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THE IMPACT OF ENVIRONMENTAL ISSUES IN THE CAPITAL GOODS INDUSTRY IN LATIN AMERICA*

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* The views expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO). This document has not been edited.

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1. THE CAPITAL GOODS INDUSTRY: RECENT EVOLUTION AND IMPASSES

1.1. The industrial sector in Latin American and Caribbean countries, 1980-90

According to the Industry and Development Global Report 1990-91, there are signs of improved growth prospects in the Latin America and Caribbean region. These signs include a slight increase in intra- and extra-regional exports, a downturn in inflation in some countries, progress in debt-for-investment swaps, and gradual removal of trade barriers. The region may be leaving behind the lost decade of the 1980s to enter a new decade of industrial recovery resulting from the painful learning process through which it has passed.

The region's major countries--Brazil, Mexico and Argentina--were subject to anti-inflation, or stabilization, policies in recent years. The industrial sector in each country was subject to the Brazilian pattern of structural change, i.e. industries with a renewable natural resource base performed better than those that grew under heavy protection. The former group includes industries such as chemicals, pulp and paper, and agribusiness. The latter group includes textiles, metal products, electrical machinery and transport equipment.

Such differences in growth suggest a need to sharpen the competitiveness of lagging industries. One way to do so is to induce direct investment to flow into a lagging industry with new technology and managerial skills. Strategic alliances are also required. The region has succeeded in attracting foreign direct investment better than other developing regions.

Industrial growth in the region is still shackled by the high level of debt, and inflation still plagues many of its countries. However, there are signs that the global and regional processes of economic integration will produce positive knock-on effects in Latin America and the Caribbean. How best to make use of these new forces is the challenge facing policy makers, governments and society in general.

Education, health, food and housing are basic requirements for the majority of the population. Competitiveness therefore results from the ability to engage human resources on a large scale in revitalizing the economy and incorporate the latest generation into economic activity. When this is not feasible, there must at least be solidarity towards the underprivileged.

1.2. Characterization of the Capital Goods Industry

The capital goods industry plays a strategic role in the development of a country. It is indispensible to dissemination of technology throughout the productive sector. It is the industry that builds industry. Capital goods are defined as plant, equipment, buildings and components that are part of a company's fixed assets and make up the means of producing goods and services.

The representativeness of the capital goods industry in Brazil can be seen from its output in the last few years of the 1980s--US$28 billion per annum (8% of GDP), in sales by close to 5,000 firms in the industry. Table 1.2 shows the figures for production, employment, apparent consumption and foreign trade.

TABLE 1.2.
Brazil: capital goods industry, machinery-production, employment, foreign trade

		FOREIGN TRADE		No OF EMPLOYEES
YEAR	PRODUCTION AT FACTOR COST	EXPORTS	IMPORTS	(THOUSANDS)
	1990 US$ BILLION	1990 US$ BILLION		IN YEAR
1980	25,53	2,32	3,64	335,9
1981	22,74	1,93	3,41	329,5
1982	18,65	1,44	2,29	299,3
1983	15,26	1,92	1,94	251,6
1984	16,03	2,61	1,79	249,6
1985	18,87	2,90	1,95	300,0
1986	21,57	2,76	2,69	350,6
1987	22,13	2,61	2,99	369,4
1988	21,49	2,63	2,86	361,1
1989	20,61	2,16	1,77	352,3
1990	18,81	1,62	1,94	331,9
1991	15,66	1,61	1,93	267,7

Source: DEE-ABIMAQ/SINDIMAQ (Brazilian machine industry association)

Brazilian industry dates from the late 19th century. It gathered momentum with World War I and began producing capital goods before WWII. Several large international corporations began operating in Brazil in this period. By the time of the first oil shock (1974-75), domestic production included a wide range of machinery and equipment conforming to international standards. Until the end of the 1970s, Brazil's import substitution policy enabled it to sustain the level of industrial output.

The 1980s were a period of stagnation, with lower investment (17% of GDP in 1989 compared with 22% in 1979), high inflation (average for the period = 18,000,000%), high domestic and foreign debts (US$60 billion and US$112 billion respectively), and a flat per capita GDP (about US$2,000).

As regards machine output, in dollar terms the value of production was about the same as at the start of the decade in 1980. However, as technological advances occurred worldwide, investment in technological modernization was insufficient. By the end of the period the industry required additional investment to boost capacity and exports. While in 1970 imports accounted for 50% of production in value terms, they had dropped to 14.6% by 1989, whereas exports increased their share from 5.6% in 1970 to 14.6% in 1989.

The progress achieved by the industry did not encompass a concern with raising productivity or assimilating advanced technology. The difficulties faced in the 1980s by the machinery and equipment industry limited its efficiency and competitiveness. This limitation arose from low investment in

modernization, excessive vertical integration, scarcity of skilled labour and lack of scale.

Advanced technology is represented by multinational firms which have a relative mastery of manufacturing technology but are weak in other areas, such as design, research, and development of products for regional markets.

The main innovations affecting the machine industry are now taking place in computers and electronics. This demands a different level of knowledge from that existing in most of the productive sector.

Chudnowski (1990) shows that in Argentina economic policies and crises after 1976 and into the '80s had a far-reaching effect on the manufacturing industry and on the machine and machine-tool segments. In 1982, output (2,500 units) was nine times lower than in 1973.

In value terms, output in 1985 (almost US$30 million) was half of output in 1984. This negative scenario in Argentina was the outcome mainly of a shrinking domestic market, falling international trade and the impact of the foreign debt crisis.

In 1986, the situation began improving somewhat as a result of the Austral Plan, but it was in 1987 with the Brazil-Argentina Integration Protocol that the impact of the Brazilian market made itself felt. Although the Argentinian market continued to contract in 1988 and 1989, exports increased, with a rise in the coefficient from 14.3% in 1986 to 75.2% in 1989, one of the highest in the world (Table 1.2.A.).

TABLE 1.2.A.
Argentina: production, imports and exports of machinery and tools

(IN MILLIONS OF US DOLLARS AND %)

YEAR	PROD.	IMP.	EXP.	CONS.	IMP/CONS.	EXP/PROD.
1980	58,6	82,2	28,0	112,8	72,9%	47,8%
1981	31,9	69,6	17,2	84,4	82,5%	53,8%
1982	18,6	39,2	9,0	48,8	80,3%	48,4%
1983	19,9	20,6	3,3	37,2	55,4%	16,7%
1984	19,2	22,6	3,0	38,8	58,2%	15,7%
1985	19,8	31,3	3,7	47,5	66,0%	18,7%
1986	33,1	16,4	4,7	44,8	36,7%	14,3%
1987	39,9	38,3	16,0	62,3	61,6%	40,0%
1988	48,6	44,7	32,6	60,7	73,6%	67,0%
1989	41,6	29,9	31.3	40,3	74,4%	75,2%

Source: AAFMHA, INDEC

The increase in production was reflected in an increase in the work force, from 1,567 in 1987 to 1,870 in 1988, engineers and managers predominating. Labour productivity also increased--indeed, it doubled between 1985 and 1988.

Production dropped in 1989 and 1990. Manufacturers endeavoured to avoid redundancies but unemployment is estimated to have risen by 4% in the industry in the second half of 1990. Data are fragmentary but it can be reckoned that between 1986 and 1990 some US$12 million was invested in the industry by the leading companies, in some cases with Italian and Spanish financing.

Despite their similar origins, the development of the Brazilian and Argentinian capital goods industries differs considerably. The Brazilian industry is bigger. In 1987 it produced 30,000 machines worth US$523 million and employed 18,619 people. This makes it six times the size of Argentina's capital goods industry in unit production, and ten times in value. As to productivity per worker, Brazil is also the leader. Its industry grew faster and integrated more fully, reflecting the country's import substitution policy.

