AREA REPORT

Copper fabrication facilities in Zambia – present scope and potential for growth

By W C Lombe

This article analyses the present vertical linkages in the base metal mining industry of Zambia. Particular attention is given to obstacles to the development of these linkages and to the potential for increased local fabrication. This is the first of two articles.

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INTRODUCTION

The history of mining in Zambia dates back to 1908 when commercial production was started at Kansanshi mine. However, large scale mining did not commence until in the 1930s. From that period to 1985, approximately 1 030 Mt of ore grading on average 2.8 per cent Cu have been processed yielding about 23 Mt of electrolytic copper and 75 kt of cobalt metals. This has resulted in a depletion of reserves of 970 Mt of ore at an average grade of 3.8 per cent.

The magnitude of these figures give an indication of the scale of mining operations in Zambia and the enormous quantities of primary metals that have been exported to support industrial activity abroad, particularly in the *developed market economies* (DME).

Comparatively, little industrial development has taken place in Zambia itself inspite of the presence of the large mining industry. The reserves, meanwhile, continue to be depleted at an alarming rate. In 1985 proven reserves were estimated at 440 Mt at a grade of 3.07 per cent. Technically this implies that during the next 15 to 20 years mining activity will have to contend with lower treatable grades of about 2.1 per cent Cu. Beyond that the treatable grades are expected to drop drastically, perhaps lending to closure of the mines.

It is against this gloomy background that concern has been mounting about the conspicuous lack of secondary metal fabricating facilities to make end-user products for the national economy, regional and international markets. All the non-ferrous metals produced in Zambia are processed to pure forms before export. For the principal metals produced, domestic consumption as a proportion of production has been estimated at less than 1 per cent for copper and cobalt, 25 per cent for lead and 2 per cent for zinc. In essence therefore, although large scale mining activity has persisted for generations in Zambia, it has at best been viewed as a source of capital and foreign exchange earnings. It does not appear to have provoked any significant downstream linkages locally.

This situation is not helped either by the import-orientedness of the resource base of the mining industry. In 1985, it was estimated that the mining industry's foreign exchange requirements were about 40 per cent of their total earnings capacity to simply maintain efficient production and arrest decline in productive capacity.[1]

In the light of the above comments it is increasingly argued, perhaps rightly, that the base metal mining industry in Zambia is extensively integrated into the developed market economies and that this obligation has obscured some basic requirements for industrialization, i e import substitution and resource based industrialization.

Technology of copper processing

It is not the intention of this study to give a detailed treatment of metallurgical production and fabrication techniques in the copper industry. It is recognized, however, that production technology cannot totally be disengaged from problems associated with the industry. The product cycle therefore forms a suitable reference point and will facilitate clarity of technical descriptions.

Fig 1 shows the processes used in copper treatment and the subsequent fabrication sector, and the interrelationship of the various processing stages. Although the diagram is for copper, processing and fabrication of the other base metals produced in Zambia, i e lead, zinc and cobalt would follow much a similar route.

Mining and processing

The copper production comes from both underground and open-pit excavations. The copper is mined mainly as sulphide ore although oxide ore is also mined. The average grades extracted are significantly high in Zambia and range between 2 to 3.50 per cent Cu which are

Fig 1
Flow sheet – copper processing

far above those mined for example in the US where they mine as little as 0.6 per cent Cu.[2]

The treatment stages commence with concentration of the ore by a variety of techniques, the main one which is flotation, to produce a concentrate containing about 30 per cent Cu.

The concentrate is then melted down in a smelter to produce and intermediate copper matte containing about 60 per cent Cu. The matte is further refined at high temperatures by air injection to produce blister copper with a copper content of 98 per cent Cu.

The blister copper is cast into anodes which form the material input for electrolytic refining during which time they are dissolved in acidic solutions and re-precipitated by use of an electric current. The re-deposited copper sheets are referred to as cathodes, and contain higher than 99.98 per cent Cu. The cathodes are further refined by remelting in a reverberatory furnace and recast in the shape of wire bars whose shape is really a matter of convenience for subsequent fabrication processes.

From the viewpoint of world trade in copper containing materials, the main traded products are the concentrates, blister copper, cathodes and wire bars. Zambia, however, sells all her copper either as high purity wire bars (currently about 80 kt/year) or cathode copper (at least 400 kt/year).

During the processing of copper a considerable amount of scrap is generated. Current estimates[3] indicate that within the *Zambia Consolidated Copper Mines Ltd* (ZCCM) operations at least 55 kt per year is generated. This scrap is recycled to either the smelting stage or wire bar melting and casting facilities. Owing to an absence of the fabrication sector in Zambia, there is no significant copper scrap industry in Zambia outside ZCCM other than about 50 t per year generated by *Zambia Metal Fabricators Ltd* (ZAMEFA).

Primary fabrication

In the past the traditional method of fabricating wire-rod for use in wire and cable manufacture consisted of rod-rolling. The wire bar was heated to about 830C° and rolled in several phases to wire-rod. In recent years, however, the trend in wire rod manufacture has been towards *continuously cast rod* (CCR). This has resulted in greatly decreased production costs due to a reduction of process steps and improved quality particularly by eliminating the need for welding a number of wire rod pieces together to produce a coil. Today a large number of CCR plants are in operation around the world using a variety of technologies including Southwire, General Electric, Properzi, Contirod, Outokumpu Oy, etc. Although variants of CCR plants are diverse, the basic aim in all of them is to produce a rod of infinite length from a pool of molten metal maintained in an inert atmosphere containing no oxygen.The variations are primarily in the method of obtaining the wire rod.

Additional shapes to wire-rod in the primary fabrication sector include bars, sections and many other profiles. These are produced mainly by extrusion in which a hot billet is pressed through a die assembly at high pressures.

Where flat products such as strip is required for subsequent sheet manufacture, slabs of hot metal are passed between two adjecent rolls to reduce their thickness.

Where tubes are not produced by extrusion they are fabricated by tube piecing.

Recent technology developments in primary fabrication have moved towards continuous casting of the above products.[4] In this technique molten metal is drawn from a holding furnace through ports comprizing of a die of the required shape. The variety of continuously cast shapes is large and includes rods, bars, sections of various shapes, hollow tubes, strips of up to 1.5 m in width and 12 mm thickness etc. Small units of continuous castors are also marketed by a number of manufacturers.

The products of the above fabrication processes (primary fabrication) are popularly referred to as copper (alloy) semi manufactures.

