Alcoa Building Pittsburg, Pa. 15219, USA
Cans	GEBAL, Paris 8e 47 rue de Monceau France
	Karges-Hammer Maschinen GmbH Frankfurter Str.36. Braunschweig, 330, FRG
Bottle closures	Pano-Verschluss GmbH KG Gesstrasse 29, Itzehoe, FRG

cont'd

Product/technology	Source
Collapsible tube	CEBAL, Paris 8^{e} 47 rue de Monceau France CHEMIMAS H-1103 Budapest, Noszlopy ut 1. Hungary
Solar energy technology	Sumitomo Light Metal Ind.Ltd. Japan Development des Applications de l'Energie Solaire F-75016, Paris 28 rue de la Soure France Phenol Engineering S.A.R.L. Av.de Lattre de Tassigny 69 330 Meyzieu, France

Remarks

Any mammoth company /Pechiney, ALCAN, ALCOA, ALUSUISSE, Reynolds, Kaiser, Montecatini/ and also the Hungarian Aluminium Corporation together with ALUTERV-FKI, its Research, Engineering and Prime Contracting Centre possess know-how concerning technologies for semi-production of different kinds, such as rolling, extrusion, extrusion press, forging, casting and special technologies for finished goods such as welding, surface treatment in the aluminium industry.

XI. MEASURES TO PROMOTE PRODUCT DEVELOPMENT EFFECTIVENESS

A. Technical advice and research

Acquiring know-how, adaptation is practically the only condition for success which relies upon the maximal knowledge of the local circumstances.

Intellectual and physical preparedness, beginning with knowing all knowable about the new product and collecting foreign experiences, shall only be completed by local adaptation. Consequently, it is not advisable to rely on foreign experts in this matter who - although with profound knowledge in their professions - do not know local circumstances. Decisive are knowledge of local conditions, personal connections that can only be acquired by local experts or by foreigners staying for at least 1-2 years at the site.

To contribute to development of the aluminium industry, to increase the aluminium consumption and to create aluminium traditons can only be achieved by a team living and working in the country.

Processing aluminium and its economic application in different fields require technological knowledge different from the traditional metal processing. An essential condition for establishing an industry is to acquire, to get acquainted with and to spread this knowledge. For this purpose, a techno-economic consulting organization is needed,

- to promote widespread economic application of aluminium,
- to introduce new application fields,
- to deepen technical aptitude for aluminium processing by consulting services, by transfer of documentations, by holding training courses,

- to promote cooperation between aluminium semis manufacturers and semis processing plants, collate present and future demands and possibilities of the aluminium industry,
- to observe international progress,
- to promote adaptation and domestic development of new finished products; designing, manufacturing and testing prototypes, all these based on the collected knowledge.

Financing this existing advisory service is the task of the aluminium industry; this organization conducts also developing activities facilitating thereby adaptation of foreign experiences, advanced fulfilment of special home demands. It should be able to design prototypes of aluminium structures required by various industries; to assist professionals in designing these prototypes and in starting mass-production of new products.

Most of the countries have created their own organizations for raising the level of use of aluminium thus justifying the necessity of this kind of consulting services. These are - among others -

- in France: Centre Technique de l'Aluminium
  87 Boulevard de Grenelle, F-75015 Paris
  /Attached to the Pechiney concern/
- in Switzerland: Information Service of the Central Technical Division of ALUSUISSE
  Feldeggstrasse 4, CH-8034, Zurich
- in Italy: Instituto Experimentale dei Metalli Leggeri
  Via G. Fauser 4, I-28100
  /Attached to the Alumetal concern/
- in Austria: Vereinigte Metallwerke Ranshofen-Berndorf
  A-5282 Ranshofen-Braunau
- in GDR: Leichtmetall Technischer Beratungsdienst
  Eisleben

- in Hungary: Research, Engineering and Prime Contracting Centre of the Hungarian Aluminium Corporation
  H-1033 Budapest, Pozsonyi ut 56.
- in Norway: Skanaluminium, Rosenkrantzgate 21
  Vika, Oslo 1.
- in the USA: The Aluminium Association Inc.
  810 Connecticut Av.
  N.W.Washington, DC 20006
- in Japan: Japan Light Metal Association
  Nikonbashi 2-Chome, Chou-ku Tokyo 103.
- in Australia: The Aluminium Development Council of of Australia Ltd.,
  56 Pitt Str. Syney, NSW 2000

B. Marketing

In the broad sense of the word, marketing implies the formation of development and sal policies based on market research and the application of methods promoting success.

The growth of aluminium consumption, the exploration of new application fields are mainly of interest for basic material producing companies. To replace traditional structural materials by aluminium in various application fields and to maintain achievements are both technical and marketing tasks. Advisably, the advisory service should also conduct marketing activity and this activity should not be confined to common technical problems of the aluminium manufacturing and processing industry but to the following areas, too:

- evaluation of progress in the semis and finished production by continuous market research, data collection and processing, documentations;
- making proposals for development decisions as well as for sale of the new products;
- propagandize of new products by technical booklets, promoting materials, publications;
- arranging exhibitions;

- cooperating with other technical fields, to incorporate aluminium products in standard manuals of these fields for designers, engineers;
- systematic standardization;
- cooperation with authorities of economics in the country for promotion and realization of concepts.