The Brazilian industry has larger establishments, with far more diversified production and greater vertical integration. Argentina's biggest firm has fewer than 300 employees whereas the leader in Brazil has 4,000, and there are many others with 500. The dollar sales of the two main Brazilian firms exceed the sum total of the Argentinian industry. Brazil also has a great many large and medium firms, as well as several subsidiaries of German companies manufacturing sophisticated machinery. These do not exist in Argentina. Argentina has some comparative advantages over Brazil--price and skilled manpower, for example. But its manufacturers have benefitted from the deficiency of Brazil's industry in two key areas: personal service and after-sales.

Argentina's industry gained more than Brazil's from bilateral trade between 1986 and 1989. It introduced economies of scale and updated its technology. However, the Argentinian industrialist still sees Brazil as a market to sell to rather than as a partner in joint ventures designed to ship to both markets. According to Chudnovsky (1990), this is due to the fact that the accords are relatively recent, as well as the lack of agreements on complementarity of production, the absence of compatible customs policies, and individualistic attitudes among industrialists in the segment.

A study produced by ABIMAQ, the Brazilian machine industry association, recommends that in view of the characteristics of the industry it must seek alternatives based on a new project. The first layer of this project should tackle the bottlenecks of the industry: supplies of inputs and components, training, energy use, methods of capitalizing firms, and development of industrial technological research.

The second layer would consist of suggesting ways for the country and region to obtain the technical and institutional infrastructure, culture, and technological and economic evolution required as a supporting element in the effort to attain development goals.

The study's conclusions point to a key change in the factors that enabled the Brazilian industry to develop and consolidate itself--cheap labour and abundance of raw materials. Although these factors are expected to continue to play a favourable role, they will have a lesser influence on total cost. Advantage must continue to be taken of them, but quality, productivity and technological development, i.e. knowledge, must be given top priority. The key forecasts are that ownership of stock in the leading firms will become more democratic, small business will become stronger, industry will reverse

the process of vertical integration, and workers will become more highly skilled.

In both Argentina and Brazil alike, the opportunities created by the new global and local environmental awareness have not yet been properly taken up. Several industries dealt with in the case studies below have channelled heavy investments into the environmental sphere, yet even so this does not constitute a new business area, except for a few more pro-active firms. In the case of the capital goods industry, internal crisis has made it less sensitive to new patterns of industrialization and the new priority given to the environment.

1.3. The Environmental Issue and its Impact on the Capital Goods Industry

In the 1970s, CETESB (the Sao Paulo state environmental protection agency) developed, drafted and published a set of technical standards to be followed in its field of activity. This led to considerable development in the Brazilian basic sanitation sector.

Five years later, the capital goods industry began organizing procedures for complying with these standards. ABIMAQ set up a Sanitation Agency Department (DESAN), which now has 60 members. Affiliated to DESAN it also created ABES, the Brazilian sanitary engineering association, a forum for environmental engineers and other professionals in the field. This led to a Programme for the Enhancement of Sanitation (PVS), a venture involving associations in the building industry, consultancy and sanitation.

In 1990, a nationwide debate took place as part of the search for ways to protect the environment. Calculations have shown that a modest programme for basic urban and rural sanitation alone would cost Brazil the equivalent of US$3.5 billion over a ten-year period. The work done so far and the funds supposedly available leave an enormous amount still to be achieved; worse still, sources of additional funds will be very hard to identify, let alone obtain.

These issues, discussed mainly as a question of welfare until the end of the 1980s, have begun to be seen in a new light. Local and global pressures have given rise to more complex environmental programmes with long-term horizons, and the narrow sanitation viewpoint has been left behind. Government and society as a whole have begun to understand the benefits to be derived from environmental practices involving all segments of the population.

Part of the capital goods industry has been able to supply equipment to the private sector, especially chemicals, petrochemicals, pulp and paper, food products, leather and footwear, during a period of very low investment by government. These industries are sources of heavy pollution and must adjust to the standards established by environmental agencies, to the pressure of public opinion and to their own needs to protect their immediate environments. Many capital goods manufacturers have taken care to adapt their production systems in order to make them cleaner, fitting filters for effluent and air, improving the operating environment and avoiding aggression against the health of their workforce and the localities in which they operate.

In 1991, however, manufacturers of pollution control equipment noted a drop in spending by industry on these items. Segments which have been performing poorly since the crisis began in 1978 have postponed investment. High-performing industries, such as pulp and paper for example, with the international market to support them, have longstanding pollution control systems in place and invest only if and when they expand capacity. Only the food industry, traditionally one of the last to be hard hit by recession, has maintained a constant level of spending.

However, this sectoral crisis, which is internal to the national crisis, is not caused by insensitivity to environmental problems on the part of industry. There are signs of a growing environmental awareness, as borne out by the agendas followed by meetings of manufacturers' associations. Equipment suppliers say there is more concern with environmental protection. Industrialists form their opinions at the same time as everyone else. Pressure from the media, environmental movements, government and the international community affect producers and consumers alike.

The capital goods industry should take more advantage of the opportunities created by governmental programmes to eliminate pollution. It must also adjust to new requirements and offer technological alternatives to firms that are investing in this area.

Non-governmental organizations can build alliances with industry to produce a viable technological solution that sustains development while protecting the environment. Events and fairs focusing on innovations in environmental technology provide an opportunity for spreading knowledge and exchanging information among industrial firms, service providers and financial institutions. In Brazil, the presence of leading firms in this field, with considerable technological capabilities, such as Degremon, Filsan, Sulzer and DBC, helps in the dissemination and adoption of environmentally sound technologies that also permit an enhancement of industrial productivity.

Interviews with managers of capital goods manufacturing firms show an awareness that the environmental challenge can and should be seen as an opportunity for the industry. Decisive action to solve the problem of urban waste disposal, for example, would itself be enough to inject new dynamism into the industry. The programmes to clean up the Tiete River and Guanabara Bay are calls for the entire industry to mobilize. Here is a chance to recover the terrain lost in recent years, in terms of training and reskilling, technological capabilities, domestic market share, capacity utilization and exports.

Virtually none of the potential market for capital goods designed for environmental protection has yet been tapped in Brazil. This is undoubtedly a very large market, and multinationals have already begun showing some interest in it. Even such different occurrences as the cholera epidemic and the holding of the U.N. Conference on Environment and Development in Rio in June 1992 may have sufficient impact to bring about more awareness of the political gains to be had from measures that both protect the environment and promote development. If this indeed occurs, environmental programmes could become one of the royal roads to economic growth.

The linkage between economics and ecology is shown by the four case studies below. They demonstrate the possibility of reconciling these two priorities with excellent market prospects for environmentally sound

technologies, prospects for the new processes and products which new sectoral investment will require.

2. INDUSTRIAL ENVIRONMENTAL MANAGEMENT: CASES AND FINDINGS

2.1. Environmental Issues in Major Industries: A Case Study Approach

Four cases were selected from different sectors where environmental degradation has been considerable; i.e. paper and pulp, energy generation, mining, chemicals and steelmaking. For each sector, a company was chosen and an active participant was invited to report on this case. Each case author was asked to report on the historical perspective of the firm, a description of the industrial sector, and the genesis and evolution of the environmental problemas. The strategy and action taken to face those problems, the sources of technology in the implementation phase and the outputs in terms of results and new capabilities were described.

