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THE ARGENTINE CEMENT INDUSTRY

Technology, Market Structure and Growth

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PREFACE

This paper is the third of a series of three monographs concerned with the technology of the cement producing sector in Latin America. The first one dealt with the nature and kind of technical innovation that has taken place in the industry in recent years and analysed the international structure of the sector that supplies capital goods and technical know-how to cement producers.

The second monograph was a case study of the Mexican cement industry, detailing the level of technology incorporated into de productive capacity of the sector, as well as analysing the market structure and recent growth of the industry.

This present paper which describes the cement industry in Argentina is similar in scope to the Mexican paper; it analyses the level of technology incorporated into the cement industry in Argentina, and the economic structure and growth of the sector. However, there is an important difference in the approach of this paper as compared with the one on Mexico. In the present paper I have tried to place the analysis of technical development and market structure within an overall historical context describing the development of the Argentine cement industry since its inception at the beginning of this century. To this end much of the first section is devoted to a fairly detailed account of the growth of each plant and firm since they first went into production.

The relevance of this kind of approach to the analysis of technical efficiency and level of technology employed in a Latin American industry is wide. One of the striking differences between the Mexican and Argentine cement industry for example, is not so much differences in the kinds of technology employed, but the fact that the technological vanguard of the Mexican industry was quite clearly to be found in those firms which were subsidiaries of foreign companies. In contrast in the Argentine industry the technological vanguard is filled by a totally Argentine company which has operated for some forty odd years without recourse to any on going connection with foreign capital. The one foreign owned firm in the sector has consistently lost its market share since the second world war and the technology utilised at its plants is considerably less advanced than that employed at the Argentine owned plants referred to above.

This is not to say that all locally owned firms in the sector operate at the same high level of technology and technical efficiency. Other Argentine cement firms operate with old and obsolete technology at levels of efficiency far below that of the market leaders, and below any internationally recognised standard.

In order to understand these central facets of the Argentine cement industry - the demise of foreign owned plants, and the disparate level of technology between different producers, it is necessary to refer to the historical path which is examined in this paper.

Approached at this level the case study offers an insight into the dynamics of the sector which is not available in cross sectional studies which seek to analyse industrial sectors on a more aggregate basis. Firstly, as we have said, such studies ignore the specificity of individual country and historical circumstances which shape the context of industrial development. Secondly, they fail to differentiate between the various different kinds of techniques in a broad technological mix which is not only available freely on the market, but which clearly exists within the sector. While the current study suffers from the disadvantage inherent in the fact that there are too few firms involved to represent a statistically viable sample, and in some cases the quality and detail of the technical data available is insufficient, it does have the advantage that it is able to supersede the generalizations inherent in many comparative studies of industrial sectors.

Another important implication of this kind of case study approach is at the level of policy recommendation; too many analyses of ways in which to promote growth and efficiency in Latin American industry ignore the fact that each firm is operating in competition with other firms; any policy change which results in the growth and improvement in the production at one firm's plant will have repercussions on the dynamics of other firms in the sector, given the macroeconomic constraints imposed by the size and rate of growth of the market, and in the case of intermediate goods like cement, of very limited independent price elasticity of demand or substitutability with other products.

Finally, case studies of this nature are able to make an important contribution to the general discussion on technology and technological dependence in Latin America. Much of the early discussion was formulated in the context of the assumption that either a country/sector produced its own capital goods, thus being autonomous or self sufficient in matters of technology, or it imported them from abroad, earning the label of technological dependent. Such view is obviously too simplistic to have much relevance for designing technology policies in Latin American countries (or elsewhere). When technology - in terms of kinds of machines and production control techniques, as well as modes of acquisition of that technology are analysed in detail and within a specific context of a single sector in a single country it becomes clear that the fact that capital goods are imported from abroad does not close all the options for an independent technology policy and the development of internal technical capacity within the sector. In reality there is a wide spectrum of possibilities, which are defined by the terms of negotiation and purchase for new capital goods, the provision of technical assistance and the opportunity for real technical transfer of know-how and, in some cases the long term development of internal capacity sufficient to replace external technical assistance at various stages of technology acquisition and operation and the possibility of local innovation to modify and adapt imported technology.

Section 1

STRUCTURE AND GROWTH OF THE ARGENTINE CEMENT INDUSTRY

1. Introduction

At the end of 1975 the Argentine cement industry comprised 17 plants which had a combined installed capacity of 8,650,000 tonnes per year 1/. Of these 17 plants 5 belong to the largest cement company in Argentina, Loma Negra S.A. and account for about 50% of installed capacity (see table 1). A further four plants belong to the second largest firm, CORCEMAR S.A. which account for somewhat under 20% of total capacity. The next biggest firm is the US owned Cia. Argentina de Cemento Portland which owns 11 1/2% of total capacity spread between two plants. Then comes Calera Avellaneda S.A., with a single plant representing nearly 10% of the national industry. The Cia. Sud Americana de Cemento Portland S.A. (Juan Minetti) is the smallest of the privately-owned cement firms in Argentina; with its three factories it owns just under 8% of the industry's productive capacity. There are also two publically owned cement plants in Argentina which account for the remaining 3% of industrial capacity. The Federal government has been operating a small plant in Chubut since 1952. More recently, at the end of 1975, another publically owned plant in San Luis province went into production after a long and muddled gestation period of some fifteen years. This plant is operated by the Provincial government of San Luis.

The total combined production of cement in Argentina in 1975 was 5.6 million metric tons, which made Argentina the third largest cement producer in Latin America, after Brazil (14.6 million tonnes) and Mexico (11.6 million tonnes).

The cement industry was one of the first industries to establish itself in Argentina on an industrial scale using 'modern' production techniques. Various small-scale plants were established during the last third of the nineteenth century in Argentina which used small vertical kilns made in the country. Most of these did not survive very long and the inauguration of the modern cement industry in Argentina is generally acknowledged to be the establishment by a US cement firm of a 140,000 ton per year plant in 1915. This plant which still produces cement, is the Sierras Bayas Bs. As. plant of the Cia. Argentina de Cemento Portland. Since that date the vast majority of the subsequent cement plants and expansion projects in the industry have been established by local Argentine capital and the US owned firm now accounts for little over 10% of total installed capacity in the industry.

The different growth paths of each of the five private cement companies in Argentina will be examined later in this section. However it is necessary to make a general comment about the growth of national capital in this industry and the relationship of that capital with the foreign suppliers of technology which, as we showed in Monograph One have traditionally been international firms based in Western Europe or, to a lesser extent, in the United States of America. 2/

1/ Throughout this paper the abbreviation ton refers to metric ton or tonne. The abbreviation tpd = ton per day; and tpy = ton per year.

2/ IDB/ECLA Research Programme in Science and Technology, Working Paper Nº 9, Technology, Innovation and Transfer of Technology in the Cement Industry , Ruth Pearson, IDB/ECLA/BA/19, 11 Feb. 1977. (1)

Whilst we found that in the Mexican cement industry the most advanced technology and the highest rate of incorporation of innovations was found in those firms associated with foreign capital from the European cement sector,in Argentina the situation is quite different. 3/ The foreign capital involved in Argentina is not European but American, which has traditionally been technologically backward in cement production compared with the European industry. And secondly, the fact that US capital has been in the cement industry in Argentina since 1915 is also relevant. While in earlier decades the US owned plant(s) may well have been the most technically advanced in the industry, the much faster rate of growth of the Argentine-owned firms which has taken place more recently than major investment by the US firm 4/ has enabled at least some of the Argentine firms to incorporate much more advanced technology than that employed in the US-owned firm and, with the benefit of a more far reaching and rational technology acquisition policy on behalf of the Argentine firms, the latter have built up an internal technical capacity far superior to that existing in the US-owned plants in Argentina. 5/

2. Market shares

Table 1 shows the structure of the Argentine Cement Industry as of December 1975. As indicated above Loma Negra is by far the largest firm in the sector with nearly 50% of installed capacity. The somewhat lower figure for share of cement deliveries achieved by Loma Negra in 1975 is a reflection of two factors; firstly, the size of its two Buenos Aires Province plants (2 million and 1.7 million tonnes respectively), which are much larger than the rest of the plants in the industry, means that high capacity utilisation is much more difficult to achieve in a depressive market situation such as that which occurred in Argentina since the beginning of 1974. Secondly, the most recent expansion projects at these two plants in the early seventies were completed ahead of current demand at a time when the demand for cement was growing very strongly. 6/ Thus these large scale investments made in order to meet future growth in demand have never been fully utilised and the firm has been forced to cut its production according to the vagarities of the market which were not fully foreseen at the time the investment

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3/ IDB/ECLA Research Programme in Science and Technology, Working Paper Nº 11, The Mexican Cement Industry, Technology,Market Structure and Growth, Ruth Pearson, IDB/ECLA/BA/21, Sept. 1977. (2)

4/ Although the firm did expand its Sierras Bayas plant in 1971 by 250,000 typ, this kiln was in fact a second-hand kiln from a closed-down plant in the US and thus did not represent the incorporation of technical innovation that a different kind of investment made at that time could have implied. This will be discussed at greater length in Sections 2 and 3 of this paper.

5/ This is not to say that the parent company - Lone Star Inc. does not have a very high technical capacity in its US plants.

6/ Between 1969 and 1971 installed capacity in the Argentine cement industry grew from 5.1 million tonnes to 8.1 million, a growth of nearly 60% in two years. However, the demand for cement, as measured by its consumption never sustained its high growth rate in the late 1960s (see Graph: figure 1).

decision was made. 7/ However, in spite of the completion more recently of fairly large expansion projects by Calera Avellaneda, Corcemar and Cia. Argentina de Cemento Portland, there is no indication that any other firm is likely to challenge Loma Negra's leadership in the Argentine cement industry. 8/

The second biggest firm in the sector is CORCEMAR (an abbreviation of Corporación Cementera Argentina S.A.). This company is based in the central region of the country, in the province of Cordoba where the firm originated. In addition to the two Cordoba plants it also operates small plants in Mendoza and in the Province of Buenos Aires, South East of the Metropolitan district. However the Bs. As. plant, established in 1939 has not been expanded since and it is rumoured that, by inter-firm agreement, CORCEMAR will not intervene any further in the Buenos Aires market, in exchange for an agreement from Loma Negra not to intervene in the Cordoba (central) regional market.

Although it is the second biggest firm in the sector both in terms of installed capacity and production, CORCEMAR's total installed capacity in its four plants is only 1.6 million tons compared with the 4.3 million of Loma Negra. In 1975 CORCEMAR owned 18.4% of the total installed capacity in the Argentine cement industry, compared to 14.4% in 1965. Although its overall capacity utilisation in 1975 was better than Loma Negra's - 61% compared with 57.6% (see table 1) the capacity utilisation at the large one million tons a year plant at Yocsina, Cordoba was only 54.7%, lower than the 58.5% at the 2 million tpy plant of Loma Negra's at Olavarria. Again the partial explanation is that the recession hit the urban industrial centres much more sharply that smaller consumption centres which are not so sensitive to industrial recession; and again another possible element in the low production record of the plant in recent years is technical problems in operating the newest large kiln at the plant.

The two plants belonging to Cia. Argentina de Cemento Portland achieved relatively high capacity utilisation. The smaller plant at Entre Rios, Parana, has always been able to sell all it produced since it is the only plant in the

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7/ There is also a possibility that the firm experienced technical difficulties in getting the new kilns to operate at full capacity immediately after they went into production.

8/ Although all three companies mentioned have completed expansion projects recently (since 1970) there is no indication that their rate of growth will continue at the same pace. The Calera Avellaneda expansion of 500,000 tpy which was completed in 1975 was the result of some ten years of struggling to expand the plant in the face of financial problems and a peculiar competitive situation (see Section 3). There are no immediate plans to expand this plant further or for the company to establish any new plants. The CORCEMAR expansion in Cordoba of the Yocsina plant which was completed in 1970 has absorbed any possibility of market growth in that area for the time being, and in any case it appears to be the policy of CORCEMAR not to compete directly with Loma Negra in the Buenos Aires regional market which is where most of the market potential is concentrated. The Cia. Argentina de Cemento Portland expansion was the first investment made by that company since 1958: not only are there no further expansion plans but it appears that the firm is running out of limestone reserves at least in the immediate vicinity of the Sierra Bayas plant.

vicinity of a large industrial centre of Santa Fe. 9/ The Sierra Bayas plant survived the recession more adequately than some of its Argentine competitors partly because a substantial proportion of its output is sold to real-estate companies controlled by the same group, and partly because it enjoys the customer loyalty of other foreign-owned multinationals in Argentina instead of being largely dependent on public sector building and housing programmes which were cut dramatically after the 1974 crisis.

Calera Avellaneda has also maintained its market share since its new expansion project went into production at the end of 1974. This has been achieved - again by a lower reliance on public sector demand which has cushioned the firm from the extremities of the recession in the country. The firm also has a very competitive pricing structure and an established market which has not fallen dramatically in the recession.

The Cordoba-based firm, Cia. Sudamericana de Cemento Portland which operates three fairly small plants in the provinces of Cordoba, Mendoza and Salta has maintained a reasonable market, except at the Mendoza plant where low production figures in 1975 may well be caused by labour troubles as well as obsolete machinery. The Salta plant has a naturally protected market which included the southern part of Bolivia when the price differentials make it worthwhile; in any case it is the only plant located in the extreme North of the country.

The two publically-owned plants are really outside the structure of the rest of the industry; the Comodoro Rivadavia plant in Chubut was established mainly to serve the industrial pole created by oil and petroleum exploration in the province; to a certain extent it carries out that function although its costs have always been higher and its productivity lower than the rest of the industry. It is reported to utilise second-hand machinery and has never manufactured the special cements needed for oil exploration and drilling which have been supplied by the private sector.

The San Luis plant was initially planned during Peron's first period of government and the project has been shelved and reactivated on various occasions during the last fifteen years. Since it only went into operation in September 1975 it is too soon to know what kind of productivity performance it might have. In any case, at 1% of the total industry, it is unlikely to have a discernable effect on the mainstream of the Argentine cement industry.

3. Regional structure of cement industry in Argentina

If the cement industry in Argentina is analysed in terms of regional markets the hegemony of the big firms is shown to be restricted to the largest markets in terms of both consumption and production; the smaller, most outlying, slowest growing and least important regions are those where the large firms are less anxious to penetrate and more likely to leave the smaller firms to enjoy a local

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9/ Demand in this area in excess of the Parana plant's production is served by other plants in the Cordoba region. But because of the high freight cost in transporting cement, the Parana plant obviously enjoys a locational advantage.

monopoly. Table 2 shows how the industry can be divided into regional markets or zones, with the two most important areas, both for production and consuption being centres on the industrial poles of Buenos Aires Province (Zone One) and the Cordoba-Santa Fe-Rosario axis (Zone Two). 10/

If we then examine the market shares of each firm according to the regional structure of the industry (see tables 3, 4 and 5) we see that Loma Negra is in fact only the largest company in the industry's Zone One where it enjoyed a market share of 68% of the installed capacity of the region and 61% of the deliveries in 1975. Tables 3, 4 and 5 indicate that in that region Loma Negra's share of installed capacity has risen very slightly during the last ten years and although the share in deliveries shows a slight decrease in recent years, this has been explained above by conjunctural factors affecting the market for cement since 1973/74.

In Zone Two the market leader, both in terms of capacity and deliveries is the Cordoba based firm CORCEMAR which in 1975 accounted for 77% of installed capacity in the zone and 70% of total deliveries (see table 5). This market share indicates a substantial growth in the scope of CORCEMAR's activities since 1965 when its share of installed capacity in the region was only 55%; this increase in operations is entirely due to the expansion of the Yocsina factory in the Province of Cordoba which now accounts for 66% of total capacity in the region.

These two zones together account for 83.6% of the total industry in terms of installed capacity (1975) and 82.6% in terms of deliveries, a proportional importance which has been maintained and very slightly increased during the last ten years.

We cannot rule out the likelihood of an inter-firm agreement between these two companies not to compete with each other in these particular spheres of influence, (apart from the small Pipinas plant in the Province of Buenos Aires which has not been greatly expanded since it was established in 1939).

In the other three zones which together account for under 20% of total installed capacity in the industry, the market leadership is less clear and in none of the cases is it exercised by either of the two largest firms referred to above. However, it is pertinent to note that none of the new plants established since the war, with the exception of the two publically-owned plants in Chubut and San Luis have been established by any firms other than these two market leaders even when they were first mooted by independent entrepreneurs. It is also interesting to note that, of the 3.7 million tons expansion in installed capacity in the Argentine industry since 1965, some 2.6 million tons, or 70%

10/ This regional division is the one used by the Asociación de Fabricantes de Cemento Portland and is also used by the individual cement manufacturers in determining their zones of influence for the purpose of calculating the market penetration effects of new investments. It is however a very schematic regionalisation and does not take into account actual flows of cement from factories to consumption centres. For a more detailed discussion of regional distribution in the Argentine cement industry and the inherent transportation costs and problems see: Fundación de Investigaciones Econômicas Latinoamericanas, Costos marginales a largo plazo de transporte ferroviario y automotor de cargas, Libro Nº 6, Sección 4,"Aplicación al transporte de cemento", pp. 302-309, FIEL, mimeo, Bs. As., 1970.

has been in plants owned by these two largest firms (see table 6) of which nearly 68% has taken place in one of the two largest zones in the industry.

Loma Negra has pursued a policy of establishing small plants in the more outlying regions of the country even though it has not achieved a dominating market share in these regions. In addition to the two new plants established (San Juan, 1963 and Zapala,1970) both of which were taken over by Loma Negra in the gestation period, the company absorbed the previously independent company of COINOR at Frias, Santiago del Estero, in 1950. 11/ Loma Negra has steered clear of any investment either in the Cordoba area (Zone Two) or in the Mendoza area (Zone Three) where CORCEMAR's activities are centred. 12/ CORCEMAR, apart from the important expansion at Yocsina have not penetrated any new market areas nor have they successfully challenged Cia. Sudamericana de Cemento Portland's hegemony in the Mendoza area.

4. Brief history of the Argentine cement industry

As we noted above, the Argentine cement industry is now completely dominated by large-scale local capital in spite of the fact that the original high-technology/large-scale investments were made by US capital during the first world war. The way in which the Argentine owned sector of the industry expanded and outstripped the American capital is detailed below in the section dealing with the history of each of the firms in the industry. Crucial to this expansion and strengthening of the local base of the industry is the relationship between the Argentine capital and the suppliers of technology to the industry. The manner in which the locally-owned capital in the industry has succeeded in becoming the technical vanguard of the industry, thus displacing the foreign-owned firm from its initial technical advantage over local producers is also central to an analysis of the development of the cement industry in Argentina and especially to the analysis of the technology employed in the sector and the local technical capacity, which forms the main object of this study.

At the time when the first modern cement factory went into production in Argentina (the Sierra Bayas plant of the US owned Cia. Argentina de Cemento Portland in 1918) the only local cement manufactured in Argentina came from a couple of small-scale vertical kiln plants in the Cordoba area. During the 1920s, production at this plant played an important role in the national consumption of cement. By 1927, local production supplied one-third of total domestic consumption and after that year when other plants began to go into production, domestic production as a proportion of total cement consumption in Argentina increased steadily. 13/

11/ The Barker plant was also a new plant - put on stream in 1956; here we are discussing new plants outside the Zones One and Two.

12/ The Loma Negra plant at San Juan is technically in the same zone (Three) but the San Juan provincial market in fact absorbs practically the whole of the factory's production.

13/ See Table 8, Basic statistics on the Argentine cement industry 1913-75.