This last task seems to be evident. A development progress lasts for several decades and is coupled with certain risks. Not only companies but authorities of national economies in the country should participate in bearing the risk in order to form advantageous basic material structure and product assortment for the country.

Development of an aluminium industry is part of a long term economic-development strategy. Coordination of the authorities, organizations and of the industry is of primary importance for the aluminium industry to maintain steady progress.

C. Standardization

Standards have to take into account the consumer's safety, integration of products, exchangeability of the pieces, environment protection, etc. When introducing a new product, it is essential that it should be evaluated by the same aspects both by manufacturers and by processing /consumers/ experts.

Manufacturers and consumers of aluminium semis should agree about quality and size specifications that have to be fixed in standards. In the process of standardization, aluminium industry's experts should take part to assist solving detailed questions to assure interest of the industry. It is advisable to recognize the interests of the manufacturers, too.

Standard specifications fall in three groups:

- material standards, specifying compositions, mechanical and technological properties, sizes;
- product standards, specifying semis' properties for manufacturing purposes; finishing goods' properties for users' purposes;
- technological standards specifying methods of processing.

Existing international standards and other foreign national standards might promote standardizing acitivity. But if these are automatically accepted,they often impede progress in the beginning of developing and industry.

It is inevitable to revise foreign ones and adapt them as the country's own standards, for they can take the country's own achievements and capabilities into account.

To prepare standards and to widen standardization fields in the aluminium industry is not the task of the advisory service but of the authorities. The consulting department should, however, take the initiative. Similarly, development of the aluminium industry and of the manufacturing industry do not constitute the task of the advisory service alone, but its task is to widen the circle of the development participants.

Manuals and reference books are essential in influencing other industries' development engineers to participate.

To post graduate various experts in the aluminium processing industry, to develop aluminium application technics is the task of the experts working in the aluminium industry.

The best method to this is the advisory service's activity in compiling and publishing relevant materials, manuals, reference books, etc.

XII. RECOMMENDATIONS

As a summary of the previous chapters, Tables 76 and 77 show the probable development targets of the semis and finished goods producing industry in the People's Republic of Mozambique.

The "suggested development" term of the Tables means a somewhat more intensive and expensive development while by the term "minimum realizable investment" the meeting of the strictly necessary demands is meant only. Both Tables contain however the suggested yearly production capacities and the estimated investment costs that are needed to realize them.

Figures 3 and 5 show the suggested time-schedules for the implementation of the investments summarized in Tables 76 and 77, for a minimally realizable program. It seems absolutely advisable to start this program soon otherwise - without appropriate plants and knowledge - the Country will not be able to process the primary aluminium produced in the planned new smelter which will be in operation at that time according to the plans; and will not be able to utilize the benefits fully, neither at home, nor at the export market, of the produced primary aluminium.

To be able to utilize investments succesfully and quickly, we suggest following steps:

Table 76

Suggested development of aluminium semi-production in Mozambique

/Output and estimated ivestment cost/

Output /in 1,000 tons/	Proposed development 1985	1990	1995	2000		Minimum realizable investment for domestic consumption 1958	1990	1995	2000	
Continuous strip casting	-	27.0	74.0	90.0		-	13.0	13.0	13.0	
*Rolled products	-	20.0	55.0	70.0		-	10.0	10.0	10.0	
*Extrusion	9.0	10.0	20.0	30.0		3.0	3.0	3.0	5.0	
Billets	-	-	30.0	45.0		purchased billets				
*Wires and bars /CCR produsts/	-	20.0	40.0	40.0		-	-	-	-	
*Castings and forgings	1.8	3.8	9.6	27.4		1.1	2.1	2.5	6.4	
Remelted scrap /excl.scrap from semis shops/	0.2	0.6	1.2	2.5		0.2	0.4	0.5	0.8	
Total /sum of the * items/	10.0	52.0	120.0	155.0		3.55	14.05	17.25	21.2	
Cost /in 1,000 US$/	**1982-1985**	**1986-1990**	**1991-1995**	**1996-2000**	**Total**	**1982-1985**	**1986-1990**	**1991-2000**	**1996-2000**	**Total**
Foundry shop /continuous strip casters/	-	16,220	28,230	37,850	82,300	-	8,100	-	-	8,100
Cold rolling mill	-	70,700	123,720	53,020	247,440	-	35,000	-	-	35,000
Extrusion shop	25,120	-	27,910	27,910	80,940	8,500	-	-	5,600	14,100
Billet casting shop	-	-	25,330	12,660	37,990	-	-	-	-	-
Continuous casting-rolling mill	-	10,620	10,620	-	21,240	-	-	-	-	-
Shops for castings and forgings	5,200	5,000	8,200	25,200	43,600	2,860	2,800	1,400	5,500	12,560
Scrap remelting	-	-	-	165	165	-	-	-	-	-
Total	30,320	102,540	224,010	156,805	513,675	11,360	45,900	1,400	11,100	69,760