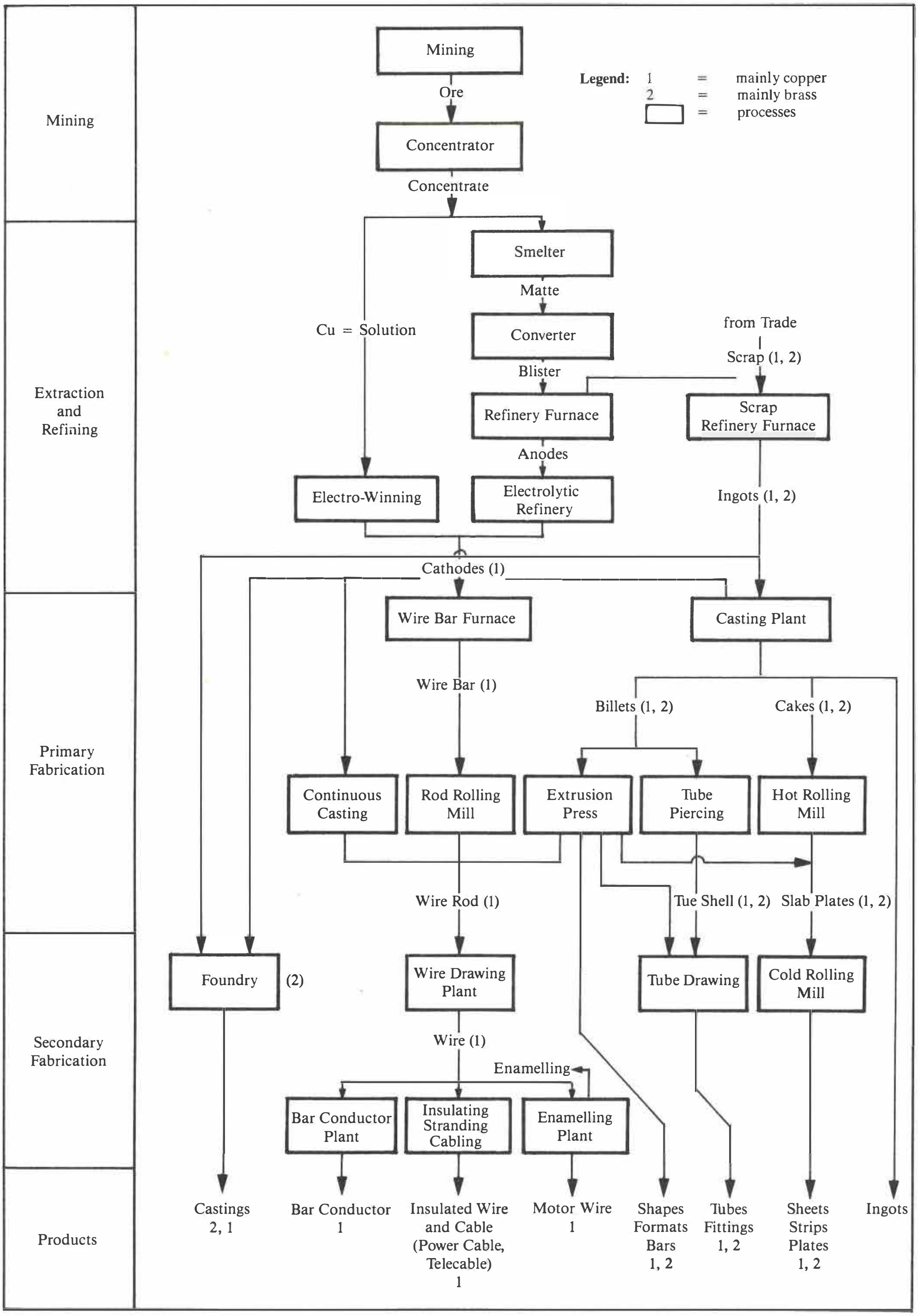
Secondary fabrication

Secondary fabrication is aimed at yielding the final end-user product. In the manufacture of copper wire, wire rod is drawn through a set of dies to reduce the diameter stage-wise e g down to 3 mm, an intermediate stage of 0.5—1 mm and a final stage to 0.4 mm. In a few cases the bare wire is used as such. Often, however, the wires are stranded together to increase the current carrying capacity or are insulated to protect life or the cable itself. The insulation material can be thermo plastics (PVC, polyethylene), rubber, impregnated paper or other material. Motor wire is insulated by dipping the copper wire in liquid vanish to deposit a thin coat after solidifying.

Tube is obtained as thick extruded, pieced or continuously cast shapes. Further reduction in the thickness of the tube is done on a bench by drawing the tube stock by chain pulleys driven by an electric motor through a gear box.

For the manufacture of sheet and foil cold rolling is usually performed on hot rolled strips or sheets to bring the thickness down 0.1—1 mm. The reduction per pass in such rolls is 20—30 per cent and to increase rolling capacity reversible cold rolling is sometimes practiced.

The last secondary fabrication method occurs in foundries. These are essentially workshops in which copper and copper alloys are melted and then cast into a wide range of intricate shapes. Most foundry products consist of copper alloys; of this alloy brass production accounts for 80—90 per cent.


Mining
Extraction and Refining
Primary Fabrication
Secondary Fabrication
Products
Legend: 1 = mainly copper
2 = mainly brass
= processes
Mining
Ore
Concentrator
Concentrate
Smelter
Matte
Converter
Blister
Refinery Furnace
Anodes
Electrolytic Refinery
Cu = Solution
Electro-Winning
from Trade
Scrap (1, 2)
Scrap Refinery Furnace
Ingots (1, 2)
Cathodes (1)
Wire Bar Furnace
Casting Plant
Wire Bar (1)
Billets (1, 2)
Cakes (1, 2)
Continuous Casting
Rod Rolling Mill
Extrusion Press
Tube Piercing
Hot Rolling Mill
Wire Rod (1)
Tue Shell (1, 2)
Slab Plates (1, 2)
Foundry
(2)
Wire Drawing Plant
Tube Drawing
Cold Rolling Mill
Wire (1)
Enamelling
Bar Conductor Plant
Insulating Stranding Cabling
Enamelling Plant
Castings 2, 1
Bar Conductor 1
Insulated Wire and Cable (Power Cable, Telecable) 1
Motor Wire 1
Shapes Formats Bars 1, 2
Tubes Fittings 1, 2
Sheets Strips Plates 1, 2
Ingots

Present and planned fabrication facilities in Zambia

In his address to the Copper Development Association in 1983, Balon stated:

> "The dream of copper producing countries, regardless of their political system, is to go as far downstream as possible into further processing or fabrication of raw materials. It is well known that the first idea of an industrialist held in terror by the demon of diversification is to annex the products either upstream or downstream, perhaps because, in this case, his creative imagination is limited by his very knowledge of these areas." [5]

Perhaps the Zambian economy may not presently be held in terror by the "demon" of diversification and downstream processing; at least not yet. The question of fabrication of products to increase local processing of Zambian metals is, however, not new and has in fact been incorporated into successive development plans. What achievements has this policy brought to the country?

In the first place it is important to recognize that Zambia is a significant producer of primary metals, particularly copper and was at one time (1977) the world's second biggest producer of primary refined copper with a world share of 9.1 per cent and exports of 666.6 kt of electrolytic copper. Due to this large output it is doubtful that increased local fabrication of copper products for domestic consumption can cause a significant diversion of the country's output for local consumption. Even then, however, it is possible that increased downstream processing can result in internal multiplier effects within the economy and also increased value added and employment gains can be created.

In terms of present local metal fabrication capacity the only notable producer is ZAMEFA. This factory, located in Luanshya, became operational in 1970 and falls under the INDECO group of companies who own 51 per cent of the company. The minority shareholders are:

- Phelps Dodge (USA) 15 %
- Svenska Metallverken (a subsidiary of Outokumpu of Finland) 5 %
- Amax Zambia Ltd (USA) 9.8 %
- Zamanglo Corporation (Anglo-American Corporation of South Africa) 9.8 %
- Continental Ore Resources (local) 9.4 %.

Both Phelps Dodge and Svenska Metallverken provide management and technical support services to the company on the extrusion and rod section, and the wire and cable section respectively.

The products manufactured by ZAMEFA fall into several categories:

- *Continuous cast rod* (CCR). This forms the bulk of their production 90 per cent of which is 8 mm diameter. Production of CCR commenced in 1983 and in 1985 7 kt of copper rod was produced mainly for exports while the budgeted production figure for 1986 was 9 kt.[6] Exports of CCR constitutes 98 per cent of their total exports and about 60 per cent of their turnover.[7] The export market is mainly in the Far East, notably India and to a lesser extent to Europe, Egypt, Malawi and Kenya.

Although they are the only significant wire-rod manufacturer in the region their exports to the region have been minimal partly due to the inability of the Bank of Zambia to offer competitive credit facilities and unsatisfactory product quality.[8, 9]

- The next range of products fall into the *wire and cable* category. ZAMEFA produces a wide range of wire and cable ranging from power cable of up to 3.3 kV to domestic or construction wire in stranded, insulated and uninsulated forms and finally to telephone cable. Total production of this category has been estimated[10] at about 1.8 kt in 1987. Other than for domestic and construction use the main consumers of this category are the PTC (approx 300 t of telecommunications cable) ZCCM and ZESCO (approx 600 t of power cable). Thus the bulk of the cable output is for domestic consumption although small quantities are exported mainly to Malawi.

ZAMEFA also has plans to commence production of magnet wire in 1987. Presently the plant is under construction. The plant will produce wire in the diameter range 0.2 mm—0.9 mm to supply local motor rewinding needs at the rate of 200 t/year. The plant will, however, have a design capacity of 600 t. Once full production is attained the surplus is expected to be exported.[11] Additionally ZAMEFA plans to commence local production of 11 kV cables for power transmission. As a result of this expansion/diversification of products ZAMEFA will probably have a wire and cable output of approximately 2.6 kt assuming 200 t of production of the 11 kV cable.