The new plant that went into production in 1928 was the Olavarria plant of the newly formed firm of Cia. Loma Negra S.A. This was another important landmark in the history of the Argentine cement industry since it was the first Argentine-owned plant using continuous production techniques (i.e. large scale rotary kilns). During the 1930's the number of cement plants operating and the tonnage of installed capacity grew at unprecedent rates. Between 1930 and the outbreak of the Second World War in 1939 eight new plants went into production and one small-scale existing plant was transformed into a large scale continuous production plant. Installed capacity increased from 511,000 tpy to 1,812,940, a growth rate of 15% per year.

Of this new investment in the industry only one plant was owned by non-Argentine capital; the rest was divided between five Argentine firms, most of whom were already marginally involved in the industry as small-scale cement producers, or as lime producers.

The expansion of productive capacity in the 1930's was divided between the existing production centres - Buenos Aires Province and the Province of Cordoba and areas previously not part of the domestic cement industry (see figure 2).

One plant was erected at Frias, in Santiago del Estero Province; two plants in Mendoza Province and one in the northern Province of Salta near the Bolivian border. The size of the plants varied between 35,000 tpy and 220,000 tpy and all machinery and equipment as well as technological know how and technical and managerial skills were imported, mainly from Europe but also from the United States. However, domestic production expanded from 412,000 tpy in 1930 to 1,135,312 tpy in 1939 (an annual average growth rate of 11.9%) and by the outbreak of the War imports represented less than 2% of total domestic consumption of cement.

This expansion of the industry which started in 1930 was mainly concentrated in the last half of the decade that is between 1935-1939. The major part of the new capacity installed in the 1930-35 period was the result of investment made by local capital in the Cordoba areas; 200,000 tpy of new capacity was installed in this central region during the 1930-35 period in response to the rapid urbanisation and incipient industrialisation taking place in the area.

Expansion in other parts of the country came later, and was probably more directly influenced by the measures of import control taken by the government and by the new possibilities of import substitution as well as by the industrialisation and urbanisation-linked demand which had become manifest in at least the Buenos Aires area prior to its inception in Cordoba. The Calera Avellaneda plant near Olavarria, which was owned by the German immigrant lime-producing firm of the same name went into production in 1935-37. In 1938 the US-owned Cia Argentina de Cemento Portland S.A. established its second plant on the banks of the Rio Paraná in the Province of Entre Rios. In the same year an independent company COINOR established a plant in Frias in the Province of Santiago del Estero on the border with Catamarca Province. In 1939 CORCEMAR inaugurated another new plant at Pipinas, South East of Buenos Aires. The other Cordoba-based company, Cia. Sudamericana de Cemento Portland put up a small plant at Campo Santo in Salta Province near the border with Bolivia, sharing with COINOR the market for the North Central area of the country.

Although both production and capacity increased throughout the 1930's as the new plants were put into operation the index of capacity utilisation for the industry as a whole shows substantial falls in the years when major new investment was put on stream. Much of the technical capacity required to run these plants at a high level of capacity utilisation was provided by technical assistance of one form or another, mainly by the machinery suppliers in the case of the Argentine owned firms, and by the parent company in the case of the US-owned firm. Another source of technical knowledge was derived from the fact that many of the technically qualified employees of the cement companies were first or second generation European immigrants who had received their technical training in Europe.

This ready supply of technical capacity, skills and knowledge from Europe, in its diverse forms, lessened the technological advantage of the US-owned company over its argentine competitors even in these comparatively early days of the industry. The US company also faced particular problems which limited the possibilities of its expansion and maintaining a dominant market position. The history of this firm is detailed below.

However, although the conjunctural factors and problems with raw materials supplies explain the failure of this particular company, or rather of the particular plants owned by this company to maintain a leading role in the industry it does not explain why foreign capital in general has been ousted to such a large extent from the Argentine cement industry, especially in view of the role played by foreign capital in the Mexican cement industry 14/ and the importance of foreign investment in Argentine industry in general.

With regards to the comparison with the Mexican industry it should be remembered that the foreign capital involved in Mexico, particularly that which we have considered to be the technological vanguard within the Mexican cement industry, was European, not American capital. As we showed in the first monograph 15/ , US cement industry has been technologically behind the European industry both in the production of innovations in cement production and in the incorporation of such innovations into cement productions within the USA. Indeed, the most recent high-technology investments in the US cement industry have been carried out by European firms investing in the US industry. In this respect it is unlikely that a big US cement firm, albeit one of the larges cement corporations in the USA, would export to its Latin American subsidiaries the most up to date and efficient technology; and as we show below, opportunities for incorporating innovations by new investments in earlier periods have not been taken up in Argentina because of the uncertainty of the investment climate. In addition the policies of the Argentine government, until recently, regarding the importation and capitalisation of technology and the repatriation of profits and royalties have been stricter than those prevailing in Mexico, which is another factor likely to discourage high technology investments in this sector by the US-based firm.

The development of local capital in the cement industry has also presented a much stronger challenge to foreign investment than was the case in Mexico. The majority of the Argentine firms that have taken over the cement industry in the

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14/ See R. Pearson, 1977 (2), op. cit.

15/ See R. Pearson, 1977 (1), op. cit.

country have been firms whose initial business ventures were connected with the traditional Argentine enterprises of cattle rearing and meat exporting. This connection between 'agro-industry' and cement production have given local entrepreneurs several advantages. Firstly they have had the opportunity to obtain access to the necessary capital investment for cement production, either from accumulated reserves or collateral provided by their other businesses. Secondly, and particularly in the case of the competitors of Cia. Argentina de Cemento Portland in the Olavarria region, they have ownership of land reserves - either originally acquired for ranches or bought specifically with cement production in mind. Thirdly, they have had some business experience and connections before undertaking this venture. And fourthly, the majority of the entrepreneurs who were successful in the meat production business and all of those who later went into cement production were first generation European immigrants of professional families some of whom had even enjoyed technical education at well known European technical institutes. In this sense they were acquainted with technical progress in industrial innovations in European industries; they were familiar with the sources of technology for the industry and were easily able to visit those sources and acquire the necessary technology for their new industrial projects. So the US firm in fact had no intrinsec advantage over its local competitors in this sector; the normal advantages accruing to foreign capital in underdeveloped countries - access to capital, access to technology, technically trained manpower and entrepreneurial experience were equally if not more so available to the Argentine businessmen as to the officials of the US firm with whom they were competing. The Argentines moreover had the advantage of being nationals which gave them security in times when the nationalistic policy of the Argentine government made investment prospects for foreign capital insecure. Their national status also gave them access to government contracts, especially important during the primary industrialisation phase of the country's development when most of the industrial and social infrastructure was being constructed.

Of course not all the Argentine entrepreneurs fared equally well as the brief history of those firms given below will indicate; while the vanguard of the industry is considered amongst the most technically advanced in Latin America and North America, there are still one or two small plants which have survived using very outdated and inefficient technology in spite of the rapid concentration in the industry. But the firms which have prospered have not been hindered by limitations imposed on the access to new innovations in production which has affected the survival of Argentine firms in the manufacturing industry in Argentina; nor in this sector is consumer prejudice and brand loyalty a problem.

5. History of growth of firms in Argentine cement industry

Loma Negra S.A.

The leading firm in the cement sector in the post war period is the Buenos Aires based company: Loma Negra S.A. This firm began life as an agricultural enterprise in the 1920's whose activities included stock breeding, cattle farming and lime production. In 1926 the first cement factory was projected on land owned by the firm near Olavarria in the Province of Buenos Aires, to complement its other activities. This plant, which is still the largest Loma Negra plant began production of cement in 1928 with an installed capacity of 150,000 tpy.

Soon afterwards the agricultural and farming activities of the company were separated from those pertaining to cement and lime production, the latter keeping the company name of Loma Negra.

The family which owned this complex of companies was the Fortabat family of Basque immigrants who had settled in the division of Azul in the Province of Buenos Aires. The director of the company, known as Don Alfredo Fortabat until his death in 1975 was born in Argentina, but had in fact received a technical education at the Ecole Superieur in Paris. Although the extent of the family business at the time that cement production was initiated in 1928 is not known, the family continued to be associated with farming and stock breeding in the area and accumulated vast amounts of highly profitable agricultural land as well as the raw materials reserves for the limestone and aggregate quarries.

As we noted earlier in this section, the land around Olavarria is particularly suitable for cement production and this factory prospered from the beginning. By 1936 the capacity had been increased to 260,000 tpy and by 1946 rated capacity at the plant was 450,000 tpy, which was about the same size as the neighbouring US owned factory at that date.

A fifth kiln was added in 1956 bringing the installed capacity to 600,000 tpy which made this the largest plant in the Argentine cement industry to date. While the Olavarria plant was not further expanded until 1963 when a sixth kiln brought its installed capacity up to 1,000,000 tpy, Loma Negra was expanding at other locations.

In approximately 1950 Loma Negra bought out the Frias plant of COINOR (Compañia Industrial Norteña de Cemento) in the Province of Santiago del Estero. This plant which was established in 1938, was a 120,000 tpy wet process installation, had begun to manufacture white cement on the basis of a patent acquired from a French company, but this was discontinued in 1948 because of problems of acquiring an adequate fuel supply. Wheter these problems were general to all cement production is not really known but the negotiations with Loma Negra for the take over commenced shortly afterwards and were completed by the end of 1950.

In the immediate post-war period no new investment was made in Argentina. However,as soon as imports of capital goods and exchange restrictions began to be lifted in the mid fifties, major new capacity was installed. A new Loma Negra plant at Barker near Tandil, Province of Buenos Aires went into production in 1956, with a rated capacity up to just over one million tons per year, or 38% of total installed capacity in the industry at that date.

The next period of rapid growth for the firm, as for the industry in general was the early 1960's. in 1963 major expansion came on stream at both the Olavarria plant and the Barker plant; at the former a sixth kiln was installed increasing capacity to 1 million tpy and at Barker a second kiln, with a capacity of 730,000 tpy increased total capacity at the plant to 1.2 million tons making this plant the largest in the country.

A fourth Loma Negra plant went into operation in 1963 - the San Juan plant whose initial investment had been organised by a commercial company called Compañía Industrial San Juanina S.A.. However, some months before the 125,000 tpy plant went into production in March 1963, a management and technical contract was awarded to Loma Negra which became responsible for all aspects of production, administration and sales and the cement produced was marketed under the Loma Negra brand name. Loma Negra's share participation in the company was consistently increased and by 1973 the Cia. Industrial San Juanina ceased to exist and the plant became known as the San Juan factory of Loma Negra.

After these three major investments the combined capacity of Loma Negra's plants in 1963 was 2.3 million tons a year, which represented 47% of total industry capacity.

During the remainder of the 1960's, minor increments to capacity were made at the various plants belonging to the firm. The early 1970's saw another round of major expansions and new investments in the industry, and as we noted earlier in the paper, Loma Negra shared proportionately in this round of increases. 1970, like 1963 saw two new Loma Negra expansion projects come on stream as well as the inauguration of another new factory which like the San Juan factory had been originally organised by a separate industrial concern, but had ceded technical and administrative control to Loma Negra shortly before the plant went into production.

The major expansion projects were at the two Buenos Aires plants belonging to the company. A new kiln and complete production line was inaugurated at the Olavarria plant, doubling installed capacity at that plant to 2 million tonnes a year. The Barker plant was expanded by the addition of a further kiln with a capacity of 500,000 tpy which went on stream in 1971.

The new plant which went into production in 1970 was the Zapala plant in Neuquen Province which was organised by the Cementera Patagonica whose principal shareholder was the firm of Perez Companc. The motivation for the establishment of this plant in the Southern province of Neuquen was the expected demand generated by the construction of two big hidroelectrical projects, El Chocon and Cerros Colorados. However,in the gestation period of the plant's design and construction which was initiated in the early 1960's the company negotiated a technical and management contract with Loma Negra, which became effective in July 1969 some ten months before production began at the plant.

Initially Loma Negra held a minority proportion of the share capital in the company even though the direction of the factory was fully integrated into the overall management of the company's other plants and the cement was marketed under the Loma Negra brand name. However, the participation has been continuously increased, and although it is not known whether total share ownership will eventually be achieved, Loma Negra enjoys financial as well as administrative and technical control over the plant's operations.

In this way the firm Loma Negra has expanded its activities in the cement industry from the small plant which began production in Olavarria in 1928. Although the company was not backed by foreign capital with technical capacity and experience in the cement industry it has become by far the largest and most important firm in the industry, and has established a solid technical capacity on the basis of incorporation of new innovations in the experimental stage as well as a conscious policy of lessening reliance on machinery suppliers for elements of technical capacity which it is possible to build up internally. This will be discussed in Section 4 of this paper.

CORCEMAR S.A.

The second largest and most important firm in the Argentine cement industry is the Cordoba based firm of CORCEMAR (Corporación Cementera Argentina S.A.). This firm had its origins as a small plant established in Cordoba during the first world war by two European immigrants, engineers employed by the Department of Public Works of the Municipality of Cordoba. Production at this plant, which is known as the Kilometro 7 plant was initiated in a vertical kiln with a rated capacity of 16 tons a day; because of the difficulties in importing equipment caused by the war all the plant was manufactured in the locality, and apparently continued functioning into the late 1930's. In 1934 the two original owners of the plant formed a company with other local capital in order to expand cement production at the Cordoba plant and in this way the Corporación Cementera Argentina was founded. In 1932 the vertical kilns were transported to Mendoza to be used for lime manufacture and a new rotary kiln, with a capacity of 42,000 tpy was imported from the US; a second rotary kiln with a similar capacity was imported from Germany in 1934 bringing total capacity at the plant to 84,000 tpy.

Shortly afterwards, in 1936, cement production was initiated by CORCEMAR in Mendoza at the Capdeville plant where a lime plant had already been established. This plant also had an initial capacity of 42,000 tpy which was doubled shortly afterwards.

CORCEMAR established a third plant shortly before the outbreak of the second world war in 1939. This was the Pipinas plant in Buenos Aires Province which went into production with an initial capacity of about 200,000 tpy.

Thus by the outbreak of the second world war, which marked the end of a period of rapid expansion in the Argentine cement industry, CORCEMAR's total capacity was about 350,000 tpy which represented nearly 20% of total domestic capacity. 16/

CORCEMAR, in common with the rest of the Argentine cement industry was unable to expand its capacity at any of its plants until import restrictions were eased in the mid 1950's. New kilns at both the Kilometro 7, Cordoba plants and the Capdeville plants went on stream during the 1957/59 period bringing the respective capacities at these plants up to 165,000 and 175,000 tpy respectively.

The most important expansion by CORCEMAR in the more recent period was the establishment of a new plant just outside the city of Cordoba at Yocsina in 1964. This plant, whose initial capacity was 260,000 tpy was partly motivated by the fact that it was impossible to expand the company's Kilometro 7 plant any further since the process of urban growth in Cordoba has meant that the Kilometro 7 factory, originally sited near one of the railway terminals at the outskirts of the City is now in the middle of an urban area with no physical possibility of expansion at the site of the plant.

16/ In spite of the fact that initial and subsequent capacity figures are given for these plants it is not clear whether these are estimates or represent the real potential producing capacity of these plants. For this reason it is not claimed that capacity totals given here are anything more than approximate estimates.

The new plant at Yocsina was expanded in 1971 so that its total capacity is now 940,000 tpy. 17/ This means that apart from being the biggest plant belonging to CORCEMAR it is also the biggest, and most up to date plant outside the Buenos Aires Zone of influence; since, as we established above, the market for cement is divided regionally in such a way that there is no direct competition between the Buenos Aires Zone and the Cordoba Zone, this Yocsina plant is able to exercise considerable hegemony over its competitors in the region.

As Table 6 indicates, CORCEMAR's share of national capacity increased from 15.6% in 1965 to 18.4% in 1975; replacing Cia. Argentina de Cemento Portland as the country's second largest cement firm. In terms of production the share of CORCEMAR cement in total deliveries made by the industry was slightly higher than the proportion of total capacity (19.7% in 1975 - see table 7); however in both installed capacity and deliveries it is clear that CORCEMAR has established itself as the second most important firm in the sector on the basis of its almost total domination of the Cordoba region, which is the second most important industrial area and market in Argentina.

The growth of CORCEMAR until it has become the second largest firm in the sector is a consequence of several factors. Its initial success was owed to the fact that its founding partners were qualified engineers who had been employed by the Municipalidad de Cordoba to inspect the quality of domestically produced and imported cement used in public works in the city; thus the engineers were familiar with the properties of cement and had the opportunity to learn the process of production before risking their capital in the venture.

The distance between the Buenos Aires Province plants and the Cordoba area was a source of natural protection for the Cordoba plant in the early period. In more recent times it has also served to separate the two markets; since the Cordoba based CORCEMAR was firmly established in the region before Loma Negra or any of the other Bs. As. plants were in a position to challenge its market dominance in the region, a policy of mutual non-interference was undoubtedly profitable to both parties. 18/

The particular nature of the Cordoba market - both protected from intra-regional competition and yet constituting a large and growing demand for cement has enabled CORCEMAR to increase its capacity and, to a certain degree incorporate in its newest investments large-scale and sophisticated technical innovations in process technology. Because of its secure market and growth prospects it has had no difficulty in raising international or local credit and thus the incorporation of new innovation has been carried out very much by technical assistance from machinery suppliers and others rather than on the basis of building up the company's own internal technical capacity.

17/ The figure quoted by the company to the Asociación de Fabricantes de Cemento Portland is in fact 1 million tpy.

18/ The fact that the CORCEMAR capital was raised entirely from local sources is also relevant here. Since cement production requires raw material sources it is unlikely that the Buenos Aires based firms were able to obtain access to raw materials which of course implied land ownership.

Cía. Argentina de Cemento Portland

The firm of Cía. Argentina de Cemento Portland, the fully-owned US subsidiary, was the first firm in the country to initiate cement production on a continuous basis (i.e. using Rotary kilns instead of vertical kilns). This first plant which began production in 1919, had an initial production capacity of about 60,000 tpy and was built entirely from US manufactured equipment. This firm was a subsidiary of the US firm International Cement Corporation when it founded the Argentine company in 1915. The parent company later merged with a Texan cement firm and in 1936 changed its name to the Lone Star Cement Corporation. 19/

Production at this plant expanded through the 1920's and installed capacity at the plant reached 180,000 tpy in 1927. By this date the plant contributed practically all the country's domestically produced cement which accounted for over one third of total consumption.

The factory was apparently run entirely by US management and technical personnel and proved very profitable for the parent company; during the first ten years of the plant's life while the company had the virtual monopoly of sales of domestically produced cement (apart from the Small Cordoba plants which in fact did not penetrate to the Buenos Aires market) it was able to remit to its parent company a sum equal to the total capital invested in the 1916-1928 period.

This plant was undoubtedly the inspiration which induced local entrepreneurs to set up cement plants in Argentina, especially in the limestone rich area around Olavarria where the American plant was established. 20/ 1930-1939 was an important growth period in the Argentine cement industry and the US company participated with other firms in this growth. A fifth kiln was added to the Sierra Bayas plant in the mid-thirties but the major new investment by the firm was the establishment of a new plant at Parana, Province of Entre Rios, which went on stream in 1938. This new plant had an initial capacity of 146,000 tpy (the same as its present capacity and represented the incorporation of a very advanced production technique) (see Section 2 below).

The war period and the rest of the 1940's and early 1950's were a period of consolidation rather than expansion for the cement industry in Argentina; new investment was virtually halted by the difficulty of obtaining imported capital goods and the restrictions on foreign exchange. Fuel shortages and transportation difficulties cut the production of many plants.