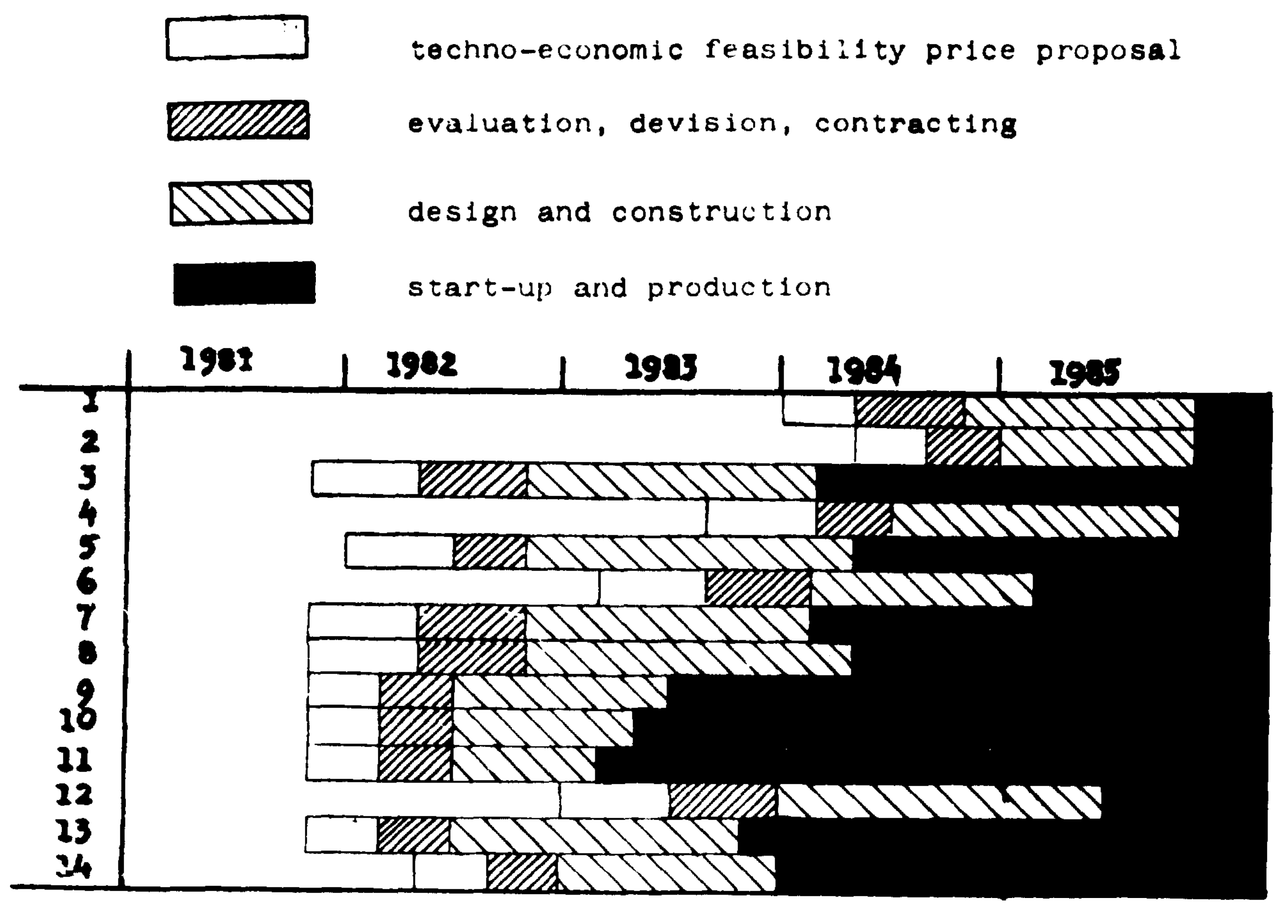
Table 77

Suggested development of aluminium end-products in Mozambique

/Output and estimated investment cost/

Output /in 1,000 tons/	Proposed development					Minimum realizable investment for domestic consumption				
	1985	1990	1995	2000		1985	1990	1995	2000	
Electrical industry	6.8	7.2	28.2	29.4		2.0	3.0	3.1	3.3	
Packing industry	0.3	0.6	0.8	1.7		0.3	0.6	0.8	1.7	
Machine industry	0.8	3.1	5.0	7.5		0.3	0.7	1.0	1.7	
Transportation, storage	4.0	4.0	5.0	9.5		0.45	0.97	2.3	4.3	
Building industry	2.9	3.2	6.9	12.8		1.7	1.8	2.4	3.4	
Apparatus manufacture	0.8	1.5	2.3	4.8		0.3	0.45	0.6	1.2	
Household appliances	1.4	1.7	2.4	3.4		1.7	1.6	1.5	1.4	
Total output	17.0	21.3	50.6	69.1		6.75	9.12	11.7	17.0	
Cost /in 1,000 US$/	1982-1985	1986-1990	1991-1995	1996-2000	Total	1982-1985	1986-1990	1991-1995	1996-2000	Total
Electrical industry	6,880	1,400	20,200	1,200	29,680	2,020	1,010	100	200	3,300
Packaging industry	1,490	1,490	990	4,400	8,370	1,490	1,490	990	4,470	8,440
Machine industry	2,850	8,200	6,770	8,900	26,720	1,070	1,420	1,070	2,500	6,060
Transportation, storage	5,640	500	2,200	15,000	23,340	990	930	2,930	4,400	9,250