- The last category of fabricated products from ZAMEFA is the *extruded products* which consist of rods, bars sections etc. About a 100 t/year of extrusion products are made on a jobbing basis. Most of this production is done on behalf of ZCCM for their bus bars, anode lugs, bars for starting sheets etc. Apparently ZCCM supply their own billet and pay for the production costs. The extrusion press was originally installed for the production of wire rod and has an installed capacity of 6 kt. With the introduction of the Outokumpu Continuous Caster the press has largely become redundant although it is also used in the production of about 300 t/year of aluminium profiles. Surprisingly no tubes and pipes are extruded at present although these are imported into the country. The reason for this is not apparent.

Other than ZAMEFA, there is another copper fabrication plant in which the Zambian government has equity participation, this is *Société de Coules* —

Continue de Cuivre (SCCC), located in France, in which the government owns 50 per cent shares. The other 50 per cent is owned by Thomson Brandt SA of France. The plant produces CCR and in 1984/85 sold 164 140 t of copper rod from which ZCCM's share of retained profits was 1.2 million Kwacha (ZMK).[12] Interestingly total sales of copper to France by ZCCM during the same year formed only 48 per cent of the tonnage sold by SCCC. Perhaps the traditional argument[13] that the main benefit for Zambia is an assured outflow for copper and a source of foreign exchange is not valid?

Outside the above the two facilities other offerers of copper and copper alloy products are a small aggregation of foundries located both in Lusaka and on the Copperbelt. These foundries are small in size excluding Scaw Ltd in Kitwe which does 30 kt/year of castings but is predominantly a ferrous foundry. There are primarily two non-ferrous foundries on the copperbelt; Foundry and Engineering Ltd in Luanshya, and Non-Ferrous Metal Works in Ndola. Although both produce primarily copper alloy castings the former produces primarily phosphor bronze, manganese and aluminium bronzes. The latter produces some tin bronze and brass. The foundries operate more or less on a jobbing basis which makes estimation of their production rate difficult. It is thought that this production would, however, be unlikely to exceed 300 t/year of total castings.[14]

At the time they were visited in October 1985 Non-Ferrous Metal works had just completed constructing a new foundry which they claimed would have an installed capacity of 1 kt.[15] If they have commenced production, this would make them a significant producer of non-ferrous castings. Further plans are also underfoot to set up a small rolling mill, for manufacture of plate, sheet and strip, with the assistance of FMO of the Netherlands.[16] The capacity of this new plant is, however, unknown.

Outside the traditional copper fabricators outlined above there has been further initiatives from non-traditional copper processing companies within the year 1986. The first one is that of Zambia Aluminium Ltd whose production has in the past concentrated on aluminium corrugated sheets and kitchen utensils. They have just finished installing a horizontal continuous castor to diversify into the production of brass semis manufacture. Their product range will include rods, hollow products, strips, and profile. They plan to commence production in March, 1987 initially with an output of 1 kt/year of continuously cast products. They plan to increase their production to a maximum of 3 kt/year by 1989. All their production is intended for exports, primarily to the UK.

The other initiatives are by *Industrial Development Company* (INDECO) who are currently evaluating a feasibility for the production of brass gate valves.[17] The feasibility was done by HMT International (India) who concluded that it was feasible to produce about 200 000 units per year. It has not been possible, however, to obtain further details on the project due to the fact that INDECO has not made a decision yet although it was reliably learnt that the company plans to integrate the project into their proposed spare parts manufacturing facilities.

INDECO have also looked at the possibility of manufacturing electric motors and transformers to provide downstream processing and backward linkages into the manufacturing and agricultural sectors. It is reported that institutions and companies such as Swedfund (Sweden), Bevi International (Sweden) and HMT International are evaluating their interests with a view of setting up a joint venture.[18] It has not been possible, however, to get details of this project.

The last INDECO initiative is the manufacture of copper and copper alloy plate and strip. The feasibility study was done in 1980 by Metra Consulting (UK) and sponsored by UNIDO[19]. The project was envisaged as a joint venture between Zambia and Nigeria and was to be located in Nigeria with the supply of primary metals from Zambia. The market study revealed that net consumption of Zambian copper metal was expected to be 23 kt in 1986 and 45 kt in 1990 in the form of copper cathodes. Based primarily on the Nigerian domestic demand of various copper and copper alloy fabricated products the project was found to be financially viable. The estimated total project cost was 49.140 M ZMK but with escalation in costs the 1985/86 estimate was about 100 M ZMK. As at 1985/86 no firm commitment had been made by INDECO. According to INDECO the study needs to be reevaluated to determine project costs and markets.[20]

With regard to the local consumption of the other primary metals produced in Zambia, Kabwe Division of ZCCM produces *lead sheet and piping* for domestic consumption. The lead sheet is sold mainly to ZCCM refineries and Kafironda who use it as an acid resistant material. Smaller quantities are sold to Chloride Zambia Ltd and Simms Electrical and Diesel Services Ltd who both use it for manufacture of automotive batteries. Sheet sales in 1985 amounted to 1.2 kt. The total local consumption of sheet and pipe in 1984/85 was estimated at 25 per cent of total sales of lead metal of 10.40 kt.[21]

During the same year local sales of *zinc* accounted for 3.3 per cent of total zinc sales of 30.3 kt. The main consumers are Galco (Zambia) Ltd and Pipeco both of the Chandaria group of companies and Monarch (INDECO) all of who use it for galvanizing. Other consumers are Mansa Batteries (INDECO) for battery manufacture and Metoxide (Chandaria) for zinc oxide manufacture for paints and tyres. In 1985, domestic sales were projected at 1 124 t for 1986.[22]

With regard to *cobalt,* local consumption is virtually non-existent. Unified Chemicals of Lusaka manufacture a range of metal salts for export and local consumption. They manufacture small quantities of cobalt nitrate. Consumption, however, cannot at best exceed 10 t/year.

Turning back to copper metal an approximate summary of the production and consumption figures is given in Table 1.

It is considered that the figures given in Table 1 for consumption should be treated as approximate and are intended to indicate general levels of consumption. Nevertheless some observations can be made from comparisons of Tables 1, 2 and 3. These are that:

- The installed capacity of CCR of 9 kt per annum is more than adequate to fulfill the wire and cable requirements of about 2 430 t per annum. Even taking into account the planned diversification by ZAMEFA into magnet wire (600 t) and 11 kV cable (200 t), the required CCR feed stock for wire and cable manufacture will amount to only 3.3 kt per annum. The country's wire and cable requirements would therefore appear to be well met by current CCR production for the forseeable future.
- The installed capacity for rods, bars and sections at ZAMEFA of 6 kt is far in excess of domestic consumption of 150 t/year. In addition the planned capacity of 3 kt/year by Zambia Aluminium will effectively increase the installed capacity for rods, bars and sections to a maximum of 9 kt/annum. Even considering that the extrusion press at ZAMEFA is also used for production of aluminium profiles. It is valid to conclude that the available capacity can well meet the demand for extruded products in copper (alloy) semis. The main problem would appear to be that rods, bars and sections are mostly fabricated in copper alloys (about 90 per cent) which are at present not manufactured in Zambia. Consideration could therefore be given to install-

Table 1

Approximate production and consumption of copper and copper alloy semis in Zambia (in t)

Product	Volume produced	Imports	Exports	Consumption
Rods, bars and sections	100	50	0	150
Strip, sheet and plate	0	174	0	174
Cables	1 800	610	20	2 430
Tubes and pipes	0	40	0	40
Castings	300	0	0	300
Total	**2 200**	**874**	**20**	**3 094**

Source:
Chitambo A et al, Market Study for Semi-Finished and Finished Copper and Copper-Alloy Products in Zambia, field notes on a visit to Zambia, October 1986.

Table 2

Approximate installed production capacities of copper and copper alloy products in t/year

Company	Rod	RBS	SSP	Cables	Tubes and pipes	Castings
ZAMEFA	9 000	6 000	—	1 800	(a)	—
Castings (b)	—	—	—	—	—	400
Total	**9 000**	**6 000**	—	**1 800**	—	**400**

Notes:
(a) Tube can be produced by extrusion in which case this is covered in the 6 kt per year under RBS.
(b) Figure includes four small non-ferrous foundries on the copperbelt.