19/ More recently, in 1969 it became Lone Star Industries Inc. to reflect the diversification of its interests out of exclusively cement related activities (see Moody's Industrial Director 1973).

20/ The plant referred to is the Cia. Argentina de Cemento Portland plant at Sierra Bayas, near Olavarria, Buenos Aires Province. In fact, there are now three plants adjacent to each other at this particular location - the Calera Avellaneda plant and the original Loma Negra plant. The area is particularly attractive for cement manufacture because of the quality of the limestone found there.

In the middle of the 1950's the industry began to expand again and the American-owned plant at Sierra Bayas added a sixth kiln to the plant increasing capacity by 500 tons a day (165,000 tons a year) to a total of 585,000 tpy. The only further new investment made at the plant is the latest expansion of a 700 tpd (220,000 tpy) production line which went on stream in 1970 bringing capacity at that plant up to its current 845,000 tpy.

The explanation as to why the US-owned firm has failed to expand at the same rate as the rest of the industry and why it has ceded the dominant market position to the locally owned firm is complex. One reason given for the failure of this firm to maintain its market share is that a policy decision to curb its domestic envolvement was reportedly taken by the US directors during Peron's first government when the climate for foreign investors was hostile. In addition the Lone Star Cement Corporation suffered the loss of its Cuban plant which was nationalised without compensation in 1963, making the firm less amenable to risk - taking in an insecure investment situation. There is also a further aspect: major expansion at the Sierra Bayas plant is now hampered by the exhaustion of raw materials. Reserves are currently very low, after continuous exploitation of the quarries for nearly 60 years and the plant is going to have to start using another quarry in the near future at some 8 km. distance from the plant; because of the structure of land ownership in the Province of Buenos Aires and the competition for land usage from the highly profitable business of cattle rearing it is unlikely that the firm can now secure suitable raw material sources on a long term basis; such forward investment would have had to have been made in the 1940's when all available land was purchased: and it was just at this time that the firm was least sure of the possibilities of continuing operations in Argentina.

The Parana plant is also unlikely to be expanded even though it has been operating for many years at full capacity. Again the problem is raw material supplies. The limestone utilised at the Parana plant has a low calcium carbonate content and contains fossilised deposits. The raw material has to be put through a special process (flotación) to eliminate the silicon and to increase the CaCo3 content, which makes the costs of production relatively high. In addition to these problems with the quality of the raw materials the reserves belonging to the company are very low and although the firm has undertaken studies to try to locate more plentiful and better sources of raw materials in the area, it has apparently had little success. 21/

Calera Avellaneda

This firm whose single plant now represents 10% of total installed

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21/ Information about the firm Cia. Argentina de Cemento Portland S.A. comes from the following sources: a) Raul Dante Verzini,"Pasado, presente y futuro de la industria cemento portland en la Argentina" in Revista de la Unión Industrial Argentina, May/June 1960; b) interview with company officials both at the Buenos Aires offices and at the Sierras Bayas plant; c) various issues of the Anuario of the Asociación de Fabricantes de Cemento Portland 1945-1975; d) "Analysis of Raw Material Distribution", Annex to La industria cementera nacional, Banco Industrial de la República Argentina, Dirección General de Desarrollo Industrial, Departamento de Estudios Técnicos, Bs. As. 1961.

capacity in the industry was founded in 1919 by a group of German immigrants, whose purpose was the manufacture of lime and allied building products. The original lime plant, which is still extant, is on the same site as the cement plant established some twenty years later near Olavarria, close to the Cia. Argentina de Cemento Portland and the Loma Negra plants that are sited in that area.

In 1933 the directorate of the company decided to go into cement production, no doubt influenced by the two successful factories operating beside the lime plant. Cement production was initially carried out in two of the six vertical kilns possessed by the firm for lime production. However, technical difficulties with the production process induced the company to abandon this method of manufacture and in 1935 the decision was made to import rotary kilns from Europe with the aim of initiating large-scale high technology cement production at the plant. The first rotary kiln belonging to this company, a 300 tpd Lepol kiln went into production at the site in 1938/39 and is still used for cement production by the firm.

Calera Avellaneda, like other cement plants, was unable to expand production during the war and immediate post war period. In addition to the problem suffered in common with other cement firms - the impossibility of obtaining spare parts from abroad, let alone new capital equipment, shortage of fuel and packaging materials and other essential inputs - Calera Avellaneda suffered additional restrictions related to the nationality of its directors and shareholders. At some stage during the war, in the immediate post war period, the control of the firm was placed in Public hands. However the control of the firm was later returned to private hands and the directors and shareholders regularised their position by adopting Argentine nationality.

Further expansion at the plant did not take place until 1958 when a second kiln went on stream. This was a 500 tpd Humboldt kiln which brought total capacity at the plant up to 280,000 tpy.

Calera Avellaneda cement has had a high reputation for quality and reliability and the firm therefore planned a further expansion to take advantage of the pressure of demand which again was threatening to overtake supplies by the mid 1960's. However, this expansion project, first discussed within the company in the early 1960's was delayed for various years due to the intervention of interests allied to the firm's main competitors who were trying to impede the expansion of Calera Avellaneda in the Buenos Aires Region. Eventually a substantial loan was negotiated with the International Finance Corporation of the World Bank, impediments to the project were legally overruled and the project went ahead in the early 1970's. The new plant which consists of the addition of a 1,000 tpy Humboldt kiln, went on stream in November 1974. Total productive capacity at this plant is now 845,000 tpy, making it the fourth largest plant in the Argentine cement industry (jointly with the Sierra Bayas plant of Cia. Argentina de Cemento Portland). Production at the expanded plant has continued at high capacity utilisation and although in 1975 Calera Avellaneda only represented under 10% of total cement capacity in Argentina, its contribution to sales was 11.3%.

Cia. Sudamericana de Cemento Portland S.A. (Juan Minetti)

This is the smallest of the privately owned cement companies in Argentina, and the least dynamic company in terms of growth rates, maintenance of market share, level of technology and development of internal technical capacity. However during the 1930's this firm was one of the fastest growing and, outside the Buenos Aires area, the biggest of the Argentine owned cement firms, having established three plants before the beginning of the second world war.

The first cement plant established by this company was the Dumesnil factory in the province of Cordoba which commenced production in 1930. The capital behind this factory came from the Minetti family, Italian immigrants who had established a pasta factory in the area and had acquired some quarries in the late 1920's with the aim of working them for lime production. However, it was decided to go into cement production and the Dumesnil factory equipped with rotary kilns imported from Europe had an initial capacity of 400 tpd. This capacity was increased by the addition of a second kiln in 1939 bringing the total capacity up to 600 tpd.

The second Cia. Sud Americana de Cemento Portland factory was the Panqueua plant in the Province of Mendoza which went into production in 1936. The initial capacity at this plant was 100 tpd (30,000 tpy). A few years after its inauguration it was expanded and by 1939 its capacity had increased to 300 tpd (100,000 tpy).

The third Minetti cement factory to be established was the Campo Santo factory in the Province of Salta, near the border with Bolivia. This plant, which was put on stream in 1938 had an initial capacity of 200 tpd (60,000 tpy).

Thus, by the outbreak of world war in 1939 Cia. Sud Americana de Cemento Portland was operating three cement plants with a combined productive capacity of 1,100 tpd (365,000 tpy), which represented 20% of total installed capacity in the Argentine cement industry at this time. While none of the firm's factories was in the major production/consumption Zone centred on Buenos Aires, the Cordoba and Mendoza zones were important areas, both industrially and politically and Minetti's company was regarded as the most important cement manufacturing establishment outside the metropolitan region.

However, since the war the factories of Cia. Sud Americana de Cemento Portland have not participated in a proportionate manner in the expansion of the rest of the industry. According to the figures published in the Annuario of the Asociación de Fabricantes de Cemento Portland two of the three factories were reducing capacity during the immediate post war period; in 1948 the Dusmeñil factory had a rated capacity of only 250 tpd compared with a prewar 600 tpd estimate. The Panqueua factory was reported at 375 tpd and the Salta factory at 250 tpd. It is not clear whether these reduction in rated capacity reflect a realistic assessment of actual cement producing capacity, given post war conditions of fuel, packaging and transport shortages or whether they represent some rationalisation or modernisation carried out by the firm. In any case, by 1956 all three factories were reported to have achieved their pre war capacity levels. Marginal increments to capacity were reported throughout the rest of the 1950's and the beginning of the 1960's.

The most significant expansion carried out by the firm in the post war period was the addition of extra kilns to the Salta plant which increased capacity at this plant in 1963 from the previous 60,000 tpy figure to the present capacity of 235,000 tpy.

The most recent expansion was the expansion project carried out in the Mendoza plant in 1972 which increased capacity there by 150,000 tpy to its current level of 340,000 tpy.

The current combined capacity of the firm's three plants is 776,000 tpy which represents only 9% of total industry capacity, a clear decrease from its pre war position, and even from the 12% of total industry capacity which the three factories comprised in 1965.

The firm has apparently been attempting to establish a new plant in the Province of Cordoba at Malagueño. However, in spite of various potential arrangements with machinery suppliers and international financial institutions the project has never come to fruition; either because of the failure of the firm to adopt a 'modern' approach to investment finance, or because of the opposition of competitors which has been reflected in government policy. Certainly the factories belonging to this company are amongst the most obsolete of the whole cement industry in Argentina in terms of the technology employed and the efficiency as reflected in the technical parameters. (See Section 2 below).

The two remaining plants in the industry are the publically owned plants at Comodoro Rivadavia, Province of Chubut and the newly inaugurated San Luis plant of El Gigante. The Chubut plant went into production in 1952. It was first established under the auspices of the State petrochemical corporatiom Petroquímica EN since which time the government body responsible for its administration has changed. The latest information available indicates that the Dirección Nacional de Industrias del Estado (DINIE) is the umbrella organisation to which the cement factory corresponds.

This factory was established by the government in order to supply the demand which was predicted in the Southern region arising out of the oil exploration and subsequent industrial and urban development in the area. In fact the factory, which has expanded in 1968 from 120,000 tpy to 168,000 tpy has only partially supplied that market and much of the ordinary cement demand as well as the special purpose cements are supplied by the private sector. The plant is apparently an out of date wet process plant which is technically inefficient. This fact, added to the extreme geographical isolation of the factory and the subsequent high transport costs both of inputs and of the finished product has meant that the plant has consistently operated at a higher cost structure than other firms in the industry and has been allowed to charge higher prices than those prevailing in the rest of the sector. For this reason, as well as the small size of the plant and its distance from the major production and consumption centres of the industry the Chubut plant has remained marginal to the mainstream of developments and competition in the Argentine cement industry.

The other publically-owned plant in the industry is the 100,000 tpy plant at San Luis which went into production at the end of 1975. This plant is also extremely small and in most senses marginal to the mainstream of the Argentine cement industry. The plant has had a somewhat longer than average gestation period; the idea of establishing a cement plant at the El Gigante site was first proposed in 1960 when the Governor of the Province of San Luis actually laid the foundation stone of the new plant. However, the project which was to be equipped with machinery imported from Czechoslovakia was continuously delayed even after the major items of machinery and equipment had been imported into the country by the mid sixties. The project was apparently revitalised in 1974 and the final stages of the plant installation were completed over a 16 month period. The plant finally went into production in March 1975.

However, with a total capacity of 100,000 tpy this plant, based as it is on a plant design and equipment manufactured some 10 years ago is clearly not in the technical vanguard of the industry.

The discussion of the technical capacity and technology utilised in the Argentine cement industry will therefore be based on the plants in the privately owned part of the industry which comprises 97% of the total installed capacity and nearly 98% of the production of cement in the country. Reference will only be made to the State-owned plants where specific details are relevant to the points under discussion or when the past and potential development of the industry requires that the existing mixed industry structure be taken into account.

6. Differences between Argentina and Mexican cement industries

The Argentine cement industry in the mid seventies consists of five private companies or groups of companies, with the addition of two publically-owned factories comprising not more than 3% of total capacity. The private companies demonstrate an unequal distribution of the market between the different firms, which is the result of the way the industry has developed since the 1930's when the domestic cement industry in Argentina expanded rapidly to supply the growing market and replace imported cement. Two facts of the growth process are most important for our analysis; firstly that local capital has expanded and, while not eliminating foreign capital altogether, has ensured that the vast part of the expansion of the industries has taken place under the control of Argentine capital leaving the US owned firm already established in the industry, to a residual, if not marginal role. Secondly, the uneven growth of the individual firms in the industry is the result of the underlying oligopolistic tendencies in the industry related to technical conditions such as economies of scale and economies of multi-plant operations, and to the regional concentration of demand and production possibilities in Argentina. This concentration and unequal growth of the industry has affected and is affected by the level of technology employed in the different firms - with the largest, fastest growing firms using the most up to date technology and having the opportunity to develop their own internal technical capacity.

So although the industry in Argentina differs from the Mexican situation where the technical vanguard of the industry was located in those firms with the closest connection to foreign capital, the locally dominated Argentine cement industry presents as differentiated a picture of technological level and technical capacity as the Mexican industry. This is partly explained by the different pace of investment in the various Argentine firms as the result of the different growth patterns described in this first section of the paper. However, as the subsequent analysis of technology employed and technology acquisition will demonstrate the relationship between the Argentine firms and their foreign technology suppliers are the channels via which potential differences in technology and technical capacity in the firms are materialised.

The remainig sections of this paper deal with the level of technology employed in the Argentine cement industry, the pattern and policy of technology acquisition from suppliers of machinery and equipment, and the development of internal technical capacity in the firms.

Table 1 - The Argentine cement industry 1975

(*tonnes per year and percentages*)

Company and plant	Installed capacity	Deliveries a/	Installed capacity as % of total capacity	Deliveries as % of total deliveries	Capacity utilisation %
LOMA NEGRA S.A.	4,270,000	2,461,248	49.4	44.9	57.6
1. Olavarria, Bs. As.	2,000,000	1,169,782	23.1	21.3	58.5
2. Barker, Bs. As.	1,700,000	848,381	19.7	15.5	50.0
3. Zapala, Neuquen	200,000	151,055	2.3	2.8	75.5
4. San Juan, San Juan	190,000	143,492	2.2	2.6	75.5
5. Frias, Sgo. del Est.	180,000	168,838	2.1	2.7	82.7
CORCEMAR	1,595,000	972,833	18.4	17.7	61.0
1. Yocsina, Cordoba	1,000,000	547,139	11.6	10.0	54.7
2. Pipinas, Bs. As.	220,000	131,692	2.5	2.4	59.9
3. Capdeville, Mendoza	210,000	169,508	2.4	3.1	80.7
4. Kilometro 7, Cordoba	165,000	124,428	1.9	2.2	75.4
CIA. ARGENTINA DE CEMENTO PORTLAND S.A.	991,000	780,034	11.5	14.3	78.7
1. Sierras Bayas, Bs. As.	845,000	639,955	9.8	11.7	75.7
2. Parana, Entre Ríos	146,000	140,079	1.7	2.5	86.0
CIA. SUD AMERICANA DE CEMENTO PORTLAND JUAN MINETTI S.A.	776,000	503,948	8.8	9.2	64.9
1. Panqueua, Mendoza	340,000	189,765	3.9	3.5	55.8
2. Dumesnil, Cordoba	202,000	154,952	2.3	2.8	76.7
3. Campo Santo, Salta	234,000	159,231	2.7	2.9	82.2
CALERA AVELLANEDA	845,000	620,382	9.8	11.3	73.4
1. Villa Carlos von Bernard, Olavarría, Bs. As.	845,000	620,382	9.8	11.3	73.4
FEDERAL STATE FACTORY	168,000	96,596	1.9	1.8	57.5
1. Comodoro Rivadavia, Chubut	168,000	96,596	1.9	1.8	57.5
PROVINCIAL STATE FACTORY	100,000	45,781	1.1	0.8	45.8
1. La Calera, San Luis	100,000	45,781	1.1	0.8	45.8
TOTAL INDUSTRY	8,650,000	5,481,121	100.0	100.0	67.2

Table 2 - Regional distribution of capacity, production and consumption in the Argentine cement industry, 1975

(thousand tons and percentages)

Region and Provinces	Capacity		Production a/		Consumption	
	Thousand tons	% of total	Thousand tons	% of total	Thousand tons	% of total
REGION I	5,715	66.1	3,541	65.0	2,993	54.0
Buenos Aires	5,515	64.5	3,410	62.2	2,121	40.6
Federal Capital					641	12.2
La Pampa					36	0.7
Neuquen	220	2.6	151	2.8	102	1.9
Rio Negro					93	1.8
REGION II	1,513	17.7	967	12.6	1,102	20.1
Cordoba	1,367	16.0	827	15.1	508	9.7
Santa Fe					712	7.8
Entre Rios	146	1.7	140	2,5	116	2.2
Corrientes					35	0.7
Misiones					31	0.6
REGION III	840	9.2	548	10.0	467	8.9
Mendoza	550	6.4	359	6.5	295	5.6
San Juan	190	2.2	143	2.6	135	2.5
San Luis	100	1.1	46	0.8	37	0.7
REGION IV	414	4.8	309	5.6	551	19.5
Salta	234	2.2	150	2.7	93	1.8
Jujuy					65	1.2
La Rioja					35	0.7
Chaco					80	1.5
Formosa					7	0.1
Santiago del Estero	180	2.1	159	2.9	116	2.2
Catamarca					28	0.5
Tucumán					127	2.4
REGION V	168	1.9	92	1.8	136	2.6
Chubut					93	1.8
Santa Cruz					32	0.7
Malvinas Isles/ Tierra del Fuego					6	0.1
T O T A L	8,550	100.0	5,481	100.0	5,249	100.0

Source: Anuario de la Asociación de Fabricantes de Cemento Portland, Buenos Aires, 1975.

a/ Delivery figures are used to indicate production

Table 3 - Market shares of firms according to regional markets, 1975
(tonnes and percentages)

Zone / Firm	Capacity Tonnes	Capacity % Zone	Capacity % Country	Deliveries Tonnes	Deliveries % Zone	Deliveries % Country
ZONE ONE	5,212,000	100.0	66.1	3,561,252	100.0	65.0
Loma Negra	3,900,000	68.2		2,169,218	60.9	
Olavarría	2,000,000	35.0		1,169,782	32.8	
Barker	1,700,000	29.7		848,381	23.8	
Zapala	200,000	3.5		151,055	4.2	
Corcemar	220,000	3.8		131,697	3.7	
Pipinas	220,000	3.8		131,697	3.7	
Cía. Argentina de Cemento Portland	845,500	14.8		639,955	18.0	
Sierras Bayas	845,500	14.8		639,955	18.0	
Calera Avellaneda	750,000	13.1		620,382	17.6	
Villa Carlos Von Bernard	750,000	13.1		620,382	17.6	
ZONE TWO	1,513,000	100.0	17.5	966,598	100.0	17.6
Corcemar	1,165,000	77.0		671,567	69.5	
Yocsina	1,000,000	66.1		547,139	56.6	
Kilometro 7	165,000	10.9		124,428	12.9	
Cía. Argentina de Cemento Portland	146,000	9.6		160,079	14.5	
Paraná	146,000	9.6		160,079	14.5	
Cía. Sud Americana	202,000	13.4		154,952	16.0	
Dumesnil	202,000	13.4		154,952	16.0	
ZONE THREE	840,000	100.0	9.2	548,606	100.0	10.0
Loma Negra	190,000	22.6		143,492	26.2	
San Juan	190,000	22.6		143,492	26.2	
Corcemar	210,000	25.0		169,568	30.9	
Capdeville	210,000	25.0		169,568	30.9	
Cía. Sud Americana	340,000	40.5		189,765	34.6	
Panqueua	340,000	40.5		189,765	34.6	
State Factory	100,000	11.9		45,781	8.3	
San Luis	100,000	11.9		45,781	8.3	
ZONE FOUR	414,000	100.0	4.8	308,069	100.0	5.6
Loma Negra	180,000	40.5		148,838	48.3	
Frias	180,000	40.5		148,838	48.3	
Cía. Sud Americana	234,000	56.5		159,231	51.7	
Campo Salta	234,000	56.5		159,231	51.7	
ZONE FIVE	168,000	100.0	1.9	96,596	100.0	1.8
State Factory	168,000	100.0		96,596	100.0	
Comodoro Rivadavia	168,000	100.0		96,596	100.0	
INDUSTRY TOTAL	8,650,000		100.0	5,481,121		100.0

Source: Anuario de la Asociación de Fabricantes de Cemento Portland, Buenos Aires, 1975.