Building industry	8,830	920	11,200	17,000	37,950	5,170	300	1,820	3,040	10,330
Apparatus manufacture	2,420	2,200	2,420	7,500	14,540	910	450	450	1,800	3,610
Household appliances	2,890	620	1,450	2,000	6,960	2,890	210	210	210	3,520
Total	31,000	15,330	45,230	56,000	147,560	14,540	5,810	7,570	16,620	44,540

Fig.3. Time schedule for the realization of development program for manufacturing aluminium finished products



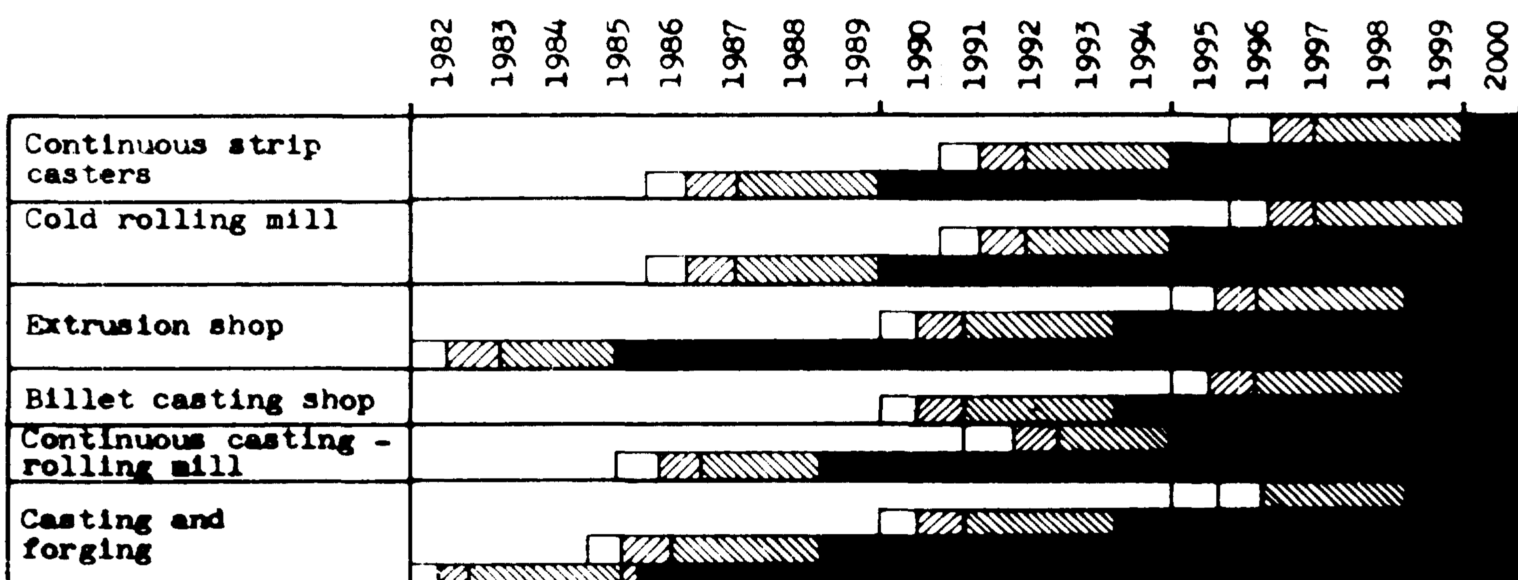
1 - Household utensils
2 - Milk cans
3 - Gas cylinders
4 - beer casks
5 - Soda-water syphons
6 - Radiators
7 - Lamp posts
8 - Cables
9 - Rain gutters
10 - Ladders
11 - Portals
12 - Containers
13 - Corrugated sheets
14 - Panels

Fig.5

Suggested time schedule for the development program of semi-production

/Each line shows a separate unit/

- techno-economic feasibility price proposal
- evaluation, decision, construction
- design and construction
- start up and production



Since aluminium processing requires a technology which is different from that of the steel, the growth of attained professional knowledge is a very important factor.