Source:
Lombe W C and Mipawa S, Mining Equipment Manufacturing, Reparing and Reconditioning Facilities in Zambia, field notes, October 1985.

Table 3

Planned production capacities of copper and copper alloy products in t/year

Company	RBS	SSP	Cables	Tubes and pipes	Magnet Wire	Castings
ZAMEFA	—	—	2 300	—	600	
Zambia Aluminium	2 000	—	—	—	—	
Non-Ferrous Metals	—	—	—	—	—	1 000
Total	**2 000**	—	**2 300**	—	**600**	**1 000**

Note:
2 kt of RBS for Zambia Aluminium include other shapes such as strip and profiles.

Source:
Lombe W C, The Manufacture of Copper Alloy Ingots in Zambia, field notes of on-going project; *Concast Technology News,* Vol 25 No 3, 1986; Jourdan P, *The Non-Ferrous Metals Industry of Zambia,* UNIDO, Vienna; Chitambo A et al, Market Study for Semi-finished and Finished Copper and Copper Alloy Products in Zambia, field notes October 1986.

ing a small induction furnace at ZAMEFA to produce copper alloy ingots for the extrusion press in order to fully utilize the capacity.

• There is currently no production facility for sheet, strip and plate. Zambia Aluminium are capable of producing strip. Given the consumption rate of less than 200 t/year, it is likely that the planned small rolling mill by Non-Ferrous Metals will meet the current demand significantly.

• There is currently no production of tube in Zambia. Zambia Aluminium are capable of producing copper alloy holloware which could be drawn into tube. In combination with the extrusion press at ZAMEFA a range of copper and copper alloy tube could probably be locally manufactured.

• The planned capacity for foundry copper alloy castings of 1 kt at Non-Ferrous Metals together with the aggregate output of the other small foundries will result in a total capacity of at least 1.4 kt. This is probably adequate to meet the countries requirements in castings.

In sum, it is likely that the installed and planned capacities in copper (alloy) semis could be capable of significantly meeting the country's requirements. However, a coordinated approach to create awareness, in product capability and installed capacities would help avoid duplication of facilities.

Vertical linkages, limitations of the domestic copper (alloy) semis market and the potential for exports

Returning to Fig 1, it is seen that at various mining and metal extraction stages a number of saleable products are produced. These are ores, concentrates, blister copper, cathodes and wire bars. In the copper industry little trade takes place in the sell of ores due to the low concentration of values. The ores are considered as low unit value material for which the low financial returns cannot usually be justified relative to the large capital inputs of 5 000—6 000 USD per tonne characteristic of the mining stage.

Most of world trade in the copper sector takes place in the form of concentrates, blister copper from the smelter and electrolytic copper from the refinery.

Table 4 gives production figures in the copper sector for 1983 for the above process streams in the developing countries (LDC) and developed market economies (DME) and the per cent share in the output of the market economies (ME).

Table 4

Mine, smelter and refinery copper production in the market economies in 1983 and the per cent share of production
(in kt)

	Production type					
	Mine		Smelter		Refinery	
Country	Vol	%	Vol	%	Vol	%
DME	2 513.0	40.2	3 091.0	51.6	5 013.6	68.5
LDC	3 732.5	59.8	2 895.9	48.4	2 308.7	31.5
Total	**6 245.5**	**100**	**5 986.9**	**100**	**7 322.3**	**100**

Source:
Vingerhoets J, Fabrication of Copper and Copper Semis in Developing Countries: Review of Evidence and Opportunitites, Tilbury University, Netherlands, January 1986.

Table 4 shows that the bulk of mine production (about 60 per cent) is concentrated in the developing countries. Smelter production is divided more or less evenly between the developing and the developed economies while the bulk of refined copper production is concentrated in the developed market economies. Thus the production of refined copper in the DME's is about twice the mine production while in developing countries refined metal production is only 62 per cent of mine production.

In the specific case of Zambia the saleable products in the copper stream are refinery products ie electrolytic cathodes (about 80 per cent) and wire bars (20 per cent). Thus all the copper produced (and also the other metals) is processed to the pure form. The conclusion is easily reached, therefore, that the degree of vertical integration between mining, smelting and refining is very high, relative to other copper producers. In the Zambian case a number of factors have worked favourably in this regard.

• *Intensity of the industry;* the large scale nature of the operation has justified the establishment of large smelter and refinery capacities. Both these operations are highly capital and energy intensive. Available figures indicate that investment costs are of the order of 1 500—2 000 USD and 400—600 USD for smelting and refining respectively.[23] Furthermore a smelter must have a minimum annual capacity of 40 kt and refinery of 60 kt. With a production in excess of 500 kt/year of copper, the advantages of large economies of scale have been fully exploited.

• *Transportation costs;* given the intensity of the industry and the geographical position of Zambia, it would not have been viable to export ores and concentrates due to high transportation costs. Through smelting, and to a much lesser degree refining, substantial weight reductions are achieved while the value added is increased. In relation to concentrates the weight reduction in smelting is 3—4 times while the value added has been estimated at 250 USD and 200 USD per tonne for smelting and refining respectively.[24]

- *Other attractive benefits;* these include low wage rates and availability of cheap energy sources, particularly in refining which is more labour intensive and where electric energy demand is high.

Turning to the primary and secondary fabricating sectors (Fig 1) the level of vertical linkages between these two sectors and the mining stage is apparently low. In 1985 98 per cent of copper production was exported as primary metal and only 2 per cent was processed into primary semi manufactures and finished products for both local consumption and exports. However, in assessing the current and potential levels of these linkages it is necessary to assess the limiting factors of an import substitution policy in the copper fabrication sector for a small economy as present in Zambia.

At the primary fabrication stage there are four major product categories fabricated in either pure copper or in copper alloys:

— wire rod
— plates, sheets and strip i e rolled products
— rods, bars and sections i e extruded products
— tubes; either extruded or piece.

The main copper alloy is brass (copper and zinc).

Table 5 shows the geographical distribution of the manufacture of the above copper (alloy) semis as estimated from refined consumption and the use of direct scrap inputs.[25]

The main observation of Table 5 is the rapid increase in the production of copper semis in developing countries which went up by more than eight times between 1950 and 1980, while that in the developed economies peaked around 1980 and declined slightly in 1982. Although the rapid increase of such production in the developing economies is noteworthy it is equally important to note the low overall proportion of production in the LDC countries. Furthermore it is also important to assess the distribution of production within the developing countries. This has been done in Table 6.

The reality of Table 6 is that Africa did not participate in the noted increased production of copper semis of the developing countries during the above period. Production in Africa remained at a very low level during the decade 1970 to 1980 of at most 30 kt. During the same decade production of the semis experienced a fivefold increase in Asia and about doubled in Latin America. Hence it is seen from these figures that the growth of production of copper semis in developing countries has been predominantly confined to Latin America (mainly Brazil and Mexico) and Asia (South Korea and Taiwan). In the latter two countries fabrication of the copper semis has infact been based completely on imported raw materials.