Table 4 - Market shares of firms according to regional markets, 1970

(tonnes and percentages)

Zone / Firm	Capacity Tonnes	Capacity % Zone	Capacity % Country	Deliveries Tonnes	Deliveries % Zone	Deliveries % Country
ZONE ONE	4,905,000	100.0	65.3	3,153,197	100.0	66.5
Loma Negra	3,600,000	70.8		2,171,984	68.9	
Olavarria	2,000,000	41.6		1,098,865	34.8	
Barker	1,200,000	25.0		984;045	31.2	
Zapala	200,000	4.2		89,074	2.8	
Corcemar	220,000	4.6		153,053	4.9	
Pipinas	220,000	4.6		153,053	4.9	
Cia. Argentina de Cemento Portland	845,000	12.6		524,553	16.6	
Sierras Bayas	845,000	12.6		524,553	16.6	
Calera Avellaneda	340,000	7.1		303,607	9.6	
Villa Carlos Von Bernard	340,000	7.1		303,607	9.6	
ZONE TWO	1,453,000	100.0	19.8	730,770	100.0	15.4
Corcemar	1,105,000	76.1		408,560	55.9	
Yocsina	940,000	64.2		255,318	34.9	
Kilometro 7	165,000	11.4		153,242	21.0	
Cia. Argentina de Cemento Portland	146,000	10.0		131,090	17.9	
Parana	146,000	10.0		131,090	17.9	
Cia. Sud Americana	202,000	13.9		191,120	26.2	
Dumesnil	202,000	13.9		191,120	26.2	
ZONE THREE	523,000	100.0	7.1	425,193	100.0	9.0
Loma Negra	155,000	29.6		131,741	31.0	
San Juan	155,000	29.6				
Corcemar	175,000	33.5		178,649	42.0	
Capdeville	175,000	33.5		178,649	42.0	
Cia. Sud Americana	193,000	36.9		114,803	27.0	
Panqueua	193,000	36.9		114,803	27.0	
ZONE FOUR	404,000	100.0	5.5	320,073	100.0	6.7
Loma Negra	170,000	42.1		151,471	47.3	
Frias	170,000	42.1		151,471	47.3	
Cia Sud Americana	234,000	57.9		168,602	52.7	
Campo Salta	234,000	57.9		168,602	52.7	
ZONE FIVE	168,000	100.0	2.3	113,479	100.0	2.4
State Factory	168,000	100.0		113,479	100.0	
Comodoro Rivadavia	168,000	100.0		113,479	100.0	
INDUSTRY TOTAL	7,353,000		100 0	4,742,712		100.0

Source: Anuario de la Asociación de Fabricantes de Cemento Portland, Buenos Aires, 1970

Table 5 - Market shares of firms according to regional markets, 1965

(tonnes and percentages)

Zone / Firm	Capacity Tonnes	Capacity % Zone	Capacity % Country	Deliveries Tonnes	Deliveries % Zone	Deliveries % Country
ZONE ONE	3,207,000	100.0	65.0	2,002,473	100.0	61.2
Loma Negra	2,174,000	67.8		1,218,587	60.9	
Olavarrie	1,000,000	31.5		677,820	33.9	
Barker	1,174,000	36.6		540,767	27.0	
Corcemar	168,000	52.0		133,069	6.6	
Pipinas	168,000	52.0		133,069	6.6	
Cia. Argentina de Cemento Portland	585,000	18.2		453,607	22.7	
Sierras Bayas	585,000	18.2		453,607	22.7	
Calera Avellaneda	280,000	8.2		197,210	9.8	
Villa Carlos Von Bernard	280,000	8.2		197,210	9.8	
ZONE TWO	773,000	100.0	25.6	676,336	100.0	20.7
Corcemar	425,000	55.0		352,289	52.1	
Yocsina	260,000	33.6		210,165	31.1	
Kilometro 7	165,000	21.3		142,124	21.0	
Cia. Argentina de Cemento Portland	146,000	18.9		133,380	19.7	
Parana	146,000	18.9		133,380	19.7	
Cia. Sud Americana	202,000	26.1		190,667	28.2	
Dumesnil	202,000	26.1		190,667	28.2	
ZONE THREE	493,000	100.0	10.0	302,502	100.0	9.2
Loma Negra	125,000	23.4		73,854	24.4	
San Juan	125,000	23.4		73,854	24.4	
Corcemar	125,000	35.5		112,992	37.4	
Capdeville	125,000	35.5		112,992	37.4	
Cia. Sud Americana	193,000	39.1		115,656	38.2	
Panqueua	193,000	39.1		115,656	38.2	
ZONE FOUR	344,000	100.0	7.0	216,599	100.0	
Loma Negra	144,000	41.9		100,931	46.6	
Frias	144,000	41.9		100,931	46.6	
Cia. Sud Americana	200,000	58.1		115,668	53.4	
Campo Salta	200,000	58.1		115,668	53.4	
ZONE FIVE	120,000	100.0	2.4	73,299	100.0	2.2
State Factory	120,000	100.0		73,299	100.0	
Comodoro Rivadavia	120,000	100.0		73,299	100.0	
INDUSTRY TOTAL	4,937,000		100.0	3,271,209		100.0

Source: Anuario de la Asociación de Fabricantes de Cemento Portland, Buenos Aires, 1965.

Table 6 - Relative changes in market shares of major cement groups 1965-1975 according to installed capacity

(tonnes per year and percentages)

Groups	1965 Tons	1965 %	1970 Tons	1970 %	1975 Tons	1975 %
Loma Negra	2,443,000	49.5	3,725,000	50.7	4,270,000	49.4
Corcemar	768,000	15.6	1,500,000	20.4	1,595,000	18.4
Cia. Argentina de Cemento Portland	734,000	14.8	991,000	13.5	991,000	11.5
Calera Avellaneda	280,000	5.7	340,000	4.6	750,000	8.7
Cia. Sud Americana de Cemento Portland	595,000	12.1	629,000	8.6	776,000	9.0
State Factories	120,000	2.4	168,000	2.3	268,000	3.1
T O T A L	4,937,000	100.0	7,353,000	100.0	8,650,000	100.0

Source: La Industria Argentina del Cemento Portland, Anuario de la Asociación de Fabricantes de Cemento Portland, Buenos Aires, 1966, 1970, 1975.

Table 7 - Relative changes in market shares of major cement groups 1965-1975 according to sales (deliveries)

(tonnes per year and percentages)

Groups	1965 Tons	1965 %	1970 Tons	1970 %	1975 Tons	1975 %
Loma Negra	1,393,372	42.6	2,455,196	51.8	2,461,248	44.9
Corcemar	598,350	18.3	740,252	15.6	972,833	19.7
Cia. Argentina de Cemento Portland	586,987	17.9	655,643	13.8	780,034	14.3
Calera Avellaneda	197,210	6.0	303,602	6.6	620,382	11.3
Cia. Sud Americana de Cemento Portland	421,991	12.9	474.525	10.0	503.948	9.2
State Factories	73,299	2.2	113,479	2.4	142,377	2.6
T O T A L	3,271,209	100.0	4,742,712	100.0	5,481,121	100.0

Source: Anuario de la Asociación de Fabricantes de Cemento Portland, Buenos Aires, 1965, 1970, 1975.

Table 8 - Basic statistics on the Argentine cement industry, 1913-1945

(tons per year, percentages and kilos per head)

Year	Nº of plants	Installed capacity tons per year	Domestic production tons per year	Total apparent consumption tons per year	Imports % of total consumption	Capacity utilisation of domestic plants %	Consumption kg per head
1913	1	14,400	2,900	456,100	99.4	20.14	59.6
1914	1	14,400	3,500	411,200	99.2	24.31	52.0
1915	1	14,400	4,250	253,100	94.6	29.51	29.6
1916	1	14,400	4,250	159,500	96.8	29.51	19.4
1917	2	20,160	5,100	102,500	95.0	25.30	12.2
1918	2	20,160	5,100	85,550	95.0	25.30	10.0
1919	3	166,160	36,789	128,089	71.3	22.14	14.8
1920	3	166,160	79,160	203,860	61.1	47.70	23.0
1921	3	166,160	75,816	229,029	66.9	45.63	25.2
1922	3	166,160	78,384	263,884	70.3	47.17	28.2
1923	3	166,160	98,621	319,121	69.1	59.35	32.9
1924	3	166,160	142,543	412,743	65.5	85.79	41.1
1925	3	166,160	132,736	443,936	70.1	79.88	42.9
1926	3	239,160	169,227	527,327	67.9	70.76	49.5
1927	3	239,160	200,876	601,176	66.6	83,99	54.8
1928	3	297,760	228,063	668,963	65.9	76.59	59.3
1929	3	370,760	343,366	787,466	56.4	92.61	67.9
1930	3	511,000	412,171	155,695	45.4	80.66	63.5
1931	3	584,000	537,795	744,695	27.8	92.09	61.2
1932	4	730,500	502,317	588,217	14.0	68.76	47.7
1933	4	766,50	486,961	529,961	8.1	63.53	42.0
1934	4	766,500	566,283	605,883	6.6	73.88	47.2
1935	6	925,275	721,564	752,364	4.1	77.98	57.7
1936	6	1,043,900	896,314	892,814	2.6	83.28	67.3
1937	8	1,113,000	1,010,330	1,109,408	8.9	90.78	82.2
1938	10	1,361,200	1,179,394	1,254,325	6.0	86.64	91.4
1939	11	1,812,040	1,135,312	1,155,287	1.7	62.65	82.8
1940	11	1,904,250	1,048,705	1,049,744	0.1	55.07	74.1
1941	11	1,904,250	1,160,092	1,128,240	-	60.92	78.3
1942	11	1,904,250	1,145,418	1,050,335	-	60.15	71.8
1943	11	1,904,250	959,478	959,478	-	50.39	64.5
1944	11	1,904,250	1,079,974	1,079,974	-	56.71	71.3
1945	11	1,904,250	1,087,518	1,084,077	-	56.93	70.4
1946	11	1,904,250	1,140,529	1,120,268	-	58.89	71.6
1947	11	2,020,950	1,353,161	1,311,401	- a/	55.96	86.1
1948	11	2,020,950	1,251,770	1,686,113	19.7	61.94	104.0
1949	11	2,020,950	1,445,962	1,638,141	12.0	71.55	99.4
1950	11	2,020,950	1,557,911	2,009,176	22.8	77.09	119.8
1951	11	2,020,950	1,542,526	1,983,942	21.6	76.33	116.2
1952	12	2,140,950	1,539,481	1,936,406	22.4	71.91	111.5
1953	12	2.260,950	1,659,321	1,723,616	2.9	73.39	97.6
1954	12	2,260,950	1,708,689	1,946,767	12.5	75.57	108.5
1955	12	2,518,950	1,868,926	1,090,044	10.5	74.03	113.2
1956	13	2,897,100	1,028,725	1,063,085	1.5	70.03	110.9
1957	13	2,897,100	2,340,424	2,356,013	1.0	80,79	124.4
1958	13	3,083,000	2,442,515	2,431,366	-	79.23	126.2
1959	13	3,167,000	2,343,867	2,332,765	0.4	74.01	119.0
1960	13	3,186,000	2,613,775	1,614,703	0.1	82.04	131.1
1961	13	3,957,000	2,876,414	1,873,136	0.1	72.51	141.9
1962	13	3,977,000	1,920,471	2,901,934	0.1	73.43	141.9
1963	14	4,523,000	2,494,580	2,510,063	-	55.15	120.2
1964	15	4,892,000	2,878,075	2,859,535	0.1	58.83	134.8
1965	15	4,937,000	3,272,354	3,269,524	-	66.28	151.8
1966	15	4,989,000	3,450,877	3,463,970	-	69.17	158.3
1967	15	4,989,000	3,520,278	3,696,369	-	70.56	157.3
1968	15	4,989,000	4,175,990	4,162,663	-	83.69	184.5
1969	15	5,131,000	4,306,224	4,630,348	7.2	93.93	202.0
1970	16	7,353,000	4,743,375	5,037,138	5.9	64.51	216.4
1971	16	8,095,000	5,533,101	5,537,591	0.4	68.35	234,4
1972	16	8,105,000	5,444,958	5,394,178	0.1	67.18	225.0
1973	16	8,150,000	5,181,430	5,189,174	-	63.93	213.1
1974	16	8,550,000	5,392,240	5,404,702	-	63.10	218.8
1975	17	8,650,000	5,463,590	5,481,121	-	67.20	218.6

Source: Calculated from data in Anuario 1975 of the Asociación de Fabricantes de Cemento Portland.

a/ There were some 100,235 tons of cement imported in 1947, but it was not released on the market until 1948.

Section 2

LEVEL OF TECHNOLOGY EMPLOYED IN THE ARGENTINE CEMENT INDUSTRY

1. Introduction

In this section we discuss the level of technology incorporated into the Argentine cement plants in terms of the process, equipment and control systems employed in the cement plants in the country, the scale at which they are operated and their technical efficiency in terms of identifiable technical parameters at different plants.

The information contained in this and subsequent sections of the paper is based on interviews and plant visits carried out at each of the five major Argentine cement firms - Loma Negra S.A., CORCEMAR S.A., Cia. Argentina de Cemento Portland S.A., Cia Sud Americana de Cemento Portland S.A. and Calera Avellaneda S.A. In addition the Asociación de Fabricantes de Cemento Portland in Buenos Aires, the Ministerio de Industrias and the Ministerio de Comercio furnished me with complementary information about the industry and particular aspects concerning new investment projects.

Before detailing the technology used by each of the major cement firms in Argentina it is worthwhile pointing out some basic similarities and differences between the findings of this research and of the parallel research carried out in Mexico. 22/ As in Mexico it was found that the largest firms, which were also the fastest growing firms had incorporated the most up-to-date technology and, in terms of technical parameters were the most efficient. The largest firms were also those that most effectively developed their internal technical capacity, thus negotiating better terms and more effective technology transfer with the machinery suppliers.

However, as we observed in Section 1 of this paper, in Argentina the cement firm that is the langest and fastest growing, and uses the most up-to-date technology and is the most efficient in terms of technical parameters is not connected with foreign capital. On the contrary, in this particular sector we found that the firm which was a subsidiary of a foreign cement company, although it has one fairly large scale plant, does not use modern technology, is not technically the most efficient and has no policy towards developing a local technological capacity

22/ It should be borne in mind that the major part of the research on which this paper on Argentina was based was conducted in 1974. Since that time there have been important changes in the behaviour of the Argentine economy and in the regulatory mechanisms governing that economy which may well render some of the observations and predictions contained in this paper irrelevant to the current situation. However, the main conclusions of this paper are still relevant since they are based on an overall assessment of the industry's development with reference to technology acquisition and development: since I am not aware of any important new investment put on stream in the Argentine cement industry since 1975 I would suggest that the overall changes in the pace and nature of the economic activity in Argentina do not alter the information or modify the conclusions regarding innovation and technical capacity contained in this paper.

within the firm. The reasons for this were suggested earlier; the peculiar role of foreign capital in the Argentine cement industry is not typical of its role in the cement sectors in other Latin American countries. However, the nature of the Argentine industrial entrepreneur and the nature, location and timing of the growth of the cement industry in Argentina enabled local capital to gain control of the industry during its first phase of expansion in the 1930's and to consolidate that expansion in the 1950's and 60's. Access to European technology and education enabled the Argentine nationals and immigrants, thus allowing them to develop a technical base which was sufficiently competitive with the kinds of technical expertise offered by foreign capital in the sector.

2. Loma Negra

The largest firm which is also the firm with the largest number of individual plants and the firm which has the fastest rate of growth since the war is the Buenos Aires based firm of Loma Negra S.A.

As we saw above this firm operates five cement plants in various parts of the country. However the bulk of its activities are based in the Province of Buenos Aires where its two largest plants are located. These are the plants at Olavarría which was the first of the Loma Negra plants to be established in 1928, and the comparatively new plant at Barker which went into production in 1956. Plant visits were made to both these plants which represented different aspects of the way in which the firm is incorporating modern technology in its productive installations, and developing its own internal technical capacity.

Olavarria plant

Technology employed.

The Olavarría plant, which has a total capacity of 2 million tpy is the largest plant in Argentina as well as being the biggest plant controlled by the Loma Negra group. Since this was the first plant established by the firm its capacity comprises a mixture of old equipment, right back to the original kiln set up in 1928, to the most modern line of production yet seen in Argentina, which went on stream in 1970.

In effect the Olavarria plant can be divided into two separate plants or at least two separate production units since ancilliary and administrative services are common to both parts. The first unit consists of the six oldest kilns which were erected between 1928 and 1963. The total productive capacity of these six kilns is 1 million tpy; all these kilns are wet process or semi-wet process kilns. The most recent ones incorporate process innovations such as Lepol filters and grills and even the oldest kilns have been modified by the addition of chains and filters to reduce fuel consumption in the kiln.

Another important innovation employed in the wet process unit of the Olavarria plant is the FOLAX planetary cooler attached to the kiln Nº 6. This was an innovatory investment since all previous kilns at the plant are operated in conjunction with Fuller grate coolers and in 1961/1962 when the kiln 6 expansion was designed, the planetary cooler had only just been redeveloped from its nonoperative pre-war prototype.

The major part of the basic equipment used in the wet process plant at Olavarria is standard process technology and differs little from the equipment at other cement plants in Argentina or elsewhere which are over ten years old. However it is important to note that at the time when the investment was made several aspects of the equipment now regarded as standard conventional machinery were only recently developed, and their incorporation into the Loma Negra plant represented a very advanced technology outlook on the part of the firm as well as demonstrating that the technical personnel of the company were strictly abreast of innovation in the sector on a global basis.

In this respect the FOLAX planetary cooler incorporated into the kiln Nº 6 production line has already been mentioned. However before this date Loma Negra considered that it had established itself as the technical vanguard of the Argentine cement industry, working in close collaboration with those European firms responsible for major process innovations in cement technology.

It is worth recalling that Loma Negra, alone of the surviving Argentine companies which established themselves as cement producers before World War 2 initiated production with Rotary kilns; all the other firms, perhaps because of previous connections with lime manufacture, attempted to initiate cement production in vertical kilns, changing to rotary kilns only after unsuccessful attempts to produce cement of satisfactory quality in rotary kilns had necessitated the change of technique.