The first step in development of an aluminium processing industry is the establishment of a managing organization, economically and technologically educated which will be able to indicate the trends and conditions of the economical use of different aluminium products in the country. The professional area of this managing body should be enlarged step by step to become a well informed and efficient leader organization of the industry. This managing body has to choose and train the technical and economic staff of the new plants. In order to increase the present aluminium consumption the following steps can be proposed:

- Survey of the actual aluminium consumption areas. Taking into consideration the short-term development program it can be suggested to develop those consumption areas which seem to be necessary for realization of long-term objectives, too. The cable-industry can be emphasized where the equipment and the professional knowledge at hand make possible to start soon cable production with aluminium. This would contribute to the rapid development of the national power grid according to the requirement.

  The aluminium can be well used for repairing commercial vehicles, for building new car-bodies, promoting in this way the decrease of weight of cars. The plants are at disposal but they need a significant technological development The development of the agriculture is a keystone for raising the living standard of the population. It is necessary to raise the technical level of plants producing household utensils. After having reached this level, there is a possibility to produce high quality products in the food industry, in the food--chemical industry /dairy, canning industry, preserving packings, cold-storage industry etc./.

- Establishing new aluminium processing plants. In the knowledge of the available metal quantity in a certain period and the long-term developing objectives it seems useful to draw up an order of importance for the processing plants.

  The development of the industry makes necessary the growth of aluminium consumption in the machine industry and in the building industry as well. Here is necessary to start with the manufacture of structures for power distribution. Beyond the cable manufacture, this covers the start-up of other structures for electric industry too, as: loss-free fittings of conductors, transformators, their shells, posts, and miscellaneous non-conducting structures. The starting with natural gas exploitation makes necessary to manufacture small and big sized containers and trucks for storage and transport of LNG. The reduction of the mass to be transported results savings in energy and manpower, e.g. through realization of manufacturing PB gas-bottles made from aluminium. It is advisable to start the preparation of the production of those products even before the development of domestic semis' manufacture, and even in case the material to be processed has to be imported.

- The third phase is raising technical level of aluminium processing and introducing the production of more sophysticated products. All structural materials, available in a given period, utilizable at the production of the products must be considered. Decision on the manufacture of the products has to be made by consideration of manufacturing possibilities, economic efficiency, and the home and export requirement respectively. The purchase of the products abroad the technology, eventually equipment, have to be taken into account at the realization of the above three phases. Purchase of know-how, cooperation with foreign experts can greatly shorten the development periods. In case of starting a new industry, which represents a great risk, it is more favourable to purchase the know-how together with the appropriate guarantees.

In the aluminium processing countries the management of the aluminium industry, the relaionship between various branches of the full verticum of the production are different. But independently from the system of the organization they established their own research and development /R+D/ organization and therein or apart from it, their technical consulting service, too.

The task of the R+D organization is generally to carry out the laboratory tests starting from the bauxite exploitation to the finished goods' production; to create new materials; to qualify the products, to carry out physical, chemical and mechanical testing of materials, to be utilized.

The task of the consulting organization is generally to train the workers for the production of finished aluminium goods, to popularize new technologies, making proposals for optimal material qualities and manufacturing methods at new products to be realized, and in general, acting as connecting link between the semis' manufacturer, the R+D organization and the finished products' manufacturers. With the help of an appropriate information-flow on technnical matters it can be achived that in a given country the general and technical knowledge on utilization of aluminium products became continuously and widely known.

A part of the leaders of the aluminium industries of the developing countries have already realized this requirement and established R+D and consulting organizations for the developing of industrial branches. The necessity of an R+D organization is demonstrated by the fact that countries with a developed aluminium industry spend abt. 1-1.5 per cent of gross return from sales of aluminium industry on research and development.

The situation is also similar at the mammoth aluminium trusts, e.g. ALCOA spends 1.5-2 per cent of his annual returns on research and development.

The form of consulting organization of applied technics depends to a great extent on the situation of the aluminium industry in a given country. Irrespective of the fact that there are acting one or more primary aluminium manufacturers, the advisory organization should be independent and neutral. It should take into account the mutual interests of all, concerned /primary manufacturers, end-consumers, semis' manufacturers, finished products' manufacturers/.

For the PR of Mozambique it is inevitably necessary to train experts working in all areas of the aluminium industry to be developed and to organize their continuous professional training, respectively. This is in any case reasonable for colleagues acting at the central managing organization of the aluminium industry. It has to be ensured that all of them working in this territory could acquire technical and economic knowledges of aluminium industries on the highest level. It is advisable to create just at the beginning the consulting body for applied technics. It can help the central managing organizations concerning the most economical aluminium products, the qualities of aluminium, necessary for them, and the appropriate technologies.