It is therefore unavoidable to conclude that the evolvement of a copper fabrication sector is closely associated with import substitution rather than mere availability of the primary metals. Increased production of copper (alloy) semis occured principally in those countries that realised a rapid rate of industrialization in the last one and half decades. In the traditional copper exporting developing countries ie Zambia, Chile, Zaire and Peru there has been no such significant increase in the produc-

Table 5

Production of copper (alloy) semis estimated by the use of scrap and refined consumption in the market economies (in kt)

	DME		LDC		ME	
Period	**vol**	**%**	**Vol**	**%**	**Vol**	**%**
1949/51	3 557	97	114	3	3 671	100
1959/61	5 161	97	182	3	5 343	100
1969/71	5 565	95	382	5	7 947	100
1979/81	8 796	90	1 003	10	9 799	100
1982	8 032	88	1 061	12	9 093	100

Table 6

Production of copper semis in developing countries as indicated by refined consumption and use of direct scrap (in kt) and % shares of production

	1969/71		1979/81		1983	
	Vol	**%**	**Vol**	**%**	**Vol**	**%**
Africa	18	5	29	3	25	3
Asia	84	22	413	41	582	57
Latin America	279	73	561	56	408	40
Total	**382**	**100**	**1 003**	**100**	**1 015**	**100**

Source:
Statistical Annex and World Metal Statistics.

tion of copper (alloy) semis as one would expect. These four countries account for just over 8 per cent of total LDC production of copper semis.[26]

This observation needs further development. Table 7 gives an indication of the diversity of product components characteristically fabricated from copper and copper alloy semis. The subdivision of the products is necessary to understand why import substitution formed a viable strategy in the so called newly industrializing countries that achieved remarkable growth in the production of copper semis, notably Mexico, Taiwan, South Korea and Brazil. The composition of their industrial growth was such that it created demand for copper products by rapid advances in the electrical and electronic goods industry, the transportation sector, mainly motor vehicles manufacture and the other sectors (construction, general engineering and consumer products).[27]

These thoughts raise serious doubts as to whether the level of industrialization in Zambia is capable of supporting a significant copper fabrication sector in line with an import substitution based policy only. Figures for domestic consumption were given in Table 1. The accuracy of the market demand is not clearly known. It is possible that these figures underestimate local consumption of copper products as it is unlikely that they include proportions of copper and copper alloy products imported into the country as part of assembled industrial equipment or under classified uses such as for ordnance.

Table 7

End-user sectors for copper (alloy) semis and examples of end-user products

End use sector and semis input	Approx % copper use	Examples of product range
Electrical/electronic (Wire/wire rod mostly smaller quantities of copper/ copper alloy strip)	53	Electrical and telecommunication cable; magnet wire for transformers, electric motors, vehicle components, switch gear etc.
Building/Construction (Copper tube, copper alloy rod and strip)	20	Valves, tubing, copper and brass fittings, hinges, brass locks and screws etc.
Industrial machinery and general engineering (Copper alloy rod, strip/ sheet, tube castings)	13	Pumps, valves, screws/fasteners brass holloware process plants, coinage, machine tools and welding equipment
Transportation (Strip/sheet, tube)	8	Radiators, carburators, bearings gear boxes, instruments, pumps wiring harness, railways and marine parts, etc.
Consumer and general products (Strip/sheet, tube, wire)	6	Air conditioning, refrigerators, cookers, TVs, washing machines, zippers, toys etc.

Source:
Based on US End-use statistics, Copper 1983, Bureau of Mines, Washington, 1983.

However, a counter check on the figures can quickly be established by assessment of other independently collected market statistics for Zambia. In 1978 Kienbaum Beratungen carried out a feasibility study for the production of semi-fabricated and cast brass in Zambia.[28] Their estimates of the market volume for copper and copper alloy products is given in Table 8.

In 1980, Metra Consulting (London) on behalf of UNIDO carried out a comprehensive field study of the demand for copper and copper fabricated products in Zambia.[29] Their data on the market volume and extrapolation of demand to the year 1990 is shown in Table 9.

Comparison of Tables 7, 8 and 9 indicates some inconsistencies in the estimated demand for copper and copper alloy fabricated products over the years 1975, 1981 and 1986. This, however, can be expected given the turbulent history and the crippling shortages of available foreign exchange following the collapse of copper prices particularly after 1975. Thus the decline of the estimated total copper consumption noticeable in Tables 7, 8 and 9 for the years 1975 (3 843 t),1981 (3 317 t) and 1986 (3 094 t) could partially be attributed to the declining foreign exchange availability during this period. It has been estimated that by the year 1984 the foreign exchange earnings in real terms had shrunk to about 35 per cent of the 1970 earnings.

The significant part of the data is the order of magnitude of the figures presented. The similarity in magnitudes of the figures reinforce a sobering realization: the local market for copper products is small and cannot support a significant diversion of the current output from the mining industry. What would be the prospects for growth of this consumption?

The simplest determinant is the fact that Zambia's population of around 6 million people, of whom only about 45 per cent are in the urban areas and about 300 000 in formal employment can hardly be considered as a significant market for the viable production of the wide variety of production listed in Table 7.

In the wire and cable industry significant localization of the country's requirements has been achieved. However, with the current electric energy surplus and rural electrification still a mere dream, one cannot forsee any exceptional demand in this area in the near future. The current economic problems have further reduced construction and industrial activity to low growth levels. Few major industrial projects are planned and construction of dwellings is at low levels.

With regard to domestic appliances, only water heaters have traditionally been locally manufactured by Monarch Zambia Ltd using up to 70 t/year of copper sheet. ITT Supersonic (Zambia) Ltd manufactures TV sets, radios and cassette recorders using imported components. Even if their requirements of strapping wire, mains cord, twin flex etc were to be localized they would hardly exceed 8 t per annum.[31] As for fridges, cookers and washing machines, it is unlikely, given the small population that such an appliance industry could be viable. In as far as wiring harnesses for cars is concerned even if 6 000 vehicles per year were produced, this would consume only about 10 t of copper.[32] Zamefa would hardly justify going into such a specialized operation on the basis of such consumption rates.

In the electrical engineering sector low voltage electrical switchgear has traditionally been manufactured by Allenwest (Zambia) Ltd, Cutler Hammer (Zambia) Ltd and Fairway Engineering. Their consumption of copper in 1980 was estimated at 50 t.[33] The only notable copper consumer in this sector was South Wales Electric (Zambia) Ltd who used about 1 kt of imported copper strip in the manufacture of electrical transformers. Sadly, they wound up in 1986 due to the erratic availability of foreign exchange.[34]

Table 8

Consumption of copper and copper alloy products in Zambia in 1975 (t metal content)

Product	Production	Imports	Exports	Consumption
Cables	1 200	1 120	100	2 220
Wire bar	400	64	50	414
Wire rod, bars sections	800	13	100	713
Telecable	150	—	—	150
Copper SSP	—	183	—	183
Copper tubes and fittings	—	68	—	68
Castings and others	20	75	—	95
Total	**2 570**	**1 523**	**250**	**3 843**

Source:
UNIDO project No SI/ZAM/75/808, Market Study for the Zambian—Egyptian Fabrication Project, March 1978.

Table 9

Estimated Zambian demand for copper and copper alloy fabricated products (t/year)

Product	1981	1985	1990
Insulated power cable and wire	1 200	1 250	1 600
Automobile harnesses	3	7	10
Telephone cable	450	450	450
Winding wire	100	100	120
Bare wire	400	420	540
Total cable and wire	**2 153**	**2 227**	**2 720**
Copper and brass tubing	20	46	78
Copper sheet and strip	224	397	573
Insulated copper strip for transformers and motors	1 023	1 500	2 000
Brass strip	20	83	83
Copper bus bar	50	200	1 000
Bronze and brass	69	102	138
Total market	**3 317**	**4 112**	**5 941**

Source:
UNIDO Project No DP/RAF/79/006. "Feasibility Study in Nigeria and Zambia on the Establishment of a Copper Fabricating Plant in Nigeria", vol 2: Export Market Studies.

In the automotive sector, Zambia has a radiator manufacturer (Automotive Radiator Ltd) using up about 40 t of copper and brass strip. However, none of the locally assembled vehicles are fitted with local radiators to stimulate consumption of strip. Current consumption, estimated at 40 tonnes, is low.

Overall, it is true to conlude that not only is the Zambian consumption of copper products small but is also disaggregated. Under such an atomistic consumption pattern, there is always the spectre of diseconomies of scale militating against the establishment of fabrication facilities.

In the Zambian situation a significant conclusion is therefore that given in the last section: that the current installed and planned capacity for a number of copper and copper alloy semis products appears easily capable of fulfilling domestic requirements in the near future. This is particularly so in wire and cable, extruded stock (rods, bars and sections), continuously cast strip, bars and sections, winding wire and the various nonferrous castings. The shortfall is in the manufacture of rolled products ie sheet, strip and plate, and also tubes for which facilities are virtually non-existent. A small scale rolling mill and perhaps a tube piecing facility could be considered to complement the available production facilities.