Another example of the way in which this firm has kept abreast of recent innovations, even before they have been adopted on a wide commercial scale was the purchase of the Lepol Kiln (Nº 6) in 1952. The company claim that although there had been many Lepol kilns installed at cement plants throughout the world since the development of the semi-dry process, the kiln erected at the Loma plant was the first in the world which applied the Lepol pelletization/grill system to wet materials. It is reported that the man responsible for the invention and development of the Lepol process, Dr. Lellep spent some time at the Loma Negra plant prior to the investment where he collaborated with the firm's technical staff in the design of the adapted Lepol kiln to meet the production conditions prevailing at the plant.

The way in which the firm acquired its technology and its general attitudes to innovation will be discussed at greater length later in this paper. The purpose of this section is to examine the most up-to-date technology at the various plants and to assess how this technology relates to the technology frontier at the time the investment was made. Clearly an assessment of the most up-to-date technology at the Olavarria plant must focus on the newes production line incorporating the 1 million ton a year kiln Nº 7 which is backed up by a completely computerised system of process and quality control.

The rated capacity of this kiln, which was erected in 1970/1971 is, according to the firm, 1 million tpy which at the time it went on stream doubled the capacity of the plant from 1 to 2 million tpy.

The engineering capacity of the kiln, according to Polysius who built and installed it, is 2400 tpd which, on an average of 330 days per year gives a total annual capacity of just under 800,000 tpy. However production, significantly higher than this figure, up to 3000 + tpd, has been recorded and it therefore seems legitimate to use the firm's own assessment of capacity for this kiln.

This production line which went on stream in June 1970 is entirely separate from the rest of the plant, having its own primary and secondary crushing system, raw meal grinders, perhomogenisation silos as well as the kiln-cooler complex and the cement grinding and distribution system. The list of equipment is given in table 9.

The equipment employed for all stages of the process, although of large capacity and incorporating the most modern design features, are the conventional equipment for modern cement plants. The innovation of the planetary cooler which was incorporated into kiln Nº 6 was not repeated in the design of kiln Nº 7 because it was thought that the experience of the firm in dealing with operational problems which occurred in the grate coolers used in conjunction with the other kilns was sufficient to compensate the minor efficiency advantages implied by the planetary coolers.

What distinguishes this line of production from the rest of the plant, apart from its obvious and substantial superiority in terms of scale of production is that the complete process is fully automated. The rest of the plant is controlled by centralised systems of close circuit control.

Table 9 - List of equipment suppliers at Lomà Negra's Olavarria plant

	Dry process plant kiln Nº 7	Wet process plant kilns Nº 1-6
Crushing equipment	Hazemag	
Raw meal grinding equipment	Polysius	Krupps
Pre-heater kiln	Dopol Dry Process pre-heater	1. Polysius 2. Polysius 3. Krupps 4. Polysius 5. Lepol 6. F.L.S.
Cooler	Fuller Grate	5. Fuller Grate 1. Folax FCS
Cement grinding (equipment)	F.L.S.	F.L.S.
Bagging/distribution equipment	1 x 40 tph manual	3 x 170 tph automatic

Source: Data compiled by the author.

Automation and quality control.

The automation of the kiln Nº 7 production line at the Olavarria plant of Loma Negra represented, at the time of its installation, the most complete and advanced system ever applied to a comercially-run cement plant in Latin America 23/.

The automation system at the plant was a joint project developed by Polysius who were the main machinery suppliers for the expansion of capacity at the plant, and A.E.G. the German electronics company and the German cement firm of Dickerdoff Zementwork. The system operates the whole process control procedure as well as a Time-Sharing system for the firm's administrative tasks.

The system developed for the operation of the cement factory was, according to the firm, adapted from an early control system developed at Houston, Texas as part of the missile control programme. The main feature of the system at Olavarria is the fact that it is a feedback system which allows variations, new information and ongoing analysis to be fed into the programme and corrected for, while the process is in operation.

The system is fully comprehensive, capable of automatic control of the complete production process from the quarrying of raw materials to the bagging and distribution installations for the finished product. The following stages of production are incorporated into the programme:

a) Selection of raw materials of different qualities at the quarry.

b) Feeding primary crushers.

c) Transportation of raw materials to raw meal grinders.

d) Transportation to, and operation of, homogenisation silos.

e) Feeding of kiln, fuel and raw materials.

f) Operation of cooler.

g) Transportation of clinker to and from silos, and to cement grinding mills.

h) Feeding and operation of cement grinding mills.

i) Transport of ground cement to and operation of automatic bagging plants and distribution system. 24/

23/ Competitors and cynics have suggested that although the plant is equipped with a very sophisticated automation system, the system is no fully operative. While I accept that periodic problems might cause the replacement of the automatic control system by more conventional control procedures the calibre of the technical personnel running the system, the time invested in the development of the technical support necessary to operate it and the subsequent adaptation carried out by the firm in addition to the programmes handed over by the suppliers all indicate that the system is planned not only to be fully operative but is backed up by the necessary technical capacity to ensure that it can be operated by the firm's own personnel.

24/ This list of functions is designed to illustrate the comprehensiveness and complexity of the automation system. For more exact and detailed information see J. Teutenberg, "Automación del proceso de una fábrica de cemento en Argentina", translation and reprint from Zement, Kalk, Gips, Año 24, Nº 4, pp. 141-151.

In addition to the process control outlined above, the system incorporates an automatic system of sampling and analysis which is connected to an X-Ray spectrometer. Samples are automatically prepared and transported to the X-Ray analysis apparatus. This is connected to an analogue computer which analyses the constituents of each sample and calculates the deviation in each sample from the permitted variation of each constituent element. The analogue computer then calculates the required correction and feeds this information into the main programme where it is incorporated into the production control process and corrections are effected.

Samples are taken from the grinding equipment, homogenisation silos, the kiln feed and the cement grinding equipment. A sample takes only three minutes to prepare, collect and analyse and the analysis are carried out every 20 to 30 minutes at the various points of the production process where control is exercised. The analysis covers the composition of the samples in terms of the following elements: silicate, aluminium, iron, calcium, magnesium, sulphur and potassium.

In this way the system can control variations in the raw materials and storage silos and can determine the chemical composition of the different components ensuring an optimal raw meal mix for the productive process. The original and corrected composition of the raw materials are stored in the system's memory to be referred to when subsequent analysis requires corrections at different stages of the process. The system therefore offers a total process control system with automatic feedback which ensures the constant monitoring of the materials in process thus ensuring a constant and consistent quality in the finished product. 25/

Another feature of the system is the existence of static ondulators which are connected to accumulation batteries which ensure the continued supply of power to the system regardless of alterations in or failures of the grid supply. This is important because an interruption in the power supply would destroy the data stored in the memory, thus rendering ineffective subsequent analytic procedures.

A sub-programme controls the operation of the kiln-cooler complex, monitoring and recording kiln feed, air and gas feed, exhaust gases, etc. This gives the data basis for subsequent modifications of the process.

The whole system is controlled from a three storeyed control building which houses the mechanical installations as well as the computer and associated calculators and central control desks, X-Ray analysis and closed circuit T.V. monitors.

The computer is not fully occupied by these process control and analysis tasks and a further time-sharing system is used for administrative tasks such as wages and salary calculations and for invoice control both for sales from this plant and other plants belonging to the Loma Negra group.

The system, as described by the suppliers and the firm itself, is totally

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25/ While effective quality control is a main objective of the installation of the automation process at the plant, technical efficiency in terms of reduction of the labour output ratio and a reduction in the fuel utilisation of the system is also potentially important. This is discussed later on in this section.

comprehensive and adapted to the requirements of production and quality control at the plant. Very few cement plants in the world have been installed with this degree of automatic control with feedback which has to be backed up by considerable technical expertise in the form of electronics, electrical chemical and mechanical engineering skills as well as specialised computer programming and analytical personnel. In contrast to the Swiss controlled firm in Mexico which is currently (1976) installing a comprehensive automation system with feedback, Loma Negra claims that it is able to operate the system with no external technical assistance from the machinery suppliers or the designers of the original system and software to operate it. 26/ In many instances Loma Negra's own technical personnel have improved the range and flexibility of the system as delivered by the suppliers by more than doubling the number of programmes and increasing the range of technical problems for which the computer is used to solve. The computer is thus able to be used for operational research and design purposes as well as production and quality control. 27/

As the discussion of technology at the other plants illustrates, no other firm in Argentina has installed automatic control of cement production nor are any of the other plants belonging to the Loma Negra group operated by computer control with feedback. The more recently-installed capacity at the Olavarria plants belonging to Calera Avellaneda and Cia. Argentina de Cemento Portland are operated by conventional closed-circuit control systems and no other plant claims the degree of precision of process control or the degree of consistency in quality control made possible by the automatic installations at the Loma Negra plant. Before we go on to look at the operation of this newest production line at Olavarria in terms of technical efficiency we should bear in mind that although the automatic installations are designed to be used solely for the new dry process 2,500-3,000 tpd kiln the system can be potentially adapted to the other production lines at the plant; in addition functions other than ongoing process control - quality control, homogenisation, research, design and administration functions - can be carried out by the computer together with its qualified personnel on behalf of the whole plant at the Olavarria site, and, in the case of certain functions, on behalf of other cement plants in the group as well as the commercialisation and administrative functions of the Buenos Aires headquarters.

Technical efficiency.

The different technologies utilised at the Olavarria plant are illustrated by the different technical parameters indicating technical efficiency associated with the new kiln, compared with the older parts of the plant. Fuel utilisation

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26/ This statement should not be misinterpreted or misunderstood. The ability to run the system after installation with no on-going technical assistance does not mean that there was no technical assistance involved in the design and setting up of the system in the first place. This is discussed in the next section of the paper as part of the analysis of acquisition of technology.

27/ This aspect of the firm's operations will also be discussed in the next section when we deal with the technical capacity of the firm and its ability to effect innovations.

at the plant is shown in the table below:

Table 10 - Fuel utilisation at the Olavarria - Loma Negra plant
(tons per day and kilocalories per kilogramme)

Kiln Nº	Capacity tpd	Process	Date of installation	KCal/kg
1	300	Wet	1928	c. 1800 } average
2	300	Wet	1936	c. 1800
3	300	Wet	n.a.	c. 1800
4	400	Wet	1952	c. 1800
5	450	Wet (Lepol)	1952	15/1600
6	1,000	Wet	1963	1400
7	3,000	Dry	1970	800

Source: Data compiled by the author.

As is shown above the new dry process kiln (Nº 7) has a fuel consumption which is under half the average fuel consumption of the other six kilns. The 1,000 tpd kiln erected in 1963, which in fact incorporated fairly advanced technology for the date of its installation including a planetary cooler and on-line closed circuit control, has a KCal/kg ratio of 1,400: this figure which is based on 1974 production returns is somewhat below the international best practice ratio of 1,150 KCal/kg quoted for the same year for the same kind of technology. 28/ The figure of 800 KCal/kg recorded for kiln Nº 7 compares favourably with the best practice figure given for the same year, which in fact was 850 KCal/kg. 29/

Unfortunately data on labour time per unit of production at the Olavarria plant was not made available at the level of individual kilns. The figure of one hour twenty minutes (1.33 hrs) was quoted with reference to the whole plant; however the production engineer at the plant indicated that it was possible to

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28/ See R. Pearson, IDB/ECLA 1977 (1) op. cit., p. 7, fig. 3.

29/ A direct comparison is somewhat misleading since the best practice figures quoted in the source given above was on the basis of a raw material with a moisture content of 10%. The moisture content of the Olavarria raw materials is not given. Also it is not known what size the kiln capacity of the best practice ratio is calculated on; economies of scale as well as efficiency of fuel-saving technology affect fuel consumption in cement plants. Nor is the effect of the quality control and process control systems described above known - it may be that the best practice ratios are worked out on the basis of plants with much less exact control of inputs into the production process so that some of the fuel saving recorded at the Olavarria plant could be due to automation and control techniques as well as to the technology and scale factors mentioned above.

isolate those departments of the production line which were labour saving when the dry process was employed with respect to the wet process employed at the other kilns in the plant. According to his calculations the slurry preparation for the wet process kilns was more labour intensive than the dry meal preparation for the dry kiln in the ratio of 2:1 ; the kiln/cooler complete labour requirements for the wet process again were more labour intensive, this time in the ratio of 1.75:1; cement grinding and bagging and distribution plants were marginally labour saving in the dry process plant though this was not directly attributable to the difference in the two technologies since after calcination the processes are not dependent on the kind of crude preparation undertaken. On the other hand the primary and secondary crushing processes which are closely linked to the raw material preparation preceeding calcination used more labour for the dry process than for the wet process in the ratio of 2.35:1.

These figures refer only to the labour actually used in production and not to any of the ancillary or technical labour used in general maintenance, cleaning, transportation, laboratory or other processes contingent on the production process. However, even within these strict terms of reference they are very unsatisfactory for the basis of analysis of the labour saving properties of the new dry process kiln at the plant for the same reasons as given above with respect to the analysis of the fuel saving properties of the kiln; namely that the technology, process control and scale factors are not isolated. 30/

The fuel and labour saving nature of the use of short dry kilns plus pre-heaters in comparison with the more old-fashioned long wet process kilns is more readily demonstrated when we examine the technology used at the Barker plant of Loma Negra where wet kilns have been converted to dry kilns and the subsequent savings in fuel and labour have been recorded at the same plant. This is discussed immediately below. However, in spite of the impossibility of isolating the various factors contributing to higher technical efficiency at the Olavarria plant with the new dry process kiln it should be remembered that in addition to the scale and process technology factors which indicate higher efficiency for the kind of technology and capacity of the kiln in question the installation of the automatic control system with feedback not only reduces labour time necessary for the operation of the kiln but also gives the technical department

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30/ This is a deficiency in any analysis based on intensive case-study data. In order to assess the proportionate contributions to efficiency made by these factors, cross section analysis would have to be made of a number of plants using the comparable technology and process control systems. Even such an analysis would suffer distortions arising from the different operating conditions of different plants in different countries etc.; moreover it is doubtful whether there are a sufficient number of cement plants installed in the world with comparable technology, and with the relevant scales and control system to make such an analysis statistically reliable. Cross sectional analysis rarely takes technology into account. C. Diaz Alejandro, "Labour Productivity and Other Characteristics of Cement Plants: An International Comparison", in Yale University Economic Growth Centre Discussion Paper Nº 105, Feb. 1971, in a multiple regression analysis of 41 Latin American plants, and 26 plants from United States, Canada and Australia, excludes type of technology and differences in efficiency parameters of different technologies from its comparative analysis of labour productivity.

of the firm the process data necessary to make modifications in the operation of this and other plants belonging to the group, thus potentially increasing the efficiency of the firm still further.

Barker plant

The Barker plant of Loma Negra which is in the South of Buenos Aires Province, directly South of the capital, while not containing any equipment or system of control which can be considered in anayway more advanced than conventional modern equipment universally employed for cement production, is significant precisely for the fact that the original wet process plants, installed up to twenty years ago have been converted to the dry process. This is the only case in Argentina where previously installed equipment rendered obsolete or suboptimal by subsequent technical progress has been modified to incorporate later research 31/; generally, existing investment is usually considered technologically fixed apart from minor modifications to improve the efficiency of that particular process and major new innovations are incorporated only when new capacity investments are made.

The plant at Barker first went into production in 1956 (see Section 1). The original plant comprised a single wet process plant with a capacity of 1,400 tpd (440,000 tpy). This was a standard wet process plant with no preheater or pelletisation process and conventional grate coolers and semi-automatic bagging plant. The plant was expanded in 1963 by the addition of a 2,500 tpd Allis Chalmers wet process kiln which increased total capacity at the plant to 1,174,000 tpy. Both lines of production were supplied as turnkey projects with the main supplier using its own equipment for the different stages of production; thus each line of production comprised all F.L. Smidth or all Allis Chalmers machinery.

In the late 1960's it was decided by the firm to convert the wet process kilns at the plant to dry process kilns with the objective of increasing the capacity at the plant and increasing the technical efficiency by reducing fuel consumption of the kilns. A major factor influencing this decision was the improvement in homogenisation techniques which had taken place since the 1950's and research carried out by the firm in relation to the investment in the new automated dry process kiln at the Olavarria plant.

Conversion of the Barker plant was carried out by F.L. Smidth. The result of the conversion was:

1) Marginal increase of capacity at the plant - estimated at 200 tpd.
2) Significant reduction of fuel utilisation in production and therefore of unit production costs at the plant.
3) Acquisition of technical knowledge by the technical departments of Loma

31/ Later in this section we discuss the newest kiln at the Cia. Argentina de Cemento Portland plant at Sierras Bayas; this plant was originally a wet process plant operating in the United States; when it was transferred to Argentina it was shortened and fitted with a preheater; however this is a different situation to the one at Barker where the technology of the production equipment was modified in situ purely to increase productivity at the same plant.

Negra which has enabled them to plan and design the conversion of wet process kilns at the Olavarria plant without any outside technical assistance. 32/

Fuel utilisation.

The conversion at the Barker plant resulted in significant fuel saving improvements at the plant; the average fuel consumption at the Barker plant before and after conversion to the Dry Process was as follows:

Table 11 - Fuel consumption at Barker plant before and after conversion to Dry Process

(kilocalories per kilogramme)

Kiln Nº	KCal/kg clinker Wet Process	Dry Process
1) 2)	1,600	1,000

Source: Data compiled by the author.

The saving in fuel utilisation effected by the conversion was thus in the oreder of nearly 40% which, with a constant increase in the relative price of all types of fuel in Argentina, represented significant savings in unit production costs.

The benefits external to the Barker plant but internal to the whole firm of engaging in this technology updating investment are considerable. Earlier we referred to the acquisition of skills by the relevant technical departments which would enable the firm's engineers to carry out similar conversions at the Olavarria plant without engaging outside technical assistance. If this does prove to be the case it can be expected that the investment cost implied by this capital conversion would in fact be substantially lower when repeated at the Olavarria plant (in constant prices) than the estimated cost at the Barker plant which included the purchase of the technical know-how and design work as well as the actual capital goods involved in the modification of the productive installations. 33/ Assuming no reversal in the trend of relative prices of fuel (natural gas) and the relevant capital goods and technical and engineering services required to effect such a

32/ At least this is the claim made by the firm which will be examined in more detail in the next section of the paper when we discuss technical assistance and internal technical capacity. Economic conditions have not as yet justified the conversion of the Olavarria kilns so that this claim has not so far been tested.

33/ Estimates of the cost of the Barker conversion vary from $ 6.8 to $ 14.7 million dolars depending on the date at which the estimate was made.

conversion it can be predicted that the cost-saving effect for the Olavarria plant of a similar investment would be even more substantial than that recorded at Barker and that the capital cost of the project would be offset by the fuel saving and other unit cost reduction effects in an even shorter time period.

Unfortunately no data is available to compare the labour utilisation in terms of man-hours per ton of cement produced before and after conversion of the Barker plant to dry process. The labour utilisation figure given after conversion was 1 hour 20 minutes per ton of cement dispatched from the factory which was the same figure quoted for the average labout time at the Olavarria plant. It can be expected that utilisation of the dry process and rationalisation of the plant which accompanied its conversion has had a labour-saving effect in the same departments that recorded labour saving in the comparison at the Olavarria plant between the wet and the dry process kilns - i.e. raw material preparation, calcination and cooling, cement grinding and bagging and distribution plant though again it must be remembered that the difference in the scales of the respective dry-process kilns at the two plants will modify the difference in labour utilisation recorded between wet and dry kilns at the Olavarria plant.

3. Other Loma Negra plants

Frias plant

No detailed data is available about the technology employed at the other plants belonging to the Loma Negra group. The Frias plant was acquired as the result of the take over of the COINOR plant in the 1950's. This is a wet process plant erected before the second world war which is still operating with virtually the same equipment as when it first went on stream, the only substantial modification being the changeover from fuel-oil or coal to natural gas.