The four cases reported in the study are:

a) Environmental Issues and Riocell's Technological Strategy (paper and pulp sector)

b) Environmental Management and Technologies Development: CESP case study (hydroelectricity generation sector)

c) Industrial Pollution Control in Cubatao (chemicals and steelmaking)

d) Corporate Strategy, Environmental Management and Technology Transfer: the CVRD Case Study (mining)

The case authors brought their own experience as well as the data available on the achieved results in each case. Luiz Antonio Slongo from Universidade Federal do Rio Grande do Sul described and analyzed the RIOCELL strategy. Luiz Fernando Galli brought up the issues faced by CESP in hydroelectric generation and the management of those issues with emphasis on the Tres Irmaos project. Werner Zulauf described the Cubatao major effort to reduce in eight years more than 90% of the pollution level provoked by the chemical and steelmaking industries established in the region. Maria de Lourdes Davies de Freitas reported the CVRD experience in mining activities with emphasis on the Carajás project environmental approach.

Such cases deal specifically with growing industrial sectors where investments and financing was made possibl and allowed a positive response to public awareness. The four cases reveal that environmental issues can be managed successfully where competent human resources and access to technology are supported by investment. A comprehensive strategy included the environmental constraints in the decision making process.

2.2. The Paper and Pulp Sector: The Riocell Case

On March 16, 1972, Borregaard of Brazil began its operations with a capacity for producing 190 thousand tons/year of brown pulp, representing sales of 22 million dollars and direct employment of 2,500 people. The initial investment amounted to 76 million dollars. At the time, this venture was

recognized as being of top interest for the national economy, according to Federal Decree number 60,803.

Economic feasibility was all that concerned the Norwegians and the Brazilian authorities. At no time, during the negotiations and the implementation phase, thought was given to ecological or social issues. The concern with communicating with the public immediately affected by the implementation of the project was even smaller. Even the data on the project's economic significance were not adequately conveyed to the population. It was believed that benefits from investment, tax revenue and jobs would be enough to compensate eventual environmental problems caused by the plant's operation. Consequently, public opinion would silence. A few small industrial plants located in the neighborhood of Guaiba, which also polluted the air and the water, were used as reference for concluding that Borregaard would be accepted with no problems.

Pressure became increasingly intense, leading the government of Rio Grande do Sul, through its Health Department, to decide on the closing of Borregaard on December 6, 1973.

2.2.1. Environmental Awareness

The former Borregaard remained closed from December 6, 1973 to March 14, 1974. At the time of the decision to order its closing, the population in the area affected by air pollution caused by the plant (approximately 1.6 million in 10 different cities), lived with a rate of sulfuric gas of 1,800 parts per million, while the World Health Organization had set a health safety maximum of 70 parts per million.

The first action taken by the firm, at the end of 1973, was the addition of a plant for the oxidation of strong black fluid. This substance is a by-product of the process of wood pulping which is burned in the recovery boiler. During the burning process, the sodium sulfide present in the fluid is converted in to sulfuric gas (H2S), which is responsible for the odor that annoys the population so much.

Starting in March 1974, the plant replaced sodium sulfide by sodium hydroxide as an input in pulp production. This modification, by restricting the addition of sulfurous compounds to the process, helped to reduce the bad odor, since it is exactly those compounds that cause the characteristic odor of pulp plants. The sulfate process, since it is the cheapest, is the most widely used throughout the world. Even though it substantially reduced the bad odor, the new process did not entirely eliminate the problem, because sulfur kept being added to the process via fuel oil, which contains 4% of that element.

In 1975, already under a new control, the services of AB Energikonsult of Sweden were hired for the design of an integrated and modern process for controlling air pollution and the treatment of the plant's contamined condensed output. As a result, there followed the implementation of the Gas and Condensed Output Treatment Unit. The contamined condensed output, from the evaporation section, was then collected in a tank and pumped to a distillation tower, in which, through a steam counterflow, the volatile portion is separated from the condensed element and burned in an incinerator. The gases from the pulping process and from the fluid tanks are collected and washed,

and later blown for burning together with the gases from the tower in the incinerator. This process reduces by 90% the bio-chemical oxygen demand of the liquid effluents dumped into the Guaíba River.

In addition to all these actions aimed at solving the problems at Riocell, in 1979 a Residual Recovery System was implemented, whose basic principle it was to control the loss of pollutants in the firm's own high-risk areas. In other words, it was an effort at preventing problems at their source. In effect, such a system is an added protection, mainly aimed at unforeseen problems, since, from the technical and legal viewpoints, all requirements had already been met.

2.2.2. Technological Response

From 1983 on, Riocell began withening pulp in its own plant, which cost almost 240 million dollars, of which 15% were used for environmental protection. Along with the whitening project, and aiming at the control of the entire finishing process with high industrial and environmental control standards, a system was set up consisting of: Chemical Plant, Turbo-generator, Power Boiler, Hydro Treatment, Whitening by Displacement Unit, and Drying Unit. Since the fuel chosen for the power boiler was bituminous coal, the company felt the need for the addition of a five-field precipitating unit, with a capacity for 475,000 Nm3/h. A concrete trunk was also built for the 126-meter high chimney. These actions substantially reduced particle emissions.

The Effluent Treatment Station is made up of: pre-treatment covering the stages of grinding, sediment removal, and neutralization; primary treatment, with primary decanting, effluent cooling, and homogeneization; secondary treatment, with an Unox reactor (closed), and the use of pure oxygen for micro-organism breathing, generated in an 02 plant using the P.S.A. (Pressure Swing Absorption) system and a secondary decanter; tertiary treatment, with coagulators, a polishing pool and a lowered effluent station with a diffusor at the end of the emission system; a system for handling and stockpiling of mud generated in the treatment system. As a supplement to the station, an impermeable emergency pool was built, for the capture of eventual load or flow peaks, thus preventing treatment shocks. With the goal of preserving the system's efficiency, even during maintenance periods, there are duplicate decanting systems.

Effluents from all parts of the plant, except those from the whitening unit, are collected by underground pipes and led, by gravity, to the treatment station. They first pass by grinding, then by sediment removal and, already prepared for treatment, they reach the neutralization tank, where the Whitening Plant effluents are also collected. The neutralized effluents are then subjected to the first treatment, consisting of removing from them the solid particles still remaining. After that, they undergo heat reduction to 37 or 38o C and move to the homogeneization pool, with a gaseified surface, from where they are pumped to the Unox reactor. The Unox system, based on the use of oxygen, more effectively stimulates the development of micro-organisms, thus representing a form of biological treatment of effluents.

Biologically treated, the effluents are then sent for tertiary treatment, which basically consists of removing their color, by coagulation with aluminium sulfate. Finally, the effluents are neutralized with calcium

oxide and transferred to the polishing pool, from which they are thrown into the Guaiba River, but without a pollutant's damaging features.

The mud generated in the three treatment stages is collected in a special reservoir, thickened, filtered and deposited into open pits in a especially reserved area. This mud, along with other residuals such as ash and sand, is subjected to a decomposition process and later converted into organic fertilizer, replacing a major part of the chemical products employed at present in the 40.000 hectares of the firm's own forest.

According to figures provided by the company, since its opening in 1988, the total investment in this plant has reached 42 million current dollars, directly related to environmental protection (see Table 2.2.2.).

Table 2.2.2.
Riocell's Investments in Environmental Protection

(in US$1.000)

Aerial emissions (odor and particles)	
. Black fluid oxidation	1.000
. Gas distillation tower,incinerator,tanks,etc	2.000
. Electrostatic precipitator for the power boiler	1.120
. Chimney for power boiler and oven	1.000
. Precipitator for recovery boiler,trunk and biler chimney, tank for dissolving and oxidizing of fluid	3.850
. Original precipitator for recovery boiler	800
. Original chimneys (recovery boiler, calcium oxide oven, dissolution tank)	400
. Washers for calcium oxide oven gases, dissolution tank and digestor	150
. Precipitator for calcium oxide oven	876
. Modification of recovery boiler	132
. Complementary equipment for secondary air installation	188
. Modification of burning process in recovery boiler	134
. Others (ducts, exhausts, fans, etc)	876
Subtotal	12.526
Liquid effluents	
. Residual recovery system	1.160
. Effluent treatment station	19.150
. Gallery and underground pipe system (expansion)	2.530
. Pipe system and pump station	2.000
. Others (tanks, locks, detectors, etc)	1.410
Subtotal	26.250
Solid industrial residuals	
. Coal handling and stockpiling	1.160
. Area appropriate for residual disposal	140
. Equipment for residual handling and disposal	950
. Others(research on the use of residuals,controls,etc)	220
Subtotal	2.470
Control of environmental quality	
. Design and implementation of laboratory for control and environmental research	400
. Equipment for environmental monitoring	250
Subtotal	650
Summary of investments	
. Aerial emmissions	12.526
. Liquid effluents	26.250
. Solid industrial residuals	2.470
. Control of environmental quality	650
T o t a l	41.896

Technologies for environmental protection and production have always been closely related to each other at Riocell. In most cases, this interdependency is natural, since a new process (as in the case of pulp whitening) forces new investment in environmental technology, and the investments in environmental control may lead to greater industrial efficiency, as was the case in the implementation of the waste control system, for example.

Such technological integration results from a mixture of ecological responsibility, discipline, quality and efficiency that has been incorporated to the firm's managerial philosophy to the extent that the firm has tried to adjust to external pressure, in terms of marketing and from society. On the other hand, the nature of the firm's activity forces long-range planning and the use of strategy. For example, eucalyptus, in spite of its short life cycle (approximately 7 years), allows for three cuts before new planting is required, which means a total duration of over 20 years. Since this has implications for investments in production processes, products and markets, management can not possibly escape from it.

2.2.3. Lessons and Perspectives

Since the onset of operations in 1972, and until the present, Riocell has increased production by 63%. The original 190 thousand annual tons of brown pulp have become 310 thousand. From these, 260 thousand correspond to whitened pulp, 20 thousand involve soluble pulp for viscose, 15 thousand for paper and cardboard, and 15 thousand of brown pulp. In 1989, operations generated sales of 223 million dollars, and the average employment reached 2,500 persons.

Control over technology, market strategy and the belief that environmental problems are under control have led the firm to plan for a significant increase in production in the medium to long run. The Guaiba plant capacity will be doubled by 1994, reaching an annual output of 720 thousand tons, requiring an investment of 650 million dollars in the industrial unit.

Given a decision to maintain a leading position in terms of new investment in the industry, Riocell has signed an agreement with Copene of Bahia which led to the creation of Norcell, which will produce 420 thousand tons/year of pulp starting in 1993.

Norcell owns an area of 120,000 hectares in Entre Rios, Bahia, which has been set aside for reforestation. Eucalyptus has already been planted in more than 60,000 hectares. Copene's investment in reforestation had been aimed at energy production, on the assumption of a worsening of the oil crisis. Since this crisis has not materialized, a decision was made to invest in pulp production, with Riocell as a partner.

This location, in the Northern part of Brasil, will give Norcell easy access to markets in Europe and the United States. Riocell will concentrate on serving markets in Latin America and the Far East. At present, 48% of Riocell's exports are sent to Europe, 10% to Latin America, 13% to the Far East, and 19% to the United States. Among them, the Far East is the most promising market.

The solution of environmental problems and the political and social acceptance gained thereby have been decisive for encouraging expansion. Riocell management knows, however, that its success thus far should not diminish its perception of possible changes both at the national and the international levels.

Expansion projects in Brasil point to the doubling of production in the next 5 to 6 years. The People's Republic of China, in 2 years (1986-88), increased pulp production by 25%. Also in Asia, Japan keeps expanding production capacity, which grew by 8% from 1987 to 1988. Japanese investment in the industry in 1988 amounted to 3.5 billion dollars, 44% larger than in 1987. European production grew 4% from 1987 to 1988, a new record. On a worlwide basis, pulp production expanded, in the same period, by approximately 4%. On the other hand, the share of pulp in the production of paper worldwide in 1988 reached 70%. This is the lowest share since 1983, when it was 75%. This represents a reduction of 1% per year.

The consequences of new changes will be pressures for price reduction and more intense international competition. At present, competitive advantage will depend very much on positive results from investments in automation, environmentally sound technology, product development and customer service, all of which have been the focus of Riocell's attention in recent years.

Attacks on the environment, until recently a privilege of developed economies, have also become more frequent in less-developed countries, mainly in the chemical and petrochemical industries, but have also been caused by pulp manufacturers, which are not only heavy users of natural resources, but tend to return to nature large volumes of highly polluting and life-damaging materials.

2.3. Hydroelectricity Generation: The CESP Case

Most of the electricity generated in Brazil is hydropower. The aggregate installed capacity of the nation's hydroelectric plants today is 50,985 MW. Coal - and oil-fired thermoelectric plants is only 3,115 MW and one nuclear power plant in operation produces 657 MW.

CESP runs 20 hydroelectric power plants, with an aggregate installed capacity of 10,174 MW, accounting for 89% of all the electricity generated in Sao Paulo and 20% of the power poduced nationwide. In the next few years, however, production will increase as new plants come on stream. Taquaruçu and Porto Primavera, to be started up in 1992 and 1996 respectively, will add 2,318 MW.

According to recent official studies, the Brazilian electric power industry has a positive short-term outlook for meeting demand. In the medium term, especially in the last five years of the century, prospects might on the contrary be negative. Thus, the key challenge ahead is to adjust the supply and to the level of projected demand. As a result, CESP is endeavoring to find ways of increasing the local supply of power, among which the following are worth highlighting:

- stimulation of the use of natural gas by industry

- construction of small and medium hydroelectric plants to make fuller use of the remainindg hydropower potential in Sao Paulo

- development of new thermoelectric facilities which could be brought on stream at relatively short notice

- stimulation of energy conservation programs

- search for new energy sources.

In line with the above targets, CESP is currently concluding design work on two thermoelectric power plants for a total of 950 MW, as well as studies and designs for development of the State's remaining hydropower potential, estimated to be 2,000 MW. These include 24 small and medium plants with generating units that vary over a wide range of capacities, from 0.5 to 50 MW.

2.3.1. Environmental Problems: Origins and Evolution

CESP's complex of hydroelectric power plants is associated with the creation of large reservoirs which, when added to those now under constructin, will flood an aggregate area of more than 7,500 square kilometers and have more than 15,000 kilometers of perimeter shoreline (twice the total length of Brazil's Atlantic coast).

As a result, almost all the hydropower potential in the State has been developed, including all the main rivers in the region (Paraná, Paranapanema, Tietê, Grande, Pardo and the upper Paraíba do Sul basin). Only a small potential remains for development, so that small and medium plants will have to be constructed for this purpose.

These hydroelectric developments have changed the course of the rivers involved along most of their length and further affected ecosystems that had already been profoundly modified by mechanized farming, urbanization and industrialization.

Some 82 percent of the State of Sao Paulo was originally covered by tropical forest. This proportion is now a mere 5 percent, almost all of it in the coastal belt and classified as State parks, forest reserves, and ecological research stations. The deforestation caused by the expanding agricultural frontier was most intense in the earlier part of the 20th century, before the large hydroelectric power plants were built.

Construction of hydroelectric plants and creation of reservoirs cause environmental changes at different levels. Years ago, electricity was considered a clean form of energy, and an indispensable element in the evolution of modern industrial society. Today is being criticized in view of the various kinds of environmental impact it causes during the design stage, construction stage and during operation.

In 1978 it set up a Department of Natural Resources, now renamed Department of the Environment and Natural Resources, to draw up and implement the company's environmental programs. Reservoir management was initially understood as consisting of a set of actions geared to the containment and

channeling of environmental changes so as to guarantee a supply of water with the quality and quantity required for electricity generation. This activity was therefore based on two programs - repair of damaged areas and reforestation of reservoir shores and islands so as to control erosion. This program also included launching of newly-hatched fishes into reservoirs to compensate for the severe disturbance of fish fauna caused by changes to the regimen of a river after dams are built along their course.

Work began on the creation of five seedling nurseries - producing more than two million seedlings - of native tree species per year for supply to the reforestation programs. In the last 12 years, however, what began as an effort to reforest areas damaged by removal of their forest cover for use as borrow pits from which earth could be taken to the dams under construction has evolved into a far more ambitious program. This program involves hundreds of native tree species which are planted to control erosion, develop, protect and sustain terrestrial and aquatic fauna, guarantee the survival of species threatened with extinction, and create areas for recreational use.

Of all the negative impacts caused by construction of hydroelectric power plants in Sao Paulo, the most conspicuous are those affecting fish fauna. Construction of a dam transforms a river into a vast lentic (still water) environment, thus hindering the survival of anadromous species that must migrate upstream in order to reproduce.

Fish hatcheries began to be created in 1963 by CHERP (Companhia Hidroelétrica do Rio Pardo), one of the five state utilities that merged to form CESP in 1966. However, a new program for conservation of fish fauna began to be developed in 1983, with implementation of a comprehensive project involving production of 11 million fish fry per annum. This new program aimed at autochthonous and allochthonous species for breeding in reservoirs, studies of the reproduction of native species in captivity, limnology and fish biology, control of fisheries, characterization of tributaries, and other forms of research and control designed to maintain and, if possible, increase the amount of fish in reservois.

New concepts related to environmental protection and conservation have been designed to:

- maintain and enhance the quality, quantity and regularity of water in reservoirs

- promote soil conservation in areas on reservoir shorelines and watersheds contributing to them

- assist in conserving or enriching genetic diversity in the reservoir's area of influence.

Environmental protection and conservation is a constant concern in all operating areas, from dam and power plant construction to power line erection. Highly satisfactory results have been obtained, with the development of an environmental awareness in the Brazilian electric industry, and pioneering achievements in several areas, e.g.:

- reforestation
- fish farming
- rehabilitation of degraded areas
- wildlife management
- environmental education
- drafting of environmental impact studies and reports

2.3.2. Strategies and Actions

Nowadays no electric power generation project can omit calculation of environmental costs, in addition to the technical and financial problems related to implementation. In a democracy, the environmental costs must be exhaustively discussed with society, on whose behalf the development is being undertaken and which will foot the bill in the last analysis. Efforts have been made to show that electric power projects should not benefit only the large-scale consumers, who are usually located a long way away from the development itself. It is a mistake to apportion to the regions in which large reservoirs are formed only the burdens and problems created by the changes made to the environment.

Conservation programs are designed in such a way as to ensure that the public resources utilized in development of the electric power generating system help to produce an optimal cost-benefit ratio. New projects have to consider the unique characteristics of each region, giving priority to ethical criteria when managing the relations between human communities and their natural environment. With regard to reservoir utilization, the central objective is to broaden the concept of hydroelectric development project into one of regional development project. This presupposes full participation by society in all stages of project development, especially in programs for multiple use of reservoirs.

This policy is implemented in accordance with the guidelines below:

- promotion of actions geared to regional development and integrated natural resources management, in collaboration with organized groups and movements as well as public institutions

- performance of studies designed to determine the scope of the company's responsibility for the environmental and socio-economic impacts caused by its projects

- promotion of actions to permit the rehabilitation and environmental conservation of areas affected by projects

- creation of links with regulatory agencies controlled by the State and federal governments, so as to take part in the production and enforcement of standards to regulate third-party activities in areas belonging to CESP.

Although many projects began before Brazil had any environmental legislation in force, it is still mandatory to have the respective environmental impact studies approved before an operating license is issued. For the first time CESP was obliged to hold a public hearing as part of the process of licensing the Três Irmaos project. At this hearing, a discussion was held with the communities in the areas of influence, with environmental

groups and other representatives of society, on the environmental impact of the reservoir. Here it was not a question of discussing whether or not construction would take place - since the plant is at the completion stage - but of discussing the environmental impact and the ways of attenuating it.

The Três Irmaos power development, with an installed capacity of 1,293 MW and a reservoir which will flood 70,000 hectares, is thus an interesting case study. This last hydroelectric plant on the Tietê was first conceived of in the 1970s, at a time when no thought at all was given to environmental problems in Brazil. Hence it was not possible to impute the environmental cost of the project or discuss its true cost-benefit ratio with the communities involved. However, discussion of the environmental and socio-economic impacts of the project required by the rules for obtaining an operating license took place as environmental issues were reaching the forefront of public awareness, especially in the State of Sao Paulo. This obliged CESP to enhance and extend its plans for attenuating the impacts of the project, postpone the deadline for completion in order to permit these environmental programs to be put in place, and, most important of all, recognize the strength of the communities involved, as well as the force of their arguments. Finally, the company took all liability for any environmental damage caused by the project.

The following environmental control and multiple use programs implemented at Três Irmaos are:

- Rehabilitation of degraded areas
- Clearing and cleaning of the impounding basin
- Safeguards for the population
- Rescue and relocation of fauna
- Fauna and flora conservation units
- Management of threatened species
- Ciliary reforestation and reconstitution of native forest
- Monitoring of the aquatic environment
- Sanitary control
- Conservation and salvage of archeological heritage
- Leisure and recreation
- Operation of hydroelectric power plants
- Fish fauna conservation
- Reforestation
- Wildlife management
- Environmental education and social communication

2.3.3. Lessons and Perspectives

After the U.N. Conference on the Environment held in Stockholm from June 5 to 16 1972, it became widely accepted that conservation is a pre-condition of development. Since the energy question is closely linked to that of the model of development, in the first half of the 1970s the Brazilian electricity industry began discussing a new rational, integrated approach to planning that could combine development with environmental protection and enhancement of the quality of life.

CESP was the first power utility in Brazil to institutionalize environmental action by creating its Natural Resources Department in 1978, precisely when the public debate begun about the proper role of state-owned

enterprises. A major issue under discussion was democratization of the uses of electricity, and an effort was made to find ways of both improving access to this input and enabling the population affected to participate in decisions about such situations. It was also a time when the idea that power utilities are responsible for environmental impacts was being transmuted into the idea that they are responsible for helping to promote regional development.

Another point worth stressing is that the company invested heavily in training and recruiting skilled environmental personnel, including over 80 university graduates (forestry engineers, agronomists, biologists, vets, animal husbandry technicians, geographers etc), holding courses and sending trainees to universities and research institutions. These technicians' enthusiasm at a time when environmental concerns were not yet fashionable, togehter with their respect for state enterprises as public organizations, was fundamental to the development, success and recognition of CESP's environmental protection programs. Today the company's Environment and Natural Resources Department is able to take an independent action, after discussing with the engineering area, the environmental impact of proposed power developments, and to put forward projects alterations whenever necessary.

The fact that CESP operates in the State of Sao Paulo is also relevant, since this is the socially and economically most developed part of the country, so that its population is the most demanding; there is more technological research and development there; and the company is located closeersities and research institutions which are important sources of knowledge and technological innovation.

2.4. Chemicals and Steelmaking: The Cubatao Case

Cubatao industrial complex is situated in Baixada Santista Area. Geographically it stands on the narrow strip of sedimentary soil in the plain by the sea between the lagoon-estuary system in Cubatao River and the slope of Serra do Mar (mountain ridge against the sea-cost) - 800 meters above sea level. On the upland we have Sao Paulo Metropolitan Area: 17,4 million people, 7951 square/kilometers and 25% of the Brazilian Revenue. The figures for Sao Paulo State are the following: 27 million people, and 46% of Brazilian Revenue. Cubatao is situated at the rear of Santos Bay, the largest Brazilian Harbour and the main port through which the products of the state go out and come in.

The existence of a 1.000 MGW hydroelectric power plant, the measures of the harbour, the existence of the best structure for road and railway system in the country and the nearness of the largest market for consuming and supplying skilled labour have been the main points that have led to the implementation of the industrial complex in Cubatao in the 60s and 70s.

Industrial plants are situated in three adjacent areas, they are characterized by their nature and the geographical position of each one, besides some of kind of industries.

The petrochemical complex is the oldest one, the origin of which is President Bernardes Refinery which belongs to the State Company Petrobrás - Petróleo Brasileiro S.A. - situated beside Cubatao urban area, made up by the Refinery itself and 16 petrochemical industries private, national and

multinational enterprises. Then there is the siderurgical complex which is integrated with two blast furnaces and two steel plants (one for continuous ingot casting) which manufactures steel plates with an output around 3.900.000 million tons of steel a year. It belongs to the state company - COSIPA - Companhia Siderúrgica Paulista. The third complex deals with fertilizers - the nucleus of which is a state enterprise - Ultrafertil S.A., a subsidiary company controlled by Petrobrás. This group is made up by 6 other private, national and multinational enterprises.

The siderurgical and fertilizers complexes are adjacent and are situated in Piassaguera, in the lower part of Mogi River, physically separated from Cubatao by a pass between Serra do Mar (mountain range) and Areais Mountain, although it is only 2 miles far from the town centre. By the fertilizers complex there is a cement plant and by the petrochemical complex there are a paper mill and two concrete plants.

The geographical factors above mentioned separate the petrochemical complex from the siderurgical and fertilizers complexes as regards the direct effects on Cubatao town, which is subjected to the effects of air pollution from the petrochemical complex only. Cubatão is affected only indirectly by the siderurgical and fertilizers complexes, as Mogi and Cubatao rivers, among other rivers, belong to the same lagoon-estuary system. The site of siderurgical and fertilizers complexes (Piassaguera) sheltered Vila Parisi, a 5.000 inhabitant-district for workmen. This district suffered the direct impact of pollution from the two complexes.

2.4.1. Environmental Problems

Industries in Cubatao were implemented at a time there were no permit requirements and no studies on environmental impacts; therefore, there were no preventive/corrective actions against pollution effects.

The consequences were very bad: anyone who passed by Cubatao, heading for Guarujá, Santos or any town in the area could see or smell the harmful effects of the pollutants generated by those industries. The atmosphere was permanently polluted by a dry smog and the appearance of industries and mountains looked like dark profiles in the gray filthy air. The bad smell of hydrocarbons, ammonia and some other pollutants completed the suffocating environment. The brooks that had sprung up limpid and flawless like crystal just a few miles upstream turned now into a dark, sticky foam. Solid, liquid viscous, toxic and inert wastes were dumped on the ground, uglifying the landscape and jeopardizing the use of vast areas meant for urban, leisure and even industrial purposes. On top of that, the waste water from Sao Paulo Metropolitan Area, on the plateau, is discharged into Cubatao River, through Henry Border power plant, after being partially treated by self-purification in Billings Reservoir.

CETESB - Environmental Protection Agency, a Sao Paulo State agency, dealing with pollution control problems since 1970 was assigned to carry out a program to fight pollution in Cubatão. By means of consecutive reappraisals of its structure (1973 and 1975) and the publication of Sao Paulo environmental legislation (Law 997/76 and Act 5468/76), CETESB took the lead in the process of staff training and instituting legal actions in order to protect the environment. According to priority, special emphasis was laid on industrial pollution control actions.

In its first phase, the environmental program of Cubatao detected 320 pollution sources, out of which 230 for air, 44 for water and 46 for soil. Sources which provocked an intense environmental degradation. Political willingness, technical capability and managerial competence reveal in the Cubatão case means to face environmental recuperation and protection.

2.4.1.1. Air Pollution

Among air pollution sources, the following stood out:

1. Particulate Matter: arising mainly from fertilizers and siderurgical industries; there was still the secondary generation of sulphates through their reaction in the atmosphere with sulphur compounds and other gases. The larger particles were made of iron oxides, phosphate rocks, lime, not-completely burnt hydrocarbons, carbonblack (black smoke). The smaller particles, which are even more harmful to the respiratory organs of men and animals, were the sulphates, responsible for the misty aspect of the landscape.

2. Fluorides were tipical pollutants derived from the fertilizers industry emitted in the form of particulate matter and gas. They were identified as the main phytotoxicant agents responsible for the destruction of the luxuriant damp vegetation of the tropical forest along the mountain slope. The lack of vegetal cover associated with the heavy rainfalls in January 1985 caused land slides in the mountain range what subjected the whole area to an emergency.

3. Ammonia: ammonia emissions derived mainly from fertilizers industry and caused frequent complaints from Cubatao and Vila Parisi dwellers. Mixtured with hydrocarbons odours, mainly mercaptans, ammonia causes a horrible smell. As it is very reactive, ammonia participated in a series of secondary reactions in the atmosphere, particularly in forming ammonia sulphate. Aerosol studies carried out in Cubatao by means of a receptor model showed a great incidence of ammonia sulphate as fine particulate matter (2.5 micra) both in Vila Parisi and in the centre of Cubatao. In January 1985, the land-slides caused the breakage of ammonia pipeline which led part ot the industrial activities to stop and the evacuation of Vila Parisi.

4. Hydrocarbons: hydrocarbons inventory has shown a total emission around 90t/d in July 84. The major emission occurred in the centre of Cubatao by the petrochemical complex. The hydrocarbons plus nitrogen oxides formed photochemical oxidants through secondary reactions in the atmosphere. Peroxidacetilnitrate (PAN), and tropospheric ozone (O3) are known to be phytoxicant and to cause irritation of the mucous membrane. The primary and the secondary phytotoxicant actions of the hydrocarbons were evident in the destruction of the vegetation in Serra do Mar along the road "Caminho do Mar" in the rear of the refinary.

5. Nitrogen oxides (NOx): NOx emissions have been calculated in 61t/d deriving from two main sources: combustion products in furnaces, boilers and engines and industrial process products in fertilizers plants. As they were responsible for the formation of tropospheric ozone, they were regarded, together with the fluorides, critical pollutants in Cubatão from the phytoxic agents (phytotoxicity) point of

view. As it is practically impossible to obtain significant reductions in NOx emissions from combustions, emissions from the industrial processes were brought under tight control. Nitrogen oxides were also responsible, together with some other pollutants, for acid rain, when they get in touch with atmospheric moisture and form nitric acid.

6. Sulphur Oxides (SOx): SOx emissions come from fossil fuel burning containing sulphur and sulphuric acid plants, this one a basic raw material in fertilizers plants. The phosphatic rock is attacked by H_2SO_4 at the beginning of the process. At first, SOx emissions were reduced by replacing high sulphur content fuels (>5%) by the low ones (1,5%). The SOx contents in Cubatão atmosphere were masked by a quick reaction with ammonia (forming Ammonia Sulphate), that is why real contents monitored in the environment did not coincide with the figures taken from the emission sources. Apparently there was less SOx than what was really emitted. In July 1984 the real emissions were 78.4 t/d, when the low sulphur content fuel was currently being used.

7. Others: besides the pollutants already mentioned, there still were chlorine emissions which destroyed the vegetation in Morro dos Areais; there were CO (carbon monoxide) emission which were later recycled as fuel, benzene emissions that led to a serious case of leucopenia in the siderurgical plant, let alone CO_2 emissions, a gas which is not considered as pollutant by any legislation, however has become a world concern for being responsible for 50% of the greenhouse effect.

2.4.1.2. Water Pollution

Among water environmental parameters, the ones that have been monitored, during the control program, are the most important: pH, DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), Total Nitrogen, Ammonia Nitrogen, Total Phosphorus, Mercury, Phenols, Faecal Coliform. Industrial water pollution sources were identified and the pollutants that had to be removed from wastes by treatment were listed. Forty-four pollution sources were identified and deadlines were fixed for implementing pollution control programs. In accordance with law wastes treatment was enforced as regards the following parameters: BOD, setteable solids, oil and grease, phenols, solvents, heavy metals, ammonia waters, organochlorides, chlorine and fluorides in the fertilizers industries and iron oxides in steel plants.

The program also included the collecting, piping and treatment system of Cubatao town wastes which has been implemented by SABESP (a state agency) the basic sanitation agency in the municipality.

2.4.1.3. Soil Pollution

Soil Pollution sources are mainly solid and viscous; occasionally, they can be liquid and even gaseous. As regards origin, the 46 sources in this kind of pollution are processing industries, industries with domestic characteristics (restaurants and offices) and urban wastes (city wastes). In this category, innumerable wastes problems (including hazaradous wastes) were

identified, such as tars, fuel tank sludge, catalyst wastes, water treatment plant sludges, dusts from eletrostatic, bag and cyclone filters, slag, gypsum, wastes from chemicals processing industry, including organochlorinates and wastes containing heavy metals. Among solid wastes pollution sources there was an unused case when several spots in Baixada Santista were contaminated by sodium pentachlorinephenate containing this chemical, hexachlorinebenzene and dioxin traces among others. The solution to this single problem costed the enterprise that succeeded the one which caused the environmental damage the equivalent to US$50,000.000, ten times the value of the plant.

Cubatao municipal government implemented a sanitary landfill in Areais where industrial wastes with the characteristics of domestic wastes are disposed of. The landfill site is equipped with percolating water treatment system by means of stabilization ponds in series. Its operation capacity is fairly reasonable. An incinerator for hospitals wastes has been operating fairly well.

2.4.2. The Interaction of Pollutants with the Environment

The effects of pollutants emission can be reduced or increased by environmental characteristics with which they interact. In the case of Cubatao, these factors are extremely aggravating, as discussed as follows:

1. Atmospheric Factors: the 700 meter high Serra do Mar massif in the nearness of industrial plants causes during winter thermal (temperature) inversion and windless periods which lead to unfavourable conditions for pollutants dispersion. Thus, pollution levels, mainly for particulate matter and O3 are far above the limits, aggravating respiratory diseases. This particular aspect has led to a contingency plan for serious episodes of air pollution consolidated in the declaration of Attention, Alert and Emergency notices. Such contingency plan started to be used a number of times causing partial or total interruptions of pollution emitting industries which lead to critical episodes. The losses that these interruptions caused industries (20 to 30 hour interruptions), together with other factors of the program methodology, worked as a driving force in the administrative decisions to implement control systems.

During the day, winds usually blow from Vila Parisi and Cubatao-Centre towards industries. In the night, they turn in the opposite direction, intensifying the effects on people at home with an aggravating circumstance: the night itself. As pollution is intensified in the night, collective anguish takes place and this fact lead people to panic.

Contrasting with windless periods that frequently occur in Cubatao, there are strong winds that blow dust that hassettled on pavements, roofs and unused plots of land, suddenly rising Particulate Matter levels. Sometimes Alert and Emergency states have occurred on account of these factors. In these cases, there was no use in stopping the industrial plants, as the main cause was the strong wind as recorded in the automatic monitors. This wind, after reaching high values, calms down very quickly.

2. Hydraulic conditions: the nearness of the estuaries of Cubatao, Perequê, Mogi and Quilombo rivers means a series of difficulties from the environmental point of view, both for the ecosystems and the industries. The pronounced variation of the syzygy tides may push the salt-water wedge as far as industrial water catchment for siderurgical plant. The discharge of pollutants

into water causes their sedimentation on account of water flow speed reduction in the change of tides; due to this, large mangrove areas are endangered, some of them irremediably.

The mangrove has a very important ecological function, for it is in the mangrove that the transition between fresh water biology and salt water biology takes place. The mangrove is the last links in the continental food chain and the first in the marine one.

3. Soil morphological and qualitative conditions: Cubatao industrial complex has contributed to the demographic and urban developments of the district and Baixada Santista. Due to this, nearly all sites have been lawfully occupied, therefore the mountains, the slopes in the mountain range and the mangrove areas have been excluded from urban occupation. On account of lawful prohibitions, which forbid the approval of formal division of land into lots. These areas are ultimately occupied by slums and clandestine division of land in building lots, what is highly harmful to these ecosystems.

Air pollution destroyed the vegetal cover of mountain range and big trees. Due to the organical decomposition of the roots, the radial texture that was responsible for the stability of the soil in the slopes has loosened. During heavy rainfalls in January 1985, there were serious land slides on the slopes of the mountain range and this was a warning that a calamity might occur.

2.4.3. Strategies and Actions

Cubatao industrial pollution problems and their consequences stopped being a domestic, Brazilian affair. It had become newsworthy all over the world. Cubatao environmental problems went so far that Cubatao started to be called the most polluted town in the world - a story of exagerations. Exagerations aside, the problems were serious and demanded solutions.

In 1983, with the redemocratization of Brazil, the first Governor to be elected, Senator Franco Montoro, took office and promised to solve, among other problems, the environmental issues, which had been included in his political program. CETESB - Environmental Protection Agency - a state agency - started being managed by a board of directors who were experts in the field. Their special task considered the problem in Cubatao as their first priority. The most important condition to solve such a problem had been materialized: Political Will.

In the first week of the new government CETESB's Board of Directors went to Cubatao to inform the Mayor and the Town Councillors of the priority for the problem as a government decision.

From that moment on, technical and administrative measures were taken. These measures are the following:

1. To provide Cetesb's regional office in Cubatao with new structure by increasing the staff with experienced professionals from other areas of the agency.

2. A judicious survey of all pollution sources of all areas in all plants (more than 100) grouped in 29 enterprises and the implementation of a "Record and Inventory of Pollution Sources".

3. Installation of a third air quality monitor, making them automatic and linking them to the telemetric network at Cetesb's headquarters in Sao Paulo plus two mobile laboratories to track down specific emissions and to develop various studies.

4. A vehicle specially equipped to operate in emergency situations and operated with a staff trained in Brazil and abroad.

5. A shift in the acoustic radar position from Sao Paulo to Cubatao to identify, measure and register thermal inversions.

6. Installation of a meteorological central station in Sao Paulo equipped with parabolic aerials in direct connection with GOES and METEOSAT satellites and meteorological radars in Bauru, Sao Roque and Ponte Nova by fac-simile as well as radio and telecommunication systems with COMDEC - Municipal Civil Defense Committee in Cubatao which has been re-organized and re-equipped by the Cubatao Municipal Government.

7. Installation of air pollution Valley Dispersion Model to identify the nature of Particulate Matter emissions leading to the emission sources.

8. Installation of captive balloons in agreement with USP - University of Sao Paulo for air sample collection and air flow studies in Cubatao - Centre and Piassaguera basins.

9. Installation of a manual monitors battery in Serra do Mar to identify the pollutants responsible for the phytotoxic actions over the vegetal cover.

10. Comparative studies on the alteration of soils in Serra do Mar between the soil in the Mogi Valley alterred and the neighbouring Quilombo Valley (not altered).

11. Toxic-epedemiological studies on the effects of chemical pollution on the health of the population.

12. Toxicological evaluation of exposure levels of infantile population to environmental pollutants.

13. Chemical characterization of rain-water.

14. Toxicity evaluation of water, river sediment and industrial effluents.

15. Implementation of contingency plan for critical episodes of atmospheric pollution consisted by detailed actions for every situation: Attention, Alert and Emergency; the declaration of the various situation was made according to the automatic sampling telemetrically transmitted to the head-quarters in São Paulo, when they were received every minute and processed every hour, what makes possible quick decision-making.

16. To determine air quality patterns for non-conventional period of exposure for Particulate Matter, Sulphur Dioxide and Fluorides, specific for environmental conditions in Cubatao.

17. Studies on the origin and the formation of photochemical oxidant to detect the phenomenon based on the primary pollutants (Nitrogen oxides and Hydrocarbons).

18. Survey and distribution of sulphur dioxide in the atmosphere and a mapping based on 29 sampling stations spread out in Cubatao area.

19. Air quality evaluation in Quilombo River Valley by means of a movable lab for comparison purposes considering the physical nearness of this Valley to Mogi River and its exclusion of pollutant plumes of industrial origin.

20. Environmental hazards evaluation and control, taking into account the presence of high polluting potencial near settlements.

21. Distribution of nitrogen dioxide and gaseous fluorides in 29 points in the district.

22. Studies on ammonia in Cubatao atmosphere.

23. Emergency actions plans (EAP) to prevent land-slides in the slopes a joint-proposal involving IPT - Instituto de Pesquisas Tecnológicas (Technological Research Institute), CETESB and DAEE - Departamento de Aguas e Energia Elétrica (Department for Water and Electricity) in order to protect directly the industrial plants in the area against the effects of an eventual muddy stream and indirectly the population, for the effects that a catastrophe on the plants could break out in the surrounding urban areas. The basic directives that guided EAP were the following:

- to increase safety measures against accidents caused by material from the slopes reaching industrial plants in the form of "muddy streams" by partly stopping them, diverting and/or reducing its kinetic energy by means of 9 dikes and 3 gabion stone dams implemented on the lower segments alongthe draining system in the slope and by building a 1.30 m high gypsum dam (measuring 130m long, 15m at the base and 13m high) to protect the ammonia main tank in the fertilizers complex;

- to reduce silting rate in the main draining systems in the area by retaining solid material in dikes, which were implemented mainly along Mogi River;

-to minimize floods by dredging (preventively and correctively) the main draining systems (Mogi, Perequê, Cubatao and Piassaguera rivers);

- to equip the dikes in the slope with instruments in order to continuously follow up and evaluate hazards during the rains;

- to take measures to prevent the leakage of fluids, by plotting and protecting pipelines and warehouses or operating them according to hazards, going so far as to close down some units under major risks during summer heavy rain periods;

- to build protecting walls and canalize brooks that cross the refinery;

- to study measure to re-arrange dwelling areas near the industrial plants, particularly in Vila Parisi. This was developed by the Cubatao

Municipal Government through an ambitious housing program called "Vila Nova República";

- to control the effects of surface erosion on the land slides areas by planting vegetable species under the technical guidance of Instituto Botânico (Botanical Institute) and financed by the industries.

24. To implement pollution control program in 320 pollution sources - air (230), water (44) and soil (46) through a participating and transparent methodology, described below under special title.

25. To follow up the program through an environmental education project and communal participation. Starting from interviews carried out with the main political, communal and syndical leaders in the District, in May/1983 environmental education and communal participation activities in Cubatao were started.

The planning of actions and the objectives of the project were defined based on a diagnosis of the local reality and on a survey on all social areas above mentioned. Thus, information on the environment was passed to the population in Cubatao, to make possible its participation in the discussions so that the population can put forward proposals and decisions regarding the environmental issue. CETESB has also developed some topics on environmental education for social areas in order to organize proposals and means of mobilizing and organizing environmental issues. These issues cropped up during discussions and meetings which included all organized communal areas.

The research work was carried out in 35 institutions from July to October 1983 and the results were presented and discussed in the City Council in November and December. A broad survey was carried among Cubatao industries about their position on environmental problems from December 83 to May 84. During 1984, new data were collected in 31 institutions representing the community about their claims to obtain an answer to social problems in the district.

2.4.4. The Achievement of the Undertaking

Except for some reaction to inspection, which occurred at the beginning of 1984, with no answer from the government, it should be acknowledged that the industrialists, although did not behave actively "for", collaborated intensively with the program, as in two periods of government significative pollution source control and polluting emissions control have been achieved.

The Primary Control Program for the Recovery of Environmental Quality in Cubatao achieved 90% of registered pollution sources and duly under control.

2.4.4.1. Air Pollution

Along 1990 a quantitative re-evaluation of the main pollutants generated by the industries that participate in the control program was carried out.

The implementation of the Control Program did not eliminate the pollutants generated by the industries, however they are controlled at the best available practicable technology for each case, by means of screen filter, gas scrubbers, electrostatic precipitators, etc. Consequently, the former levels of pollutants emission were considerably lowered, because there is no zero discharge technology. Ammonia and fluorides are typical pollutants generated by the fertilizers' industry and they are most important as regards quantity, but for their phytotoxicant potential and for their harmful effects on the natural vegetation in Serra do Mar.

The particulate matter (dusts), the main pollutant (first priority) which totalled 114,414.4 tons/year in the main pollution sources has been controlled to an overall level of 72.4% which generates a remaining total load around 31,546 tons/year.

The expected total level for dust primary control achieves 93% and the 20.6 points differential that still remains to be obtained depends exclusively on the equipment that is lacking at COSIPA. As regards nitrogen oxides, only the control of emissions concentrated in Ultrafértil-FAFER and Ultrafértil-Sao Marcos nitric acid plants was foreseen.

The hydrocarbons, sulphur dioxide and nitrogen oxides at the distributed atmospheric emission level result from fuel oil burning in the industrial processes. The Control Program sought to control the concentrated emissions of these pollutants.

In the case of hydrocarbons, they derived from the oil refinery and as regards sulphur dioxide a preliminary reduction of 29,595 tons/year had been obtained as a consequence of the replacement of high sulphur content fuel oil by low sulphur content one. Therefore the control obtained in the program was restricted to the emissions concentrated in the sulphuric acid plants belonging to Ultrafértil-Sao Marcos and Copebrás.

2.4.4.2. Water Pollution

The main water pollutants controlled by the primary program were estimated per industry, based on the pollution loads evaluated in 1984 and the remaining loads quantified along that year.

By adopting technical measures during the Control Program, the generated pollutants were controlled at the best available practicable technology level. Numbers of noble fishes and crustaceous returned to the ecosystem, however there are some restrictions to their consumption on account of the presence of some persistent pollutants in the biological chain, mainly from contaminated benthal organisms and planktons.

The primary control succeeded in getting its objective and this led to the reduction of 23,689 ton/year of several pollutants and 183,900 tons/year of settleable wastes which were formely discharged into water courses. As regards organic load which represented the highest quantitative polluting

potential in the industrial processes, considerable reductions have been achieved for each industry.

2.4.4.3. Soil Pollution

After collection, domestic solid wastes are disposed of in landfill sites. As regards hospital, laboratory and pharmaceutical wastes, they are incinerated after being specially collected. The systems are operated by the municipality and inspected by CETESB.

Industrial solid wastes are controlled at control program level and were classified according to their hazard standards: inflammability, corrosiveness, reactivity, toxicity and pathogenicity. In accordance with existing standards, solid wastes are classified into three categories: Class I - hazardous, Class II - non hazardous and not inert and Class III - inert.

Along the Control Program, several alternatives recommended by the world technology for industrial solid wastes recycling and/or disposal such as: industrial landfill, encapsulation, recycling