The above considerations paint a realistic picture more than they give a negative impression; the potential of an import substitution strategy in the Zambian context, would at the very least, have to combine with competitive manufacture of copper semis for exports. In this sense the present scales of economy are inadequate. The arising corollary question is whether an export-oriented copper (alloy) fabrication strategy by way of a resource based industrialization policy would be successful in Zambia. There is little doubt that a positive answer to this question is desireable because of the potential benefits inherent in the exports of copper semis. Some of these benefits include:

- The generation of income from the fabrication sector in the form of profits and government revenue. Furthermore the employment created will translate into increased purchasing power and hence a broadening of the tax base.
- Forward linkages due to the availability of (cheap?) local copper semi manufactures will be encouraged. This will contribute to a broad industrial development policy and increased self reliance in a number of sectors.
- The higher value added in copper semis will not only increase but diversify the foreign exchange earning capacity. The price of copper sheet (1 200 × 600 × 1 mm) in December 1986 was 1 939 GBP/t compared to the LME price 934 GBP/t representing a value added of the order of 100 per cent.[35] It is also commonly accepted that the price fluctuations in the copper semis are far less than in the case of primary metals. Stable and renumerative proceeds from the sector would facilitate efficient planning of the allocation of fiscal resources for development.
- Investments in mining, smelting and refining represent considerable sums. Investments in semi-manufacturing facilities are lower and are of the order of 800—1 000 USD/t for a tube mill and 1 000—1 500 USD/t per annual capacity for a rolling mill.[36] Given the higher value added for copper (alloy) semis, investment per unit value added is much less in the manufacture of copper (alloy) semis.
- Skills and industrial experience will be acquired. Due to a long tradition of mining these skills are probably inherently available domestically but would need some restructuring. Whereas the desirability of an export-oriented copper semis is unquestionable, the feasibility of such a strategy is not so clearcut. What is the available scope for exports of copper semis for Zambia? Table 10 gives a general impression of trade in copper semis in the developed market economies.

The most striking feature of Table 10 is the dominance of Europe as the biggest trading block in copper (alloy) semis. 80 per cent of all trade in the copper (alloy) semis in the developed market economies takes place in Europe. The other notable feature of Table 10 is that Japan is one of the largest exporting countries of copper (alloy) semis but its total imports are very limited. On the other hand North America imports more copper semis than it exports. This has been attributed to the low import tariffs on copper semis in the United States of America.[37]

Table 10

Total imports and exports of copper semis in DMEs and the % shares (in kt)

	Exports		Imports	
	Vol	**%**	**Vol**	**%**
Western Europe	1 285.3	79	997.0	79
North America	115.5	7	228.2	19
Japan	191.1	12	2.5	—
Other DME	37.1	2	26.2	2
Total	**1 629.0**	**100**	**1 233.9**	**100**

Source:
IWCC, World Trade in Copper and Copper Alloy Semi-manufactures, 1981.

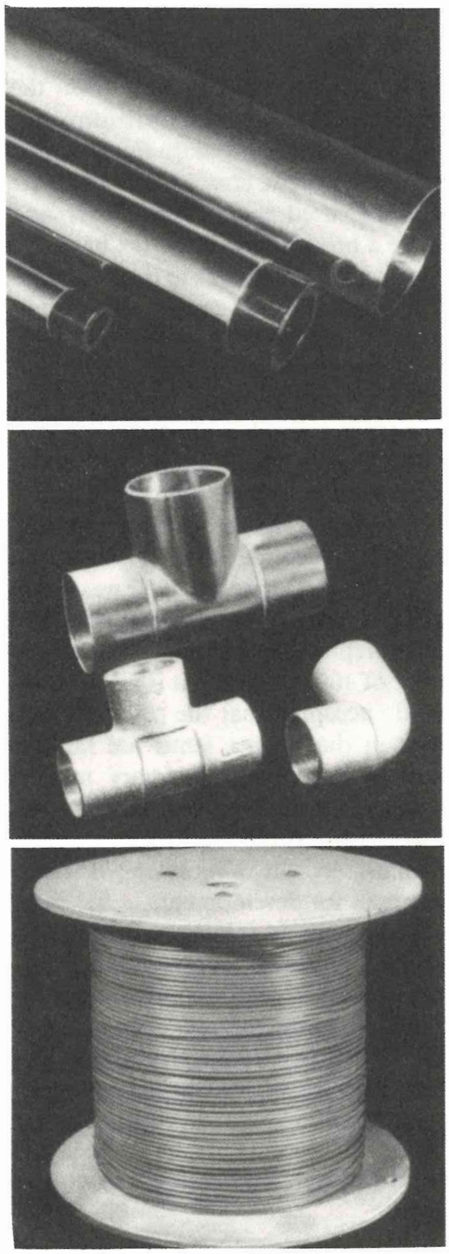
In assessing the possibility of exports for a Zambian copper semis fabricator, it is important to examine a little more closely the structural aspects of world trade in the copper semis. Returning to the European market, Table 11 shows the source of imports of copper semis into Western Europe in 1979 from non-European sources. Although the data relates to a slightly different period to that in Table 10, the conclusion is nevertheless valid. Total imports of copper semis into Western Europe from outside are negligible compared to imports from within Europe. In 1979 nearly 70 per cent of these imports originated from the USA and were generally specialized alloys unlikely to be manufactured by a developing country such as Zambia.[38]

With regard to exports, although Western European countries exported nearly 1.3 Mt of copper semis in 1981, about 75 per cent of these went to other countries within Western Europe. Furthermore, within the EEC, 86 per cent of all imports in 1981 originated from countries within the customs union.[39] From these figures it appears justifiable to assume that although Western Europe forms the biggest trading block in copper semis, most of this trade is intra-region oriented.

Intra-region trade in copper semis is, however, not only confined to Europe. In the Far East a similar trend is observed where Japan and to a lesser extent Australia and Europe are the main exporters of copper semis. In 1981 Japanese exports at 134.1 kt accounted for 50 per cent of Asian imports, notably to Hong Kong, Taiwan and Singapore. The situation is similar in Latin America where in 1981 60 per cent of imports came from North America and only 30 per cent from Western Europe.

Thus it can be concluded that there is a reasonably high tendency towards intra-regional trade in copper semis manufactures. Transport costs which are higher for copper semis than for cathodes and to a lesser extent tariffs

Intra-region trade in copper semis dominate in the DMEs and makes market penetration for LDCs like Zambia very difficult. Photo shows US fabricated semis exported to Europe.



which for example limit imports into the EEC to a particular ceiling are probably the main factors responsible for this.[40] Thus a Zambian fabricator producing for the European market faces a higher transportation charge than his European competitor producing for the European market.

Other than transportation costs, tariffs and the intensity of copper semis production in developed market economies, there is an additional feature characteristic of the copper semis industry. This is the degree of vertical linkages between primary metal producers and fabricators in developed economies. In the brass mill sector of the USA four of the six largest fabricators are integrated with mining and refining companies.[41] In Japan, the main producers of brass mill products are Sumitomo. Furukawa, Mitsubishi and Kobe Steel. The first three companies are integrated with refining.

In Europe the three largest German producers are Diehl, Gutehoffnungshütte and Metallgesellschaft with the latter two being integrated with refining. In France Pechiney Ugine Kuhlman is the only major integrated fabricator. In the UK two large producers of brass mill products; *Imperial Metal Industries* (IMI) and *British Insulated Calender Cables* (BICC) are integrated with refining.

In the case of the wire and cable industry concentration and integration with refining are at even higher levels than in the brass mill sector.[42] This is encouraged by the fact that the advent of CCR has changed the structure of the wire and cable sector significantly. Compared to mining, smelting and refining, the investment costs, estimated at 70—100 USD/t of annual capacity are very low and large plants producing in excess of 100 kt per year are not uncommon.[43] As a consequence, in 1979, custom refiners and primary producers together accounted for nearly 50 per cent of CCR capacity. Thus arguably CCR is another refinery shape in Europe rather than a semimanufactured product.

The regional concentration and vertical integration of the copper semis sector has significant consequences for relocation of the productive capacity to developing countries including Zambia. The main consequence is the difficulty of penetrating markets within existing intra-regional trade which are characteristically dominated by a limited number of companies producing close to highly competitive consumption centres. Ironically most of the integrated producers in Europe and Japan are also, directly or indirectly through associate companies, bulk buyers of Zambian copper. These include BICC, IMI, Pirelli International SA, Sumitomo Metal Mining, Furukawa Electric, Delta Metal, Hitachi, Mitsubishi Metal Mining, Diehl Metal Works, Metallgesellschaft AG and Gutehoffnungshütte AG.[44] Perhaps this is an example to typical TNC behaviour of spreading risk by wider raw material sourcing?