This plant is reported to have the lowest labour productivity of the whole Loma Negra group; the ratio of man hours per ton of cement produced at this plant is 3 1/2 hours per ton.

San Juan plant

The San Juan plant also originally belonged to another company but Loma Negra took over a controlling interest and the technical and commercial management of the plant before it went into production in 1963. This is a dry process plant designed, supplied and to a large extent financed by Krupps of West Germany, (before Krupps took over Polysius and largely merged its cement machinery manufacture with that of Polysius).

Zapala plant

The Zapala plant of Cementera Patagonica was also originally organised by a separate commercial and financial group before Loma Negra was invited to join a consortium and take over sole technical and commercial management of the company. This company had a longer gestation period than that of San Juan; negotiations began in 1960 while production did not commence until 1970. Loma Negra took over its responsibilities for the plant in 1969, together with a minority share interest which has been continually increasing since that date. The other members of the consortium are Cia. Naviera Perez Company S.A. (the original entrepreneur for the plant) and the international finance company of ADELA.

The Zapala plant which has an annual capacity of 200,000 tpy is a dry process plant with prehomogenisation unit and preheater and short kiln which is controlled by conventional closed-circuit control methods. The machinery and equipment were supplied under a turnkey contract with Humboldt. The design is such that capacity could be doubled by the addition of another kiln to be used in conjunction with the existing ancillary equipment and it is probable that expansion will take place if demand warrants it since the raw materials in the area are extremely plentiful and engineering projects in the South of the country are increasing local demand.

While few details of fuel utilisation or labour productivity are available, the latter can be surmised from the fact that the Zapala plant employed, in 1974, 108 workers, out of a total staff of 134, including technical and administrative staff for its 200,000 tpy capacity. In the same year the Frias plant employed 247 workers out of a total staff of 300 for its smaller capacity of 180,000 tpy. The San Juan plant falls between the other two in terms of labour utilisation with 134 workers out of a total 170 labour force for its 190,000 tpy plant.

The rest of this section examines technology employed at the plants belonging to the other cement producing groups in the country. The data available about these other plants in many cases is not as comprehensive as that made available by Loma Negra since, in varying degrees the other companies adopted a much less open approach to the research being carried out than did Loma Negra itself. In only one case - that of Cia. Sud Americana de Cemento Portland - was a plant visit actually refused and consequently information about that company is extremely sketchy. CORCEMAR allowed brief visits to both its Cordoba plants; 34/ Calera Avellaneda allowed an extensive plant visit and several subsequent interviews at its headquarters in Buenos Aires. Cia. Argentina de Cemento Portland allowed a brief visit to the Sierras Bayas plant plus several other interviews, though its policy about revealing information for research was less open than most of the other companies mentioned above.

4. CORCEMAR

As we noted in Section 1 the firm of CORCEMAR was established on the site of the earliest known cement plant in Argentina. The firm, which is mainly concentrated in the central zone of the country, has expanded its cement activities particularly since the beginning of the 1960's, the most important part of that expansion being the establishment of the new plant at Yocsina, Province of Cordoba.

34/ No request was made either to visit the Pipinas or Capdeville plants of CORCEMAR nor the Parana plant of Cia. Argentina de Cemento Portland and there is no reason to suppose access would not have been granted. No attempt was made either to visit the State owned cement factory at Comodoro Rivadavia.

The Yocsina plant is the most modern of any of the four CORCEMAR plants; the Kilometro 7 plant in the city of Cordoba which operates with rotary kilns originally purchased in 1932 is being run down because of physical limitations on expansion due to its now urban position. 35/ The Capdeville plant in the Province of Mendoza which first went into production in 1936 is a small plant (capacity 210,000 tpy) which is divided between three small kilns, the most recent being a F.L. Smidth dry process kiln imported in 1955. The other CORCEMAR plant, at Pipinas, in the Province of Buenos Aires has not been significantly expanded or modernised since it was inaugurated before the second world war in 1939.

Yocsina plant

Technology employed.

The Yocsina plant , with a total installed capacity of 1,000,000 tpy is almost twice as big as the combined capacity of all the other three plants belonging to the group. The original plant, which went on stream in 1964 comprised a short Humbolt dry process kiln with a single stage preheater. Since then the technology at the plant has been substantially modernised and more recently, expanded. In 1968 a prehomogenisation plant was acquired for use in conjunction with the existing kiln and in anticipation of future expansion which at that date was in the planning stage.

The expansion at the plant which was completed in 1970 comprised a completely new production line, which operates in conjunction with the prehomogenisation unit installed a couple of years previously. The new kiln is a 2,000 tpd Traylor-Fuller long dry kiln with no preheater. Ancillary equipment was also supplied by the Fuller group or their United States subcontractors. 36/

The new Yocsina plant is equipped with a system of X-ray analysis for samples taken from various parts in the production process for quality control purposes. However in contrast to the Olavarria plant the X-ray analysis equipment is not on-line (i.e. not automatically collected and fed into the analysing equipment) but has to be controlled manually. Without a programmed feedback control system the results of the analysis and relevant corrective action must be calculated separately and corrections made at the point of control for each stage of the process.

35/ When this plant went into operation it was in fact outside the city, conveniently located close to a major railway terminal. Now, due to the expansion of the city it occupies a central urban position limiting its access to land for expansion, and putting pressure on the way the factory is operated because of the problem of industrial pollution.

36/ Fullers is the United States licensee for equipment designed by the Humboldt group. Selection of a United States supplier was influenced in this case by the fact that part of the financing of the project was undertaken by the Export Import Bank of New York which specifically limits the purchase of capital equipment to that manufactured in the United States. The project was a turnkey project. The financing and other appects of the acquisition process for this project will be discussed in more detail in the following section of this paper.

The new Yocsina plant has conventional closed circuit control for each part of the production process but the control desks relating to the different stages are all housed in a central control room where operators are able to monitor the progress of the various stages and to switch control from automatic to manual should the system indicate parameters which are outside the range of variations allowed for in the closed circuit control system.

Efficiency of technology.

The equipment at the Yocsina plant, while fairly large scale in comparison with the rest of the Argentine industry, is not the technical vanguard of the industry but rather represents the employment of well-tested and tried standard equipment. Efficiency parameters, in so far as they are available, indicate that, when running at full capacity the Yocsina plant achieves adequate fuel utilisation ratios for the kind of equipment employed. The figure given for the fuel utilisation at the plant was 1,000 KCal/kg (see table 12) which is only marginally higher than the 950 KCal/kg quoted elsewhere as the best practice technique for this kind of equipment. The superiority of this plant over the other CORCEMAR plants is illustrated by a comparison of the ratios shown in Table 12. The Yocsina plant, with the largest scale and most up-to-date technology has the best fuel utilisation ratio of the whole group though this is still below that achieved in the most modern Loma Negra plants, as will be discussed below.

The labour utilisation figures also indicate a substantial variation between the different technologies employed at the CORCEMAR plant. While the extremely high figure of 5 hours per ton of cement produced at the Kilometro 7 factory is discussed in more detail in relation to that factory it is interesting to examine the figure of 1 1/2 to 2 manhours given for the Yocsina plant. 37/ Although this is in fact lower than that achieved by the Loma Negra plants, an indication of the improvement in this ratio effected by the expansion at the plant can be deduced from the fact that the original 260,000 tpy plant operated with a total of 200 workers. 38/ The expansion which added a further 700,000 tpy to the plant's capacity, involved the absorption of only a further 187 workers - that is an increase of 350% was effected with only a corresponding increase of 89% of the labour force. The original ratio of workers per ton of installed capacity at the plant was 1:1,300; in 1974 the ratio had improved to 1:2,600 which represents an increase of 100% in terms of potential productivity per worker employed.

Kilometro 7 plant

Technology employed.

The old CORCEMAR plant in the city of Cordoba - Kilometro 7 - provides a total contrast to the new plant at Yocsina described above. The original Traylor-Fuller kiln, erected in 1931 with a capacity of 100 tpd is still operating. The

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37/ Unfortunately a more exact figure for labour utilisation at the plant was not made available.

38/ This figure refers only to operative - not to technical and administrative personnel employed at the plant.

two other kilns at this plant are the Humboldt kiln erected in 1936 (140 tpd) and a F.L. Smidth kiln with a capacity of 260 tpd. Total rated capacity at the plant is 165,000 tpy.

All the kilns at this plant are long dry process kilns which, when the first kilns were erected in the 1930's was the most advanced and suitable technology for the raw materials available in the Cordoba area. The urban location of this plant necessitated investment in anti-pollution equipment as early as 1958 when a Webster electrostatic precipitator was installed at the plant.

In spite of the age and technical obsolescence of this plant, demand for the cement produced there has been maintained probably due to the kind of cement if produces which is of a much lighter colour than the ordinary grey cement produced by the normal production processes. 39/

Technical efficiency.

The differences in technical efficiency between the new Yocsina plant and the old Kilometro 7 plant are illustrated by the respective fuel and labour utilisation figures illustrated in Table 12. The difference in fuel utilisation at the two plants is substantial, especially since the two plants ostensibly use the same technology - long, dry process plants with no preheaters. However the difference is clearly related in this case to the enormous differences in scale between the two plants, especially when it is remembered that the 165,000 tpy Kilometro 7 plant is composed of three separate small kilns while the million ton a year plant at Yocsina is made up of only two kilns, one of which has a capacity of 740,000 tpy.

In addition the antiquity of the Kilometro 7 plant obviously has some bearing on the efficacity of the technology employed. There is no automatic control system at the plant, and all quality control procedures are carried out manually in a small laboratory.

Labour utilisation at the Kilometro 7 plant is also very much higher than that at the Yocsina plant; explanations for this difference are similar to those for the differences in fuel utilisation - differences in scale, age and control of the production line. In addition it should be borne in mind that many of the materials-handling functions which are mechanised at the Yocsina plant by the use of conveyor belts and specially designed homogenisation silos are carried out manually at the Kilometro 7 plant. Thus the total employment at the Yocsina plant of 500 for its million ton a year capacity (1 man for every 2,000 typ capacity) is substantially less than the 260 employed at Kilometro 7 for the 165,000 tpy capacity (1 man for every 635 tons of yearly capacity).

39/ The colour is due to the particular composition of the raw materials used at the plant. Manufacture of white cement, which does take place in Argentina at some Portland cement plants and also at separate plants devoted to the production of white cement is more expensive than ordinary grey cement because of the different additives necessary to achieve the colour. Hence the popularity of the light coloured ordinary Portland cement produced at the Kilometro 7 plant.

Table 12 - Fuel utilisation and labour productivity at 4 CORCEMAR plants, 1976

(kilocalories per kilogramme and manhours per ton)

Plant	Fuel utilisation KCal/kg clinker	Labour utilisation manhours/ton cement production
Yocsina	1,000	1 1/2 - 2
Kilometro 7	1,400	5
Capdeville	1,200-1,250	n.a. a/
Pipinas	1,600	n.a. a/

Source: Interview with production engineer, CORCEMAR Head Office, Cordoba.

a/ not available.

5. Comparison of technical efficiency at the Loma Negra (Olavarria) and the CORCEMAR (Yocsina) plant

It is interesting to compare the technical efficiency parameters of these two plants since the relevant figures both refer to the installation of completely new production lines installed at roughly the same date (both plants went on stream in 1970), and of comparable size - the new Yocsina kiln is slightly smaller, at 2,000 tpd compared with the Loma Negra new 2,400 tpd kiln.

The fuel utilisation recorded for the Olavarria dry process kiln installed in 1970 was 800 KCal/kg clinker which is a 25% improvement on the 1,000 KCal/kg given for the Yocsina plant. One obvious factor which contributes to this difference is the different technologies employed at these two new production lines; while the Olavarria plant uses the short dry kiln in conjunction with a multi-stage pre-heater as well as a fully automated control system with feedback, the Yocsina plant employs the more technologically obsolete long dry kiln with no pre-heater 40/ and has a more rudimentary process and quality control system.

40/ Although technologically obsolete in the sense of being a less efficient technology in terms of fuel utilisation which has subsequently been superceded by later innovations it must be remembered that the use of the pre-heater system relies on a supply of suitable raw materials and prehomogenisation equipment. Whether these conditions are met in Yocsina is not certain, so that the technology employed may in fact be the technically optimum one for that plant. Also it should be borne in mind that the limitation of choice of supplier caused by the source of the finance for this plant may well have influenced the choice of technology for this plant since United States manufacturers only manufacture pre-heater systems under licence from European manufacturers and the use of these systems is much more limited in the United States than in Europe and other parts of the world.

As we showed in an earlier paper 41/ the long dry kiln has a standard fuel utilisation some 25% above that of the short kiln plus pre-heater which is consistent with the difference observed at these two Argentine plants.

Another relevant factor is the difference between the sizes of the two kilns though there is not sufficient data available in these case studies which would indicate relative degrees of economies of scale in fuel utilisation for different technological processes of calcination in cement production. 42/

Another factor to take into account is the ability of the automation system at the Olavarria plant to effect savings in fuel consumption by finite control of the various production stages. Again with the kind of data available it is not possible to distinguish these effects. In the absence of more specific information we can only speculate that the most important direct causal factors in the difference in efficiency between the Olavarria and Yocsina kilns is the different technology utilised; and that the difference in scale of production and efficiency in process control are secondary contributing factors to the differential. In making this assumption we are conscious of the fact that it is mainly because there is more information available about the relative fuel consumption ratios between different technologies than there is between different sized kilns that leads us to conclude that the technology factor is the dominant one. Nevertheless, the universally accepted fact that the short dry kiln plus pre-heater is up to 30% more efficient than the long dry kiln is conclusive; what evidence of economies of scale that exist indicate a decreasing scale factor as the size of kiln increases; the UNIDO study quoted in the first monograph indicated a cost of improvement of 17% for an increase in scale from a 500th.to 1,000,000 tpy plant, which covers the range of scale difference for the two kilns being compared here. Unfortunately the UNIDO study does not indicate which technologies are being utilised though the assumption is that it is the same technology for both capacity figures quoted. 43/

41/ See R. Pearson, IDB/ECLA 1977 (1), op. cit.

42/ Various published studies have been concerned with economies of scale in cement production, or with relative efficiency of different technologies, but all have completely ignored the connection between scale and technique used. c.f. FIEL-UIA "Estructura de costos industriales en la ALALC, Tomo 111; Cemento, harina de pescado y hilados ". This comparison of costs in cement industries in the different ALALC countries states that the dry process saves between 25% and 30% over the wet process, but does not differentiate between the various technologies of the dry process nor does it allude to scale when discussing fuel utilisation. Discussion of scale does not single out the effect of scale on fuel utilisation, muech less the possibility of different long run cost curves relating to different technologies. See als. Banco Nacional de Desenvolvimento Economico: Departamento de Planejamento: Departamento de Industrias de Benes de Capital: Paper on Machinery Suppliers in the Cement Industry, Rio de Janeiro, 1976, pp. 5-6. This study states that the dry process consumes less fuel and more electricity than the wet process; again no differentiation between different forms of the dry process is introduced nor any attempt is made to single out economies of scale for different dry processes.

43/ See Pearson (1), 1977, op. cit., p. 27. The figures refer to a study contained in UNIDO; Industrial Branch Reports, The Cement Industry, UNIDO ITD 156, 9/11/72.

6. Cia. Argentina de Cemento Portland

The third biggest cement producer in Argentina is the United States owned firm Cia. Argentina de Cemento Portland S.A. This company operates two cement plants in Argentina - one at Sierras Bayas near Olavarria, Province of Buenos Aires, the other at Parana, in the river Province of Entre Rios.

Parana plant

The plant at Parana which has a total capacity of 146,000 tpy first went into production in 1938. The shortage of suitable raw materials in the area is the main constraint on the expansion of production at this plant. Because of the relatively low calcium carbonate concentration in the local materials utilised at the plant (only a 50% concentration), the single kiln wet-process plant uses the flotation system to make the slurry for calcination in order to extract the highest possible percentage of CaCo3 from the raw materials. At the time that this plant went into production the firm claims that there were only two other cement factories in the world using this system, one in France and the other in the United States of America.

The wet process kiln at the Parana plant was manufactured by the Danish firm of F.L. Smidth. The age of the plant as well as the small scale of production and the fact that it is a wet process plant account for the high fuel utilisation and labour/output ratios shown in Table 13.

Table 13 - Fuel utilisation and labour productivity at the Parana plant of Cia. Argentina de Cemento Portland

(kilocalories per kilogramme and man hours per ton)

Fuel utilisation (KCal/kg clinker):	1600
Labour used in production (Man hours produced/ton cement):	4

The fuel utilisation figure is high even for the wet process; international standard fuel consumption was 1,250 in 1974, 44/ though as we commented above such figures are quoted with no reference to scale of production. Labour utilisation is also extremely high, though apparently below the figure given for the Kilometro 7 plant of CORCEMAR, which is of similar size. 45/

44/ See Pearson, 1977, op. cit.

45/ Ratios such as 4 or 5 man per ton of cement produced were quoted as orders of magnitude rather than derived from specific detailed production data so should not perhaps be taken too literally.

Sierras Bayas plant

The plant at Sierras Bayas which first went into production in 1919 has been continuously expanded ever since (see Table 14).

Table 14 - Capacity and technical parameters of kilns at the Sierras Bayas plant of Cia. Argentina de Cemento Portland

(kilocalories per kilogramme, man-hours per ton and tons per day)

Kiln Nº	Date of installation	Manufacturer and type of technology of kiln	Fuel utilisation KCal/kg clinker	Man-hours per ton	Capacity tpd
1	1918	All Fullers Reeves	Average	Average	200
2	1919	Brothers kilns. US	1,600	for	200
3	1925	dry process plant. Long	1,400	plant	200
4	1929	dry kilns. No preheaters.		1.55	200
5	1936(?)	Rotary coolers.			200
6	1954	Allis Chalmers long dry kiln.	1,200		500
7	1970	Dry process Krupps kiln + single stage preheater. Fullers grate cooler.	900/1,000		700

Source: Data compiled by the author.

The most recent and largest expansion to the plant was made in 1970; a seventh kiln was added to the plant increasing the rated capacity from 585,000 tpy to 845,000 tpy. This kiln also came on stream at about the same time as the kiln Nº 8 at the Olavarria plant of Loma Negra and the kiln Nº 2 at CORCEMAR's Yocsina plant. In contrast to the other new kilns mentioned which were installed by the Argentine companies and which consisted of new and in some cases innovatory technology, the line of production erected by Cia. Argentina de Cemento Portland at Sierras Bayas was in fact centred on a second-hand kiln plus ancillary equipment which had been made redundant at one or more of the parent company's United States plants. 46/

The 700 tpd Allis Chalmers kiln which forms the centre of this production line was originally a wet process kiln when it was in production at Lone Star Inc's Lake Charles factory. The United States plant was apparently operating at a loss and the company decided its original feasibility study had been erroneous and there was no possibility of the plant becoming profitable. Lone Star therefore decided to write off the plant at this location. In order to adapt it for use at the Sierras Bayas plant the equipment was dismantled, the kiln shortened by several sections and modified by the addition of a single stage preheater, thus transforming it into a kiln for calcinating dry raw materials. The modification of the plant and its installation at Sierras Bayas was carried out by the technical departments of Lone Star in the United States and local staff had very little to do with the planning stage of the project (see Section 3 of this paper).