It has to be ensured for the leading technical and economic experts of the manufacturing plants the exchange of working experiences of production methods at foreign plants with the same profile. From the point of view of the present Mozambiquean aluminium finished goods production the studying of aluminium cable production would be of outstanding importance for the managers of cable producing plant which produced copper cables before. Similarly, it seems necessary to extend the knowledge of aluminium utensils' manufacturing plants' managers which would enable them to improve the quality and efficiency of products being manufactured at present as well as to learn new products manufacturing based on the same technology.

As it can be read in details in the present study, the economical aluminium finished goods production cannot be reached in a country with relatively small aluminium-consumption when the home requirements are only satisfied. Therefore, it is not practicable to deal with the production of each kind of aluminium products. In several cases it is more economical to build up an intensive exchange of products between countries of a given geographical area. In this way it would be possible to satisfy the needs of the surrounding countries wiht different kind of products, to produce economically aluminium finished products.

The participation in the international distribution of labor is not only advantegeous but nearly inevitable in our days and its importance will further be growing in the future. During the developing works it must be tried to conclude bilateral or regional operative agreements. The latter can be especially important from the point of view of expanding market, exchange of experiences in production, possibly of common financing some investments, too.

The creation of the finished goods industry of the aluminium and starting of the production put on the first place the question of the secondary metal utilization too enlarging the metal stocks. The organized recovery of aluminium scrap arising in the processing industries as well as from products having got into general use and their recycling is an important economical factor. It is necessary to work out a price-policy which makes the collection of scrap attractive and at the same time it ensures economical advantages for the users of secondary metal.

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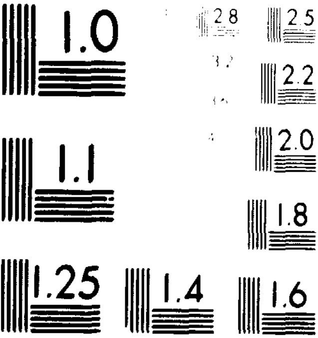
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Metal Forming, London /English/
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Revue de l'Aluminium, Paris /French/
Schweizer Aluminium Rundschau, Zurich /German, French/
World Metal Statistics, Birmingham /English/

DATA REQUIRED FOR THE ELABORATION OF A DEVELOPMENT STUDY FOR ALUMINIUM INDUSTRY

1. For the year of 1980 the actual and for the years of 1985-1990-1995-2000 the planned or supposed data needed:

   a/ per capita GDP in US$ or in MT

   b/ the population, the manpower and the average salaries /wages/ of unskilled, skilled workers, technicians and engineers,

   c/ the production /output/ in US$ or MT, the investments or field assets /land, equipment, buildings, civil works/, manpower /worker+employees/, gross profit /before taxation/ and profits of:

   - electrical industry
   - packaging industry
   - machine industry
   - transportation and storage
   - building industry /constructions/
   - apparatus manufacture
   - household appliances production,

   d/ the consumption of the production of the listed sectors, in agriculture /irrigation, horticulture, animal husbandry, canning and cooling industry/,

   e/ the import-export of the above sectors.

2. The aluminium consumption of the People's Republic of Mozambique in 1978, 1979, 1980 in whole and in details, according to the sectors listed in 1/c.

3. For the years of 1978, 1979, 1980

   a/ the volume of export-import, respective Italy, France, Belgium, Federal Republic of Germany, India and the heighbouring countries in US$ or Mt, b/ the import of aluminium basic material and semis, the semis specified as:

- rolled products
- foils
- extrusions
- Properzi-rods and -wires
- drawn wires and cables
- castings
- forgings

in volume /tons/, in value /US$ or MT/, fco Maputo,

c/ the local selling prices of the specified semis, to the public sector and to private enterprises,

d/ the custom duties on the imported semis, the source of import /countries/,

e/ the usual freight costs inside the country /tons/km, m^3/km/ on rail, ship or camions,

f/ the buyers' list of the detailed semis, their activity /what do they use the semis for, for production, for maintenance, etc./,

g/ the import of aluminium finished goods /e.g. cables, boxes, cans, machine parts, window frames, building structures, household appliances, etc./ in tons or pieces, the import prices of them fco Maputo, the custom duties, the wholesale prices and buyers, the retail prices in some cases,

g/ the average prices of some complementary materials

	Al	Fe	Cu	PVC	Wood
			MT/kg		
Basic material					
sheet					
wire					
rod and shape					
tubes or pipes					

4. Data regarding the existing aluminium finished goods producers /cooking utensils, window-frame, cable-producers/

   a/ name and adress of these factories

   b/ their production in 1980 in tons or pieces or meters, etc.

   c/ their detailed material consumption /Al, iron, steel, plastics, etc./

   d/ the utilities they use up for the production /electric power, water, fuel oil or coke, gas, etc./

   e/ number of employee's direct manpower /skilled, unskilled, technicians, engineers/,

   f/ their direct material costs, direct manpower costs, other input costs, factory overhead costs /or factory costs altogether if details are not available/, administrative overhead costs, sales and distribution costs

   g/ their production costs /operating costs, depreciation, interest or financial overhead costs/

   h/ their sales revenue /gross profit before taxation, net profit/

   i/ their fixed assets, such as land, equipment, buildings and civil work installations

   j/ their main equipment /a list consisting of the type, the age etc./

5. The present utility prices, their expected changes until the year 2000 /1985-1990-1995-2000/

   - electric power
   - water /industrial and cleaned/
   - fuel oil
   - coke
   - gas, etc.