If a Zambian copper semis producer wants to break into the European region market, he would have to be an extremely cost-efficient producer. Even if he was he would have to be acceptable as a reliable supplier both in terms of quality specifications and the quality of doing business. Although this does not seem difficult it must be remembered that copper semis are mostly traded on a job-order basis and are characterized by a multiplicity of technical specifications determined mainly by DMEs. One example is drawn tube for which there are as many as 20 specifications.[45] This has led to the description of the copper semis trade as a buyers market and the buyers are in Europe.[46]

If a Zambian copper semis producer wanted to produce for export to Europe it would appear beneficial to join forces with a Western multinational, probably a non-integrated fabricator. A multinational partner would offer advantages of wider sourcing particularly with regard to technological back up and an intimate relation and understanding with the overseas market and the end-use fabricators. Even then due to a large installed copper semis capacity in developed economies, particularly in Europe, a wider target market than Europe such as that including African regional markets should be aimed at. In this respect, it is useful to briefly assess the potential of African markets for a Zambian copper semis manufacturer.

Table 12 shows imports of copper semis by developing countries and the origin of the imports.

Table 12 shows that the total quantities of copper semis imported by African countries is generally very small. In 1981, African countries imported about 61 kt of copper semis. Furthermore 90 per cent of these imports originated from Western Europe. In a scramble for regional markets of copper semis manufactures in Africa, the main competitors for such markets are therefore likely to come from Western Europe.

Table 13 gives a breakdown of the imports of copper semis by African countries up to the year 1979. From a regional point of view it is clear that the most important copper consuming countries in Africa are the North African countries namely Algeria, Egypt, Libya, Morocco and Tunisia. In 1979 these five countries accounted for 60 per cent of all African imports. For all practical purposes these countries can be considered as part of the European trading block. A Zambian copper semis exporter to these countries is likely to encounter similar difficulties as those outlined above for Europe ie the markets are in close proximity to large pro-

Table 11

European imports of copper semis from non-European countries in 1979

Country	t	%
USA	23 818	69.7
Japan	6 736	19.8
Canada	2 646	7.7
Australasia	448	1.3
South Africa	376	1.1
India	78	0.2
New Zealand	59	0.2

Source:
Commonwealth Secretariat, CFTC/IDU, Mining Equipment Manufacturing and Reconditioning Facilities, Preliminary Study prepared for SADCC by the Commonwealth Secretariat, January 1986.

Table 12

Imports of copper semis by developing countries and origin of the imports
(kt)

	Latin America		Asia		Africa	
Origin	**Vol**	**%**	**Vol**	**%**	**Vol**	**%**
Western Europe	17.0	30	86.9	33	55.1	90
North America	34.2	60	12.6	5	1.9	3
Japan	5.4	9	134.1	50	3.9	6
Australia, South Korea and Taiwan	0.4	1	33.3	12	0.5	1
Total	**57.0**	**100**	**265.9**	**100**	**61.4**	**100**
Share in imports of LDC countries	**15 %**		**69 %**		**16 %**	

Source:
IWCC, World Trade in Copper and Copper Alloy Semi-manufactures, 1981.

duction centres with low distribution costs compared to the Zambian producer.

The West African market is the next market of importance with notably Nigeria and Ivory Cost being the main consumers of copper semis. Between Nigeria, Ivory Coast, Ghana, Cameroon and Senegal the region accounted for 21 per cent of total African imports for copper semis in 1979. In the absence of figures on transportation costs to this region it can only be assumed that a Zambian producer would not suffer the same cost disadvantages as exporting to Europe.

Furthermore, a Zambian producer buys the metals on the basis of the LME prices less the average cost of freight to Europe. This saving has been estimated at 104 USD/t of metal.[47] The European fabricator on the other hand is assumed to pay the full LME price. Assuming that the cost of transporting the semi manufactures to the region is of the same order of magnitute from Zambia as from Europe it appears reasonable to suggest a marginal production cost benefit for the Zambian fabricator in lieu of the transportation discount. The situation, however, needs further study to make meaningful conclusions.

The East, Central and Southern African States can be considered to be one block. They in actual fact form the core countries in the region groupings of the *Preferential Trade Area* (PTA) and *Southern African Development Coordination Conference* (SADCC). Recent consumption figures for a number of countries within SADCC and PTA are given in Table 14.

The data presented in Table 14 may not be complete and have been abstracted from an ongoing study programme. In particular it is not known with certainty what installed facilities exist in these countries for the manufacture of copper semis, particularly for Angola and Mozambique. However, a comparison of the import figures presented in Table 13 collaborate, in orders

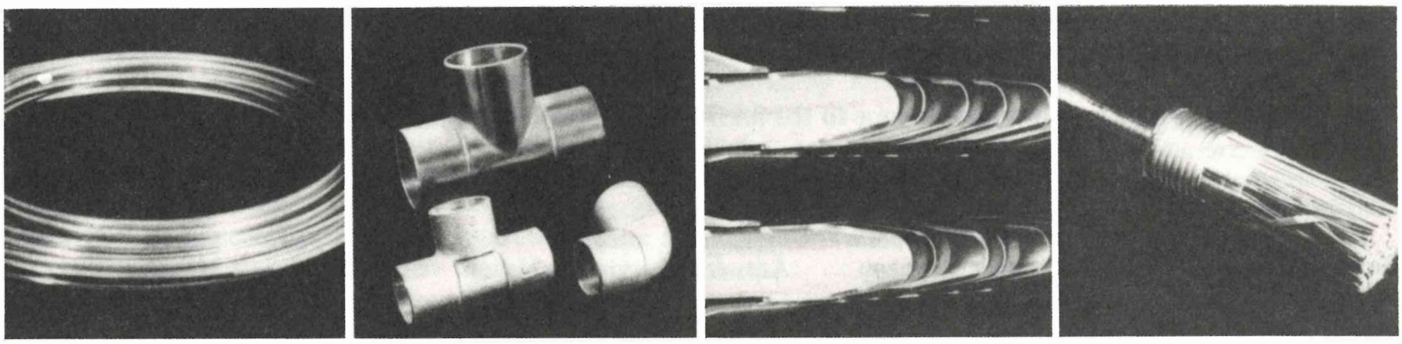
Table 13

Imports of all copper and copper alloy semi-manufactures by African countries
(in t)

Country	1977	1978	1979
Algeria	7 905	9 650	6 766
Angola	162	232	554
Benin Peoples Rep	63	14	11
Burundi	19	8	—
Central African Rep	13	2	5
Chad	5	11	2
Congo Rep (B)	22	28	38
Djibouti	—	3	3
Egypt	5 734	6 008	4 715
Equatorial Guinea	—	11	5
Ethiopia & Eritrea	182	204	46
Fr E Africa	110	116	95
Gabon	142	62	60
Gambia	26	5	1
Ghana	1 318	1 218	607
Guinea Republic	14	20	15
Ivory Coast	1 092	1 649	1 536
Kenya	474	1 212	860
Liberia	61	101	72
Libyan Arab Rep	4 724	6 692	3 714
Malagasy Rep	47	56	63
Malawi	26	18	18
Mali	52	17	42
Mauritania	15	3	35
Maurtius & Seychelles	68	68	44
Mayotte	—	2	—
Morocco	7 514	7 227	6 528
Mozambique	91	293	85
Namibia	20	—	—
Niger	20	36	73
Nigeria	3 640	6 537	6 035
Portuguese W Africa	5	—	—
Rhodesia	—	—	2
Ruanda	17	13	2
Rep of Cape Verdi	—	7	3
Sao Tome Principality	—	27	7
Senegal	183	184	197
Sierra Leone	2	16	1
Somalia	6	20	35
South African Rep	1 989	2 129	4 663
Spanish N & W Africa	91	194	150
S Helena & Deps	3	3	3
Sudan	366	177	145
Swaziland	—	—	93
Togo	20	52	41
Tunisia	3 589	3 221	3 012
Uganda	67	8	82
United Rep Cameroons	148	269	444
United Rep Tanzania	143	267	94
Upper Volta	11	10	10
Zaire	97	135	160
Zambia	174	27	86
Total	**40 470**	**48 352**	**41 258**

Source:
UNIDO Project No SI/ZAM/75/008, Market Study for the Joint Zambian—Egyptian Fabrication Project, March 1978.