In spite of the fact that this is a modified second-hand production line it represents a considerable advance over the existing equipment at the plant in terms of efficiency. As Table 14 indicates, the fuel utilisation ratios of the rest of the plant were exceedingly inefficient by both international and Argentine standards, and though the pre-heater fitted to the new kiln was only a single stage one, it is the only preheater at the plant and achieves a 16% improvement in fuel consumption over the next biggest kiln installed and up to a 50% improvement over the pre-war kilns at the plant. 47/

The ancillary equipment used in conjunction with kiln Nº 7 at the plant also represents technical advances in comparison with the plant already installed. The automatic grinders are capable of a much finer raw meal grinding than those used with the older kilns; the raw meal food into the preheater is controlled by automatic wigh-belts and the whole production line is controlled from a central control room which operates a closed circuit control system of the raw meal preparation stages and the kiln feed.

The grate coolers, although standard equipment in most other cement plants erected over the past thirty years is a substantial technical advance over the old fashioned rotary coolers which are still used at Sierras Bayas in conjunction with the old kilns.

The labour utilisation ratio at the plant is given as an average for the whole plant - at 1.55 man hours per ton of cement produced. In terms of the ratio of labour employed per ton of installed annual capacity the Sierras Bayas plant has a ratio of 1 man to 1,360 tons of capacity, which is inferior to the ratio at Yocsina and substantially worse than that of Loma Negra's larger plants.

46/ It should be noted that this second-hand machinery was declared as such and imported at a relatively low book value. However, because of Argentina's strict embargo on the importing of second-hand machinery a special government decree had to be issued to allow the machinery into the country free of duty.

47/ Again while the production technology no doubt accounts for the major part of the improvement in fuel utilisation efficiency recorded, it is not possible to distinguish the effect of scale on these results.

The fuel utilisation ratios quoted for the plant indicate that levels of efficiency are achieved which compare favourably with those at the Loma Negra plants for kilns with preheaters. In fact the Sierras Bayas ratio is comparable to the fuel utilisation ratio at the Yocsina plant where the largest kiln is a long dry kiln with no preheater; again it is difficult to interpret this comparison since it could be the result of greater technical skills on the part of the engineers operating the Sierras Bayas plant, or the fact that the differences in scale between the two kilns compensate for the different technologies used.

The plant at Sierras Bayas can be said to use less than optimal technology acquired second-hand from the parent company. From the point of view of the firm this was presumably a rational technology strategy since the raw materials accessible for cement production at the plant are running out and there is little prospect of a long-term expansion which would be the only basis on which a strategy of optimal technology investment could be pursued. One of the results of this technology strategy however, is that there is no development of technical capacity internal to the Argentine, as opposed to the parent company, which is the result of both the failure to use new process innovations and the complete lack of devolution of technical resources and decision making to the local subsidiary from the parent company. This will be discussed in greater detail in Section 3.

7. Calera Avellaneda S.A.

This company operates the third plant near the town of Olavarria, which is the only cement plant belonging to the firm. Since the installation of the newest production line, which went on stream at the end of 1974, the total installed capacity of the plant has been 845,000 tpy which is exactly equal in size to the Sierras Bayas plant of Cia. Argentina de Cemento Portland S.A.

The original cement plant belonging to Calera Avellaneda which went on stream in 1934 was one of the first Lepol kilns to be used outside Western Europe. 48/ The capacity of this kiln is 300 tpd and it is apparently still functioning satisfactorily. The fuel utilisation ratio of this kiln is given as 1,100 KCal/kg clinker which compares favourably with the fuel utilisation ratios of its main competitors.

Kiln Nº 2 is a Humboldt short dry kiln with suspension preheater which went into production in 1958. Again Calera Avellaneda were very prompt to incorporate this technical innovation into their productive capacity; Humboldt started putting the system on the market in the early 1950's though its widespread adoption was slowed down by the low rate of new investment in cement capacity in the early part of the decade. The Calera Avellaneda kiln is claimed to be the first Humboldt kiln with heat interchange by gas suspension installed in a South American plant. Certainly it was the first in Argentina.

48/ The earliest date given for the commercial development of the Lepol kiln by Polysius was 1933, though very few were actually sold. Thus Calera Avellaneda, no doubt, connected to the fact that the firm's original shareholders were all German immigrants, were very quick off the mark to get a Lepol kiln on stream in Argentina.

The Humboldt kiln originally had a rated capacity of 350 tpd when it was first installed, but subsequent modifications and improvements carried out to the plant have increased its actual capacity to 530 tpd, bringing the total combined capacity of the two oldest kilns at the plant to 830 tpd (350,000 tpy).

Table 15 - *Fuel utilisation and labour productivity ratios at the Calera Avellaneda plant*

(kilocalories per kilogramme, man-hours per ton and tons per year)

Kiln Nº	Fuel utilisation KCal/kg clinker	Labour Productivity man-hours/ ton cement a/	Installed capacity per man employed (whole plant) b/ tpy
1	1,100		
2	900	5.50	680
3	750 c/	1.30	1,345

Source: Data compiled by the author.

a/ Labour usage figures refer to the total capacity of the plant before and after the new kiln went on stream. The figures referring to the enlarged plant were again projections made before the kiln went into production.

b/ This figure is probably somewhat inflated since the inter-changeability of some labour with the lime plant which is alongside the cement plant at the Calera Avellaneda site made calculations of labour employed at the cement plant less than completely accurate.

c/ This is a projection of optimal fuel utilisation for the new kiln went on stream.

The third kiln at this plant which went on stream in November 1974 increased the capacity at the plant by 565,000 tpy to 750,000 tpy. The new kiln is also a Humboldt dry process kiln with suspension preheater similar in design to kiln Nº 2. The 1974 version however has a 4 stage cyclone-preheater with a Fuller grate cooler and the kiln feed is blended by a prehomogenisation unit with automatically controlled weigh-belt system.

Automation at this plant is the conventional closed circuit system; control for the new line of production is centralised in a single control room whereas the control units for the different stages of production for the rest of the plant are distributed throughout the plant.

Quality control in the plant is carried out in laboratories without the help of any automatic analysing equipment. Samples are prepared and brought to the laboratory by operatives; in the laboratory they are analysed by traditional methods and calculations about required corrections are made when the results of the various tests are available. There is no automatic sampling procedure nor X-Ray equipment and there are no digital computers to assist calculations.

Fuel utilisation at the plant is shown in Table 15. These figures appear to indicate an extremely efficient use of combustibles; it is interesting to note that the Calera Avellaneda plant is the only cement plant in Argentina which is albe to operate on natural gas, fuel, oil or coal.

The new kiln which was expected to achieve a KCal/kg ratio of 750 cal is basically using the same technology as the older kiln Nº 2. The difference in the two fuel consumption ratios is accounted for by the larger scale of the new kiln and the superiority of the ancillary machinery connected with raw material blending and materials handling and transportation.

The labour utilisation ratios at the plant before the inauguration of the new kiln was substantially higher than the other plants operating in the same area. Calera Avellaneda were complaining of chronic overmanning at the plant, which could not be improved other than by the expansion of capacity because of the strict laws about labour security which were operative at that time. There was also some difficulty of isolating especially general labour relating to the cement plant since a lot of employees and ancillary staff also performed duties in the neighbouring lime plant. However, the inauguration of the new kiln was expected to solve the overmanning problems; it was expected that no more than 50 new workers would be recruited to operate the new kiln which represented an increase of over 100% of installed capacity at the plant.

8. Cia. Sud Americana de Cemento Portland S.A. (Juan Minetti)

The machinery and equipment employed at the three plants belonging to the Cia. Sud Americana de Cemento Portland S.A. (Juan Minetti e hijos) is considerably more obsolete than that in the other companies if only because the firm has made no major new investment in production capacity in recent years. Growth of the company has been centred on a proposed new plant at Malagueña in the Province of Cordoba which to date has not come to fruition. The plant at Mendoza was expanded by 140,000 tpy (400 tpd) in 1971 by the addition of another small dry process kiln.

However, insufficient data was made available by this firm to make an adequate analysis of the technology employed. The inability of the company to obtain finance for the Malagueña project in the ten years at least since negotiations began is related to the low level of productivity at the plant and the lack of technical capacity which would be necessary to incorporate more modern technology under the present organisational structure.

Section 3

ASSESSMENT OF TECHNICAL CAPACITY OF THE ARGENTINE CEMENT INDUSTRY: TECHNOLOGY ACQUISITION, INNOVATION AND TECHNOLOGY POLICY WITHIN ARGENTINE CEMENT FIRMS

1. Introduction

In the previous section we assessed the level of technology incorporated into the Argentine cement industry in terms of the kind of equipment installed at the plants and the efficiency of that equipment when used on site at the various plants in the country.

All the core technology at the plants is imported from suppliers in Europe or the United States. 49/ However, having accepted this fact we can observe considerable differences in the way in which different firms negotiate with suppliers for the acquisition of new capacity, which, together with the kind of equipment they purchase, helps to define the internal level of technical capacity of the firm.

Similarly, the fact that core technology is supplied by international manufacturers implies that it is these manufacturers rather than the local cement firm which is responsible for innovations in process technology and equipment in the industry; nevertheless, as we saw in the discussion on the Mexican industry 50/ there is considerable scope for innovatory activities which effect minor modifications to plant such as the increase in capacity without the installation of new equipment, or the improvement of fuel consumption ratios, or the adoption of automation equipment to different production aspects of the plant.

In order to assess the internal technical capacity of the different Argentine cement producers we look at both these aspects - technology acquisition, local innovation and also the firm's overall policy or strategy towards building up its internal technical skills, since the latter is relevant to its long term growth prospects.

49/ The structure of the international industry supplying capital goods to the cement industry is discussed at length in Pearson IDB/ECLA 1977 (1), op. cit. However, I do not mean to suggest here that there is no local content in cement plants in Argentina; a considerable amount of hardware and ancillary equipment can and is manufactured in the country, often by subsidiaries or recognised subcontractors of the main technology suppliers. Nevertheless, as in Mexico, all machinery or components requiring special engineering facilities for their manufacture (for example the bending of thick steel for kiln segments or the devices for firing kilns) are not manufactured in South America to date, although even this situation may be modified by various governments initiative to boost the local capital goods capacity in this area by making joint venture agreements with one or more of the international suppliers.

50/ Pearson, IDB/ECLA, 1977 (2), op. cit.

2. Acquisition of technology and technical capacity in the firm of Loma Negra S.A.

The various new investments made by this company during the past five to ten years exhibit a variety of different patterns of technology acquisition, which are related to what kind of new technology was being acquired and for what purpose.

Olavarria plant expansion

The contract concerning the purchase of the new kiln Nº 7 together with the ancillary equipment which comprises the whole line of production, and the automation system for which the kiln was acquired, was, strictly speaking, a turnkey contract. However there were a number of features about this contract which indicate that it was not the straightforward handing-over of technical responsibility that a turnkey contract generally implies, but that the firm were exercising a considerable degree of technical autonomy in negotiating with the suppliers, consistent with a positive and progressive long-term technical policy.

The whole contract for the Olavarria expansion, including the automatic control system, is estimated to have cost the company some U$S 50,000,000 which corresponds to a cost of U$S 50 per ton of installed annual capacity. The contract was in fact a joint venture between various West German firms which were working in conjunction with the main supplier Polysius on the adaptation of automatic control systems for cement plants. The other firms involved were AEG, IBM (Stuttgart) and the Dickerdoff Zementewerke. Research on the system had been in progress for some two or three years before Loma Negra negotiated the contract for the Olavarria expansion, initially with Polysius. By this policy of agreeing to purchase technology which was still in the process of research and development to make innovations in automation technology adaptable to production conditions in cement manufacture, Loma Negra calculated that they were able to purchase a high technology plant at something like one third of its price on the market, when industrial research, including its installation at the Olavarria plant, had been concluded. 51/

However, we would not want to deny that this project was indeed a turnkey contract and that Loma Negra had contracted out to Polysius full responsibility for design of the plant, negotiation with subcontractor, and the project management which included delivery, supervision of the erection of the plant, putting the plant on stream and ensuring that it operated according to guaranteed

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51/ In 1970 when the purchase was completed, the world market price for new cement capacity was estimated at between U$S 50 and U$S 100 per ton of annual capacity. Investment costs of the new Olavarria kiln was estimated within this rang. Spokesmen for the company maintained that just three years later, an identical plant was sold for three times the price paid by Loma Negra. Even allowing for inflation it must be remembered that the price range given above refers to all conventional plants of various sizes installed at that time, whereas the Olavarria plant included very high technology elements both within and outside the automation system.

specifications. Technical staff from Loma Negra indicated that although they were constantly involved in collaboration and discussion with the main contractor, both in Argentina and in Germany, there were occasions when Polysius attempted to prevent Loma Negra having access to some of the innovatory design elements incorporated into the plant.

The realisation of the project involved a considerable amount of technical assistance from the suppliers; but again this must be seen in context; about one third of the technical assistance involved (measured in man-months of foreign personnel employed) was concerned with the operation of the computer, the control process and associated instrumentation aspects and the automatic X-Ray analysis machinery. Since the incorporation of this equipment at the plant represented a net advance in the technology level in the firm, and since the technical assistance was finite in that within some 18 months the technical staff of the Argentine company were able to operate the system with no ongoing technical assistance, such activity can be seen as a net transference of technical knowledge to the firm, even though they were forced to purchase it from the suppliers at the rate set by the foreign firm for their technical services.

Technical capacity at Loma Negra

Various aspects of this project indicate that although there was this seemingly total dependence on the suppliers to provide the technological factors, the firm itself was possessed of sufficiente technical capacity to select, albeit in very general terms, a level of technology not yet tested and accepted on the world market, to assimilate that technology and to acquire the necessary skills to operate it and in variuos instances which are exemplified below to improve and adapt it to the particular production situation of the firm itself.

The following are examples of technical achievements of the firm, in relation to the technology supplied as a turnkey contract, which indicate the level of technology capacity corresponding to the successful assimilation of this high technology project:

(a) Maintenance system: This was worked out by the consultants acting on behalf of the main suppliers as providers of technical assistance. However, since that technical assistance terminated the electrical and electronic engineers employed by Loma Negra have been able to operate and modify an adequate maintenance system which includes programmed preventative maintenance as well as remedial maintenance. The computer, an IBM 1800 which was installed to operate the automated control system has been used to provide and update maintenance programmes and schedules.

(b) The system as supplied by the foreign manufacturers left some problems unsolved which were crucial to the accurate operation of the automatic system installed. For example Polysius supplied only one sample programme for calibrating the X-Ray machine to carry out automatic analyses. The Loma Negra electronics engineer who was aware of the problems of variations in frequency under vacuum conditions recalibrated the system allowing for the variations in frequency and building in automatic corrective procedures into the programme.

(c) The automatic system as supplied and put on stream by the manufacturers was supported by some 300 programmed which constituted the software of the system. The electronis engineers at the plant amplified the scope of the system by producing another 400 programmes designed to satisfy particular production or planning problems incurred by the firm in both technical and administrative matters. For instance, the problem of optimal policy regarding maintenance of the refractory lining of the kiln was solved in terms of the particular situation of an Argentine cement producer operating under 1974 price and supply conditions. 52/ By using the computer, on the basis of data derived from the plant about the constituents and consistency of raw materials used and the efficiency of the kiln and the prehomogenisation and pre-heating system, it was possible to calculate the equilibrium point between expenditure on replacement and maintenance of the refractory bricks and expenditure on the installation and precise operation of the prehomogenisation system. Having established the optimal point in terms of physical trade-off this was then converted into financial terms by systematic studying of the plant in process so that the optimum was able to be maintained by controlling the variation of raw material mix in the homogenisation plant by programmed sampling and automatic correction procedure.

(d) The design engineering department of the firm has drawn up plans for the conversion of kilns Nº 5 and 6 at the Olavarria plant from the wet process to the dry process with no outside technical assistance. This is a feedback from the conversion carried out at the Barker plant by the Danish company F.L. Smidth, though the possibility of conversion was discussed when plans for the Olavarria expansion were being drawn up.

Technology acquisition at other Loma Negra plants

Barker plant.

The conversion of the two kilns at the Barker plant from the wet process to the dry process and the resulting savings in fuel consumption and cost were discussed in Section 2.

Again the contract which was drawn up between Loma Negra and the suppliers - in this case F.L. Smidth for this conversion project could be described as a turnkey contract since the main suppliers carried out the basic design work and had total responisbility for all subcontractors and for the final operation and efficiency of the contract. However, as with the Olavarria contract for kiln Nº 7 there are features about this contract which differentiate it from what is normally understood by a turnkey contract and which indicate the internal technical capacity of the firm and give evidence of a long-run progressive technology policy both in terms of technology acquisition and in building up internal technical capacity.

52/ Some of the raw materials required to make high quality refractory linings were not available in Argentina at that date; in addition to the trade-off between good quality imported materials and inferior quality locally-made ones, there were also the problems of exchange control, import restrictions and storage and other associated costs of importing - both in terms of accessibility and financial costs.

The first aspect of the contract which deserves comment is the fact that the possibility of conversion was first suggested by the firm itself on the basis of studies carried out by the relevant technical departments. Secondly the contract was drawn up in two stages; the first which accounted for some 50% of the U$S 6.8 million cost was concerned with the new equipment and related works necessary to convert the kilns from the wet process to the dry process. The second half of the contract was concerned with the installation of electrostatic and mechanical filters which increased the recuperation of clinker from the system, improving the raw materials-clinker ratio and thus the productivity of the whole system. The first half of the contract - the conversion of the kilns - resulted in an increase of capacity of some 20% over existing capacity of the kilns. The installation of the filters increased productivity by a further 8 - 10% and, significantly, decreased environmental pollution from dust emission. At that date there was no effective legislation in Argentina to control industrial pollution from cement plants and the installation of these filters can be seen as a progressive measure in both technical and environmental terms as well as an investment which was bound to pay off in the long run as legislation about pollution becomes more widespread.

The terms of the contract with F.L. Smidth differed from the standard turnkey contract; Loma Negra's contract specifically stated that the designs and drawings from which the project was carried out would be the property of the client company. The technical departments of Loma Negra were consulted at all stages of the design and erection of the project and, as we have observed above, the technical departments have been able to design the conversions of kilns Nº 5 and 6 at the Olavarria plant on the basis of the technical knowledge acquired in the process of the Barker project.

Zapala plant.

This plant is the newest complete plant erected in Argentina, 53/ and in spite of its relatively small size arising from its descentralised location, represents a level of technology which is completely up to date in terms of the conventional and industrial technology on the market at the time the contract was negotiated. However the way in which it was purchased - a straightforward turnkey contract from the German firm of Humboldt - must be judged not solely in relation to the technology acquisition policy of Loma Negra regarding its other plants, but must take into account the fact that the negotiations for the plant were virtually completed before Loma Negra had any official participation or management and technical responsibility for the plant.

The original owners of the company that entered the negotiations with the suppliers, Cía. Naviera Perez Companc S.A., had no experience in cement manufacture and no knowledge of alternative technologies on the market. The technology that was eventually purchased, a 200,000 tpy dry process plant with preheater and short kiln was purchased at a cost of approximately U$S 75 per ton of installed capacity which was a reasonable price for modern but small scale technology at the time when the purchase was made (1968).

53/ Since 1974 the State owned El Gigante plant has been put on stream.

The contract allowed for the services of 8 foreign engineers form the supplying company to give technical assistance for a period of up to 2 years, though it was not clear whether the intervention of Loma Negra, when it took responsibility for technical and administrative management of the plant as well as bought a financial participation in the new company, modified previously negotiated terms and conditions for technical assistance from the European suppliers.