6. The present construction /building/ prices /with erection/ in MT/m^2 and MT/m^3, the expected changes until the year of 2000, of

   - open sided /storages of agricultural buildings/,
   - uninsolated workshops with or without cranes,
   - insulated workshops and offices with or without air-conditioning,
   - cooling houses,
   - civil works /roads, canalization, etc./.

7. What is the average rate of return of new investments in general, what are requirements on behalf of semiproduct plants and finished goods producing plants, what are the expected changes until Anno 2000? For the development of the aluminium industry is foreign loan contemplated, if so, to what extent?

   What are the prevailing interest rates in the public sector and in the private sector in case of

   - short term loans,
   - long term loans

   and what are the expected changes until the year 2000?

   What depreciation rules and laws are in force in the P.R. of Mozambique and what are the expected changes until 2000?

8. Which government organization supervised by the existing development organization?
   Which organizations are supervised by the existing development organization?
   Which are the responsibilities and rights of the existing development organization?

Are there any plans of increasing and enlarging the organization and changing its rights and responsibi- bilities?
Are there any valid agreements or planned agreements with foreign partners in the field of the development of the aluminium industry?

9. What is the planned smelter-capacity, when is expected to be realized, with a planned run up to the production and a further enlargement until the year of 2000?
What is the planned output, step by step in primary aluminium /billets for rolling, billets for extrusion/?

Is the collecting of aluminium scrap realized or planned for the future?

Annex II.

LIST OF STANDARDS, RECOMMENDATIONS AND TECHNICAL REPORTS OF THE ISO

/International Organization for Standardization/

ISO/R	115-1986	Classification and composition of unalloyed aluminium ingots for remelting
ISO/	121-1980	Magnesium-aluminium-zinc alloy ingots and alloy castings - Chemical compositions and mechanical properties of sand cast reference test bars
ISO/R	164-1960	Composition of aluminium alloy castings
ISO/R	208-1961	Composition of aluminium alloy castings
ISO/R	209-1971	Composition of wrought products of aluminium and aluminium alloys - Chemical composition /per cent/
ISO/R	388-1964	ISO metric series for basic thicknesses of sheet and diameter of wire
ISO/R	503-1966	Composition of wrought magnesium-aluminium--zinc alloys
ISO/	793-1973	Aluminium and aluminium alloys - Determination of iron - Orthophenanthroline photometric method
ISO/	795-1976	Aluminium and aluminium alloys - Determination of copper content - Oxalyldihydrazide photometric method
ISO/	796-1973	Aluminium and aluminium alloys - Determination of copper - Electrolytic method
ISO/	797-1973	Aluminium and aluminium alloys - Determination of silicon - Gravimetric method
ISO/	808-1973	Aluminium and aluminium alloys - Determination of silicon - Spectrophotometric method with the reduced silicomolybdic complex

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ISO/R	827-1968	Mechanical property limits for extruded products of aluminium and aluminium alloys
ISO/R	828-1968	Mechanical property limits for rivet stock of aluminium and aluminium alloys
ISO/R	829-1968	Mechanical property limit for aluminium alloy forgings
ISO/	886-1973	Aluminium and aluminium alloys - Determination of manganese - Photometric method /Manganese content between 0.005 and 1.5 %/
ISO/R	952-1969	Testing of light metal and light metal alloy tubes
ISO/R	953-1969	Drift expanding test on light metal and light metal alloy tubes
ISO/R	954-1969	Simple bend test for light metal and light metal alloy sheet and strip of thickness between 0.2 mm /0.008 in/ and 7 mm /0.25 in/
ISO/R	955-1969	Flattering test on aluminium and aluminium alloy tubes
ISO/R	956-1969	Tensile test for light metal and light metal alloy wires
ISO/R	958-1969	Wrapping test of aluminium and aluminium alloy wire
ISO/	1118-1978	Aluminium and aluminium alloys - Determination of titanium - Spectrophotometric chromotropic acid method
ISO/	1247-1974	Aluminium pigments for paints
ISO/	1784-1976	Aluminium alloys - Determination of zinc-EDTA titrimetric method
ISO/	2063-1973	Metallic castings - Protection of iron and steel against corrosion - Metal spraying of zinc and aluminium

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ISO/ 2085-1976	Anodizing of aluminium and its alloys - Check of continuity of thin anodic oxide coatings - Copper sulphate test
ISO/R 2092-1971	Light metals and their alloys - Code of designation
ISO/ 2106-1976	Anodizing of aluminium and its alloys - Determination of man per unit area of anodic oxide coatings - Gravimetric method
ISO/R 2107-1971	Light metals and their alloys - Temper designations
ISO/ 2128-1976	Anodizing of aluminium and its alloys - Determination of thickness of anodic oxide coatings - Nondestructive measurement by split-beam microscope
ISO/ 2135-1976	Anodizing of aluminium and its alloys - Accelerated test of lightfastness of coloured anodic oxide coatings
ISO/TR 2136-1977	Wrought aluminium and aluminium alloys - Rolled products - Mechanical properties
ISO/R 2142-1971	Wrought aluminium and aluminium alloys - Selection of specimens and test pieces
ISO/R 2143-1971	Surface treatment of metals - Anodization of aluminium and its alloys - Estimation of the loss of absorptive power by colorant drop test with prior acid treatment
ISO/R 2147-1971	Aluminium alloys - Sand cast test pieces - Mechanical properties
ISO/ 2297-1973	Chemical analysis of aluminium and its alloys - Complexometric determination of magnesium

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ISO/R 2376-1972	Anodization /anodic oxidation/ of aluminium and its alloys - Insulation check by measurement of break-down potential
ISO/R 2378-1972	Aluminium alloy chill castings - Reference test bar
ISO/R 2379-1972	Aluminium alloy sand castings - Reference test bar
ISO/R 2437-1972	Recommended practice for the X-ray inspection of fusion welded butt joints for aluminium and its alloys and magnesium ant its alloys 5 to 50 mm thick
ISO/R 2637-1973	Aluminium and its alloys - Determination of zinc - Atomic absorption method
ISO/R 2767-1973	Surface treatments of metals - Anodic oxidation of aluminium and its alloys - Specular reflectance at 45 degrees - Total reflectance - Image clarity
ISO/TR 2778-1977	Wrought aluminium and aluminium alloys - Drawn tubes - Mechanical properties
ISO/TR 2779-1973	Aluminium machining alloys - Chemical composition and mechanical properties of Alloys Al-Cu6 Bi Pb and Al-Cu4 Pb Mg
ISO/R 2931-1975	Anodizing of aluminium and its alloys - Assessment of quality of sealed anodic oxide coatings by measurement of admittance or impedance
ISO/R 2932-1973	Anodizing of aluminium and its alloys - Assessment of sealing quality by measurement of the loss of mass after immersion in acid solution

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ISO/R 3116-1974	Wrought magnesium-aluminium-zinc alloys - Mechanical properties
ISO/TR 3134/1-1977	Light metals and their alloys - Terms and definitions - Part I. Materials
ISO/TR 3134/2-1977	Light metals and their alloys - Terms and definitions - Part II. Unwrought products
ISO/TR 3134/3-1977	Light metals and their alloys - Terms and definitions - Part III. Wrought products
ISO/TR 3134/4-1977	Light metals and their alloys - Terms and definitions - Part IV. Castings
ISO/ 3210-1974	Anodizing of aluminium and its alloys - Assessment of sealing quality by measurement of the loss of mass after immersion in phosphoric-chromic acid solution
ISO/ 3211-1977	Anodizing of aluminium and its alloys - Assessment of resistance of anodic oxide coatings to tracking by deformation
ISO/ 3255-1977	Magnesium and magnesium alloys - Determination of aluminium - Chromazurel S photometric method
ISO/ 3256-1977	Aluminium and aluminium alloys - Determination of magnesium - Atomic absorption, spectrophotometric method
ISO/ 3335-1977	Extruded solid profiles in aluminium-zinc-magnesium alloy Al 244.5 Mgl /7020/ - Chemical composition and mechanical properties
ISO/ 3978-1976	Aluminium and aluminium alloys - Determination of chromium - Spectrophotometric method using diphenylcarbazide, after extraction
ISO/ 3979-1977	Aluminium and aluminium alloys - Determination of nickel - spectrophotometric method using dimethyl-glyoxime

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ISO/	3980-1977	Aluminium and aluminium alloys - Determination of copper - Atomic absorption spectrophotometric method
ISO/	3981-1977	Aluminium and aluminium alloys - Determination of nickel - Atomic absorption spectrophotometric method
ISO/	5191-1980	Wrought aluminium and aluminium alloy products - General conditions for inspection and delivery
ISO/	6581-1980	Anodizing of aluminium and its alloys - Determination of the fastness to ultra-violet light of coloured anodic oxide coatings.
ISO/R	2101-1971	Aluminium and aluminium alloys - Shear test for rivet wire and rivets
ISO/R	190-1961	Tensile testing of light metals and their alloys
ISO/R	191-1971	Light metals and their alloys - Brinell hardness test
ISO/R	192-1971	Light metals and their alloys - vickers hardness test

Remark: R = Recommendation
TR = Technical Report

Source: 1981 ISD Catalogue, Genève