"Even if the Zambian producer produced for the SADCC and PTA market exclusively the consumption would be unlikely to support a significant diversion of the Zambian primary metals."



of magnitude, with the consumption figures in Table 14 for the countries listed in Table 14. According to Table 14, the approximate total consumption of copper semis in this region is 2 334 t of which the potential for a Zambia fabricator is of the order of 1 434 t. From Table 13, the same countries imported about 1 600 t of copper semis in 1980. It can therefore be assumed that the orders of magnitude of the PTA/SADCC regional market are correct.

This would not therefore change the main conclusion arising out of Table 14 which is that the PTA/SADCC market for copper semis is small. This merely reflects the comparatively lower levels of industrialization of the sub-saharan region in relation to the North African countries. It can be concluded from the data that even if the Zambian fabricator produced for the SADCC and PTA market exclusively the consumption levels would be unlikely to support a significant diversion of the Zambian primary metals.

This conclusion is painful because in the SADCC and PTA regions, Zambia has considerable transportation cost advantages. These cost advantages have been estimated in a recent study and are given in Table 15. In the table the transportation cost advantage has been calculated as the sum of the average European transport cost to each country and the Zambian fabricator's discount of 104 USD, less the cheapest transort cost from Zambia to each destination.[48]

Table 14

Estimated consumption of copper semis in selected PTA/SADCC member states and the estimated market potential for a Zambian copper semis producer.
(in t)

	Wirebars section, etc			Tubes, pipes, etc			Plate, sheet, strips, foil		
	Consumption estimation	Local production	Maximum market potential for Zambia	Consumption estimation	Local potential for Zambia	Maximum market potential for Zambia	Consumption estimation	Local production	Maximum market potential for Zambia
Kenya	90	0	90	30	0	30	185	0	185
Zimbabwe	400	400	0	400	400	0	500	100	400
Zambia	150	100	150	40	0	40	174		174
Angola	25		25	30		30	40		40
Mozambique	10		10	5		5	10		10
Tanzania	70		70	40		40	75		75
Malawi	10		10	10		10	15		15
Bots, Les, Swazi	10		10	5		5	10		10
Total	**765**		**365**	**560**		**160**	**1 009**		**909**

Source:
Marinjsen J et al, Manufacture of Copper and Copper Alloy Semis in Zambia, Summary of field notes, December 1986.

Table 15

Transport costs from Luanshya and Europe to the SADCC/PTA region in USD/t

From / To	LUANSHYA Road	LUANSHYA Container	LUANSHYA Open wagon	EUROPE (container) Hamburg R'dam Antwerp	Scandinavia	Lisbon	Spain	Felixstowe	Europe average	Advantage Zambia incl disc.
Luanshya	0	0	0	200	216	230	208	208	209	313
Dar es Salaam	108	80	86	120	136	150	128	128	129	153
Mombassa		154	160	120	136	150	128	128	129	79
Nairobi	227	174	180	140	156	170	148	148	149	79
Bulawayo		55	73	149		179	157	157	157	206
Harare	74	60	86	154		184	162	162	162	206
Durban		84	135	120		150	128	128	128	148
Beira		83		120		150	128	128	128	149
Maputo		82		120		150	128	128	128	150
Lilonge	94									
Blantyre	118									
Francistown	89									

Source:
Van Manen B and Meijen F, Manufacture of Copper and Copper Alloy Semis in Zambia: Transport, field notes, August 1986.

It is clear that Zambia could enjoy substantial transportation cost advantages particularly to Tanzania, Zimbabwe and Mozambique over a European competitor. Such a benefit could be critical in reducing the landed cost of copper semis in the regional market as it provides some leeway for production costs to be marginally higher in the case of a Zambian fabricator compared to a European competitor. The market potential of the region is, however, disappointingly small.

In summary, the emergent picture of the potential export benefits for a Zambian copper semis fabricator is that of mixed fortunes. The domestic and the immediate regional markets are undoubtedly the most attractive. These are, however, both rather small and cannot support large scale fabrication facilities. One therefore has to worry about diseconomies of scale. The term diseconomies of scale has, however, at times superficial undertones. The bottom line in scales of economy in the fabrication sector, as in many other sectors, is not definitive and certainly there is no study that unambiguously and categorically defines this bottom line. In this study its use must therefore be accepted as a vague generality whose basis of validity requires further data. Within this generality it can be said that an export-oriented fabrication sector would avoid diseconomies of scale. The markets abroad are, however, more competitive. What chances does a Zambian fabricator have in these markets abroad?

Unfortunately this question cannot be answered without a proper feasibility study and this is not meant to be such a study. Clearly, however, the critical piece in the jig-saw puzzle is the production costs of the copper semis for a Zambian fabricator. The technology of fabrication is reasonably standard and is freely available. The more critical factors in the production costs are the cost of labour and utilities and the cost of the raw material inputs.

No detailed data is available on the cost of labour in the copper semis sector in developed countries. In the production of CCR in industrialized countries, the wage costs have been estimated at 20 per cent of total costs.[49] If we assume a hypothetical example in which a British employee earned about 800 GBP per month, ie 12 000 Zambian kwacha (ZMK) at 1 GBP = 15 ZMK, and a Zambian worker earned 1 200 ZMK per month the Zambian wage costs are easily one tenth of the British fabricator. This would imply that a Zambian producer can hypothetically save 18 per cent on total production costs over a British competitor. Even if the Zambian worker earned as much as 25 per cent of his British counterpart, the Zambian fabricator will still potentially save 15 per cent on total production costs. Thus the cost of labour can be a significant saving on production costs for a Zambian producer as long as indiginous labour was predominantly employed.

No figures are available on the cost of utilities but a similar reduction in production costs can be assumed to be operative in view of the energy and water abundance in Zambia at much lower tariffs. The cost of raw materials depends on who the Zambian fabricator is. If the fabricator is non-ZCCM, at best his cost of raw materials is the LME price less the transportation discount to Europe. If the fabricator is ZCCM, the raw material cost input can be potentially reduced. This is because in their production cycle ZCCM generate a number of intermediary products which are traditionally recycled or processed further, ie not sold. In this category would be scrap (from cathodes, used anodes, wire bars etc) which has been mentioned earlier and the anodes which are sent to the refinery for further processing. These intermediate products could be partly relocated to the manufacture of copper semis, thus reducing further the input material costs. Furthermore, with the current contraction in processing operations within ZCCM, available infrastructure is being created on which little investment capital would be required to install water, electricity and other reticulation systems.

In sum there are positive factors which are in favour of an export-oriented resource-industrialization strategy. However, further work would be required to confirm this. Even if wage costs were low in Zambia the labour efficiency is much higher in developed economies and the cost of services for plant maintenance (spares etc) is also relatively low in Europe.

On the employment creation aspects it is doubtful that a significant number of jobs can be created. It is simply a fact that the whole copper sector including semis production does not create much employment due to the capital intensity of the industry. In mining, for example, the capital/output ratio is 5 to 6, in smelting 6 to 8, in refining 2 to 3 and CCR 1 to 1.5.[50] Although the fabrication sector has a lower capital intensity than the preceeding operations, it has been estimated that the processing of 100 kt of refined copper would create jobs for less than 500 people.[51] Thus the direct contribution to employment creation of the copper semis sector may not be so significant. Nevertheless the labour costs are significantly much lower in Zambia. Perhaps a suitable balance between capital intensity and labour intensive production techniques could be struck in the Zambian case such that labour efficiency is still maintained at competitive levels.

Notes:

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[31] MEMACO: Personal communication, February 1987.

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[34] See note 6.

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[36] See note 5.

[37] See note 13.

[38] See note 19.

[39] See note 13.

[40] Ibid.

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[43] See note 5.

[44] See note 31.

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[46] See notes 1, 5 and 17.

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