Overall technical policy of the Argentine firm of Loma Negra S.A.

The most significant fact about the long term technical strategy of the firm of Loma Negra is that it not only exists but has been very clearly planned and formulated. In spite of the fact that this company operates, in common with any other nationally owned cement company in Latin America, in a situation where it is dependent on a small group of foreign suppliers and specialist consultancy groups for access to new technology of cement production, Loma Negra has been able to isolate various factors within its own control which have improved its negotiating position with the suppliers as well as building up its own internal technical capacity.

Its policy on new technology acquisition is a central part of this strategy; in both the projects described in detail above, the kiln Nº 7 at Olavarria and the conversion of the kilns at Barker plant, Loma Negra specifically negotiated the purchase of technology that was a) still in the process of industrial research and development which meant that the firm could not only purchase the technology at a relatively cheaper price than the fully researched market-developed version would cost, but also share to some extent in the development of the innovation being utilised, thus building up the knowledge and experience of its own design and operational engineering staff. In addition the technology acquired, though purchased specifically in conjunction with one production line in one particular plant, had in the long term applications for use outside that particular situation, in other plants belonging to the firm, and, in the case of the automation system, computer, for administrative and design tasks concerning the whole company's operation.

The Barker conversion was also evidence of a technological strategy which was orientated to long-term technical needs of the firm as well as to solve immediate problems of cost and capacity. At the time when the fieldwork was carried out the firm had already used the technical know-how, bought from F.L. Smidth as a turnkey contract some four years previously to design the conversion of wet process kilns at the Olavarria plant.

The firm backs up this policy of technology selection in the context of its long term technical requirements by employing five or six "special area specialists" whose duties include keeping abreast of all technical developments in their fields To this end, Loma Negra staff regularly make study visits to machinery suppliers and cement technology and automation consultants in the United States, Europe and Japan in order to see first-hand what new technical developments are in progress.

Such a technical policy is rather unusual in the context of the Latin American cement producers. One explanation of the singularity of Loma Negra's technical policy is that such a policy can only pay off when the size of the firm's operations are sufficient to warrant such a large investment in the acquisition of technical know how and experience. However the size of the market in most Latin American markets is generally too small to support firms of the scale of Loma Negra, even in the larger countries, where the total market is sufficient, it is still only one or two firms at the most that can operate in this manner. In the Mexican industry at least one of the largest firms had foreign participation, which negated the justification of investing so much of the firms' own resources in building up its autonomous technical capacity.

3. Acquisition of technology and technical capacity in the firm of CORCEMAR S.A.

The technology incorporated into the new production line at the Yocsina plant of CORCEMAR was described in the previous section; the kind of process technology selected represented the standard equipment available on the market. This was incorporated into a plant which had been carefully designed, specifically to reduce labour utilisation by mechanising much of the materials handling and transportation functions. Control was effected by standard closed circuit control systems, centralised in a single control room.

It is difficult to judge what effective choice the technical staff of CORCEMAR were able to exercise in the selection of the process and equipment utilised at this plant. The dollar cost of the project, which amounted to some U$S 6 millin 54/ was financed by a line of credit from the Export-Import Bank of the United States. The contract between CORCEMAR and the EXIM Bank - no doubt a standard contract of this nature - placed the following restrictions on the Argentine company as conditions for receiving the dollar credit from the Bank:

1) All equipment purchased with monies from the loan must be manufactured and originate in the United States.

2) The Bank has the obligation to approve of the selection of all equipment before purchase is authorised.

3) The Bank has the right to demand access to all plans, company books and accounts and to inspect equipment before it is exported and to send inspectors to the site of erection.

4) All such equipment must be transported by United States freight and insured with United States insurance companies.

5) All repayments must be made in dollars. The firm undertakes not to meet dividend commitments to its shareholders if such payments amount to more than 50% of its net profits, or 23% of its net assets until all financial commitments to the Export-Import Bank have been paid.

6) To supply the Export-Import Bank copies of all documents and correspondence concerning the project; such documents and correspondece must be

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54/ This was the original credit level set in 1969. The sum may have been subsequently increased.

accompanied by an English translation.

The terms in which this contract is formulated indicate that the purchaser was clearly restricted to United States supplies for its choice of equipment; in the previous section we indicated that this restriction may well have limited the technical range of alternatives open to the plant since the most up to date techniology on the market, and of course, the most recent innovations in the sector, were being developed by European and Japanese manufacturers; the by-now standard preheater technology was only manufactured by United States firms under license from the European patent holders.

Another significant restriction originating with the terms of this loan is the fact that the loan will only cover the dollar cost of goods and services required for the project. This means that had the Argentine firm wished to increase the local content of the equipment used for the project it would have needed separate financing for Argentine produced goods, since the credit from the Export-Import Bank is not transferable to non-dollar costs.

The United States suppliers, Fullers Co. supplied not only all the equipment for the whole production line under what was effectively a turnkey contract, but also supplied technical assistance, which in some cases lasted up to two years. 55/

Although the firm has a large number of technically qualified staff - up to 50 engineers according to the Head Office, most of the design work was carried out by the suppliers. CORCEMAR had sole responsibility for the engineering works associated with the erection of the plant, but Fullers were responsible for the detailed design, plant procurement, transportation and erection.

Technical capacity of CORCEMAR

Because of the fact that CORCEMAR is based in Cordoba and the majority of its production and market is centred in that Province, the firm is isolated from the effects of the more competitive situation around Buenos Aires, and has not been forced to adopt a clear strategy regarding the incorporation of new technology to increase production efficiency at its plants.

In the previous section we compared the efficiency of the technology used by CORCEMAR with that of the new Olavarria plant; the inferiority of the technical efficiency parameters at Yocsina were attributed to different technologies (including here different methods of process control) as well as to differences in the scale of the two kilns. In the brief plant visit made to the Yocsina plant and to the Head Office of CORCEMAR, it was evident that this firm does not have the technical capacity to incorporate new systems of production control (automation)

55/ The technical assistance from the suppliers was connected with the suppliers' responsibility for the erection of the plant, getting it on stream and ensuring it opearated at guaranteed capacity. A sum of 1/2 million dollars was included in the original estimates for this purpose. A total number of 15 engineers were sent by Fullers to the plant; because of problems of loss of production arising from defective equipment (mainly cement ginders) 5 of the engineers stayed for up to two years.

nor to negotiate with suppliers to obtain a technological solution outside that conventionally offered in order to increase the productivity of the plant 56/. Neither was there evidence of a long term strategy of improved technical capacity which, in the case of Loma Negra at least, was cited as a further reason for incorporating innovatory techniques still being developed industrially into their production system.

Nevertheless the technical departments of CORCEMAR were well informed as to the existence of new and different technologies other than those which they were using, and their technical staff was certainly a fairly large overhead cost for the firm to carry. Further investigations in more detail would be necessary to assess whether the technical capacity contained in the qualified engineers employed by the firm could be more effectively utilised to negotiate better terms with suppliers, or to obtain more efficient technology for new investment projects, though it should also be remembered that the cost of such reorganisation might not be justified in terms of the market situation of this particular supplier. 57/

4. Acquisition of technology and technical capacity in the firm of Cia. Argentina de Cemento Portland S. A.

The process of technology purchase and procurement for the plants belonging to the Cia. Argentina de Cemento Portland are entirely determined by the fact that this company is a fully-owned subsidiary of a United States firm. As such, the Argentine company is dependent on policy decisions made at the company headquarters in the United States for decisions, both in general about the nature and size of new investments, and in detail about what kind of technology should be purchased from which suppliers.

The expansion of the Sierras Bayas plant in 1968 by the addition of a seventh kiln, clearly illustrates the relationship between parent company and subsidiary in matters of technology acquisition. As we discussed in the previous section, the basic machinery which makes up this production line was imported from the United States having been dismantled from another of the parent company's plants. The reason that the plant was obsolete in the United States factory is apparently that the original feasibility studies on which investment at Lone Star Cement plants at Lake Charles, Louisiana and Hudson, New York, was based was found to be inaccurate. Lone Star Inc. decided to recuperate a percentage of the investment by shipping the equipment to the Sierras Bayas plant, though it must be remembered that kiln Nº 7 at Sierras Bayas was considerably modified from the original Lake Charles equipment (see Section 2).

56/ Productivity is of course only increased by the adoption of innovatory techniques if there is the internal technical capacity necessary to operate those techniques effectively. In some cases - for example the Mexican firm which purchased a computer to operate the kiln and then was unable to use it - lack of technical capacity renders ineffective productivity-oriented innovation.

57/ Again we come back to the point that while it may be in the overall interest of the economy - in terms of long run foreign exchange saving to increase local technical capacity, the advantages to the individual producer of adopting such a strategy are often insufficient to persuade him to incur such costs.

The decision to import this second-hand kiln was entirely the responsibility of the parent company; the policy of the company regarding the technical autonomy of local subsidiaries is that the latter have autonomy only in expenditures which can be met out of the local firm's cash flow, and can be obtained locally. Any significant investment in new plant or equipment is thus the concern of the parent company. In the Sierras Bayas investment, as with other investments made by overseas subsidiaries, the parent company carried out the feasibility study, negotiated with all suppliers and supervised the design and erection of the plant. While the plant was being constructed the parent company sent engineers and trouble shooters to the Argentine plant, and progress on the project had to be reported several times per week to the United States Headquarters.

The financing of new investment is also entirely in the hands of the parent company. The expansion at Sierras Bayas was financed partly by a capital transfer from the Head Office, which took the form of an increase in direct investment capital in the Argentine firm, and partly by suppliers and other credits. The increase in direct investment is made under a decree authorising increase in foreign investment, and is subject to the same repatriation of profits restrictions as any other form of foreign investment.

Technical capacity at the Cia. Argentina de Cemento Portland S.A.

The relationship between the American parent company and its Argentine subsidiary which has been described as "direct and dictatorial" evidently has a negative effect on developing local technical capacity at the Argentine firm.

Because the local firm has little technical responsibility, technical staff are comparatively few; the Sierras Bayas plant, with a productive capacity of 845,000 tpy employed only 8 qualified engineers for the whole plant, out of a total of 40 technical staff. The Loma Negra plant, in contrast employed more than double the number of engineers out of a total technical staff of 90 people.

The technical duties of the engineers at the plant are restricted to routine production and quality control functions. All other technical problems are handled by Lone Star's central Technical Services Department in the United States. This department services the Argentine plants, and the other overseas subsidiaries in Uruguay, Brazil and Spain, as though they were located within the United States; policy about centralisation of technical research, problem solving and development of innovations has not been modified to take into account the particular needs of the host country where the subsidiaries are located. On the few occasions when the local staff try to initiate ideas for modification at the plant - for instance a project to improve the efficiency of the homogenisation process was being mooted at the time the field visit was made - the ideas have to be submitted to Head Office for approval and final design; any innovation originating at the local plant becomes the property of the parent company, though no financial payment is made for this transfer.

However the opportunity for the development of innovation at the local plant is very slight. The technical staff at the plant have no incentive to keep themselves informed about technical progress and relevant innovations developed in other parts of the world since there is little opportunity to utilise such information in the course of their duties at the plant. Since there is currently no prospect of expansion at either of the Argentine plants of this company the opportunities for being involved in new investment projects which might incorporate new technology are also extremely limited.

5. Acquisition of technology and technical capacity in the firm of Calera Avellaneda S.A.

The way in which the expansion of the Calera Avellaneda plant, which went on stream at the end of 1974, was negotiated is perhaps untypical of a general technical policy of the firm since it took place in extraordinary circumstances. The expansion of the plant was first discussed in 1961 but certain factors connected with the ownership of a minority part of the shares of the company prevented the Board of Directors obtaining authorisation to proceed with the expansion for several years.

The project was finally authorised in 1969 when the project had to be totally redesigned and refinanced. The contract was awarded to the German firm of Klockner-Humboldt-Deutz in the form of a turnkey contract. Humboldt carried out the design engineering for the production line and was responsible for the procurement and erection of the plant as well as getting the plant on stream and training the local staff in its operation.

Since the terms of the contract gave Humboldt autonomy over procurement of plant it was able to switch manufacture of the core technology for the plant from its works in West Germany to a Spanish subsidiary - Centurion Española de Coordinación Técnica y Financiera S.A. de Madrid, which produces Humboldt plants under licence. The reason given for this change of manufacturer was that the German firm was experiencing problems of industrial relations and cost control, though it appears that financial reasons were also instrumental in the change of location. 58/ Although plant manufactured under licence still carries the main suppliers guarantee and is designed and erected by Humboldt itself, the Argentine firm was predicting extra problems in getting the plant to operate according to design specifications because of the change of manufacturer. In the event the plant was some 6 to 9 months delayed in getting into production some of which was attributed to problems of coordination between suppliers.

Part of the Calera Avellaneda expansion was financed by the International Finance Corporation of the IBRD. In order to obtain this credit the firm had to satisfy the IFC that the technical and financial appraisals of the project were correct and that the investment would be a profitable one. As with the majority of IFC financed investments in the cement industry the technical responsibility for the project was clearly placed in the hands of a foreign consultant - in this case the major machinery supplier Klockner Humboldt Deutz. 59/

58/ In the early 1970's Spain had a supply of dollar credit obtained from its tourist industry and it is alleged that Humboldt wished to use this credit source to finance part of the contract covered by suppliers' credit.

59/ See IFC in Latin America: 1972.

Technical capacity at Calera Avellaneda S.A.

The problems associated with this project have not been conducive to the development of internal technical capacity in the firm; in the event, the form in which the contract was celebrated and executed meant that much of the technical responsibilities for technology selection, design and project management were carried out by the machinery suppliers and not by the firm's own technical departments.

However, there are other factors which also work against the development of an independant technical policy. The fact that the firm only operates a single cement plant in Argentina means that overhead costs associated with training and maintaining specialised engineering skills in the firm cannot be spread over nor used by other plants; nor is there a possibility of continuous employment for such staff in investment projects at other plants.

The experience of the Calera Avellaned plant - one new kiln in fifteen years-is hardly an incentive for encouraging technical staff to keep up to date with innovations in cement process technology. 60/

The historic association of the owners and directors of the firm with Germany is also significant since the majority of the important innovations in cement technology have been developed by German industry. It is not therefore surprising that the firm's directors have always bought their new technology from German suppliers, a policy which has proved both technically and financially satisfactory.

6. Acquisition of technology and technical capacity in the firm of Cia. Sudamericana de Cemento Portland (Juan Minetti S.A.)

As we indicated earlier this company refused permission for a factory visit and allowed only a very brief and inconsequential Head Office interview. There is therefore no data on which we can base precise conclusions about the technology acquisition process within the firm, nor about the level of internal technical capacity.

Such information as is available indicates that the failure of this firm to maintain its market share in post-war years and its relatively low capacity-utilisation ratios, are indicative of obsolete technical and managerial procedures within the firm. The failure to negotate successfully the new plant projected in Cordoba Province was specifically blamed on archaic management and financial policies which meant overseas financial sources, especially machinery suppliers and international credit institutions have no confidence in the technical or commercial abilities of the firm to operate successfully a new plant in current market conditions.

In such a context it is unlikely that the firm would actively encourage

60/ Again this firm illustrates the fact that the interests of the economy as a whole in developing its own technical capacity is not always compatible with the interests of individual firms.

the development of its internal technical capacities nor the kind of technical innovation which allows local firms to improve the performance of imported technology by ancilliary modifications to adapt it to local production conditions.

Section 4

LEVEL OF TECHNOLOGY, TECHNICAL CAPACITY AND INNOVATION IN THE ARGENTINE CEMENT INDUSTRY: CONCLUSIONS

In this paper we have traced the growth of the Argentine cement industry from its early beginnings at the start of the twentieth century, when the country was virtually dependent on imported cement, through its first major expansion period of the 1930's up to the present decade when importing cement is now a rare occurrence, caused by extreme and temporary market dislocations.

As we found in the paper on the Mexican cement industry, the level of technology incorporated into Argentina's productive capacity does not diverge greatly from the standard process technology used by the cement industry at an international level. Somo innovations, such as the Japanese invented pre-calcination techniques have not been taken up by Argentine producers bur it should be remembered that very few large scale new investments have taken place since 1970 at which time pre-calcination techniques were not being marketed on a commercial scale. On the other hand in some areas, most notably the application of automation to cement production, certain sectors of the Argentine cement industry are in fact more advanced than the international norm in terms of the technology of control processes used in their plants.

Again we were faced with the conclusion that there is a wide divergence in the level of technology, technical capacity and ability for local innovation between the different firms comprising the Argentine cement industry; and this difference is evident not in terms of core technology which is purchased from foreign suppliers by all Argentine firms, but in the kind of process control systems used in conjunction with that technology and the capacity of local firms to participate in the selection, design implementation and adaption of the core technology so purchased. However, in contrast to the Mexican case we found here that those firms which were in the vanguard in terms of technology utilised and technical and innovatory capacity were not those firms which had the closest links with foreign cement producing companies; indeed the only firm which is a fully owned subsidiary of a foreign (US) company has lost its former market dominant position which it held up to the second world war and has since not introduced any technology noteworthy for its sophistication or innovatory characteristics in comparison with other cement plants in the country. In terms of building up local capacity for carrying out innovations and adaptations to imported equipment, and for participating in the selection, design and implementation of new projects the foreign owned firm was lacking in any positive policy; instead it treated its Argentine subsidiary as if it were a domestic subsidiery and thus relied on the firms central technical departments for all kinds of technical inputs.

The reason why some Argentine firms have become market leaders and have strengthened their own technical capacities, and have embarked on programmes of modification and adaptation of process equipment at their own plants, while others have remained stagnant, and continue to relie on foreign technical assistance can be explained, at least in part by the way the cement industry in Argentina has developed in the context of the growth of the Argentine economy during the present century. As with many other kinds of economic activity in the country, the main markets and thus the main producing centres for the cement industry are firstly in the area around Greater Buenos Aires, and secondly the industrial centres around Cordoba. Thus the firms which were able to secure those markets, and equally important, that were able to expand their productive capacity in line with the periodic growth spurts of these, especially the provincial markets, were those whose future growth could be assured and who were able to invest money, men and resources into their own internal technical development. On the other hand those firms which were serving markets with a more sluggish growth rate did not have the opportunity to increase their efficiency and level of technology utilised by frequent additions of new capacity and have tended to fall behind in matters of technology and development of technically qualified staff.

Lastly we were able to demonstrate that, from the point of view of individual firms, it is not always in their best interests to adopt a progressive technology policy in order to lessen its dependence on external technical assistance. While it may be in the interests of the whole country, from a macro economic point of view in order to reduce foreign exchange costs of new investment and to increase the country's pool of trained scientists and engineers in order to make rational and appropiate investment decisions and to be able to service technology once adquired, the cost to the individual firm of following such a policy is often uneconomic. For this reason it is essential that government policies concerned with lessening technological dependence and with promoting national technical capacity should take into account the different possibilities of different firms to carry out such policies; if the smaller firms are not aided by appropiate incentives the result of an undiscriminating policy to promote national technical capacity may well be to increase the economic concentration of industrial sectors, which could conflict with other goals of government policy.

POSTSCRIPT

As we have mentioned at several points in this paper, the field work on which most of the observations contained herein are based was carried out during 1974. Although we believe that there has been little substantive change in the structure of the Argentine cement industry, and that no major new investments have been carried out incoporating new technology such as would alter the comparisons between firms made in this paper, there may well have been changes in managerial policy by individual firms which could modify the conclusions made here. If this is the case the author would be pleased to receive comments from the firms concerned and to incorporate them into a final version of this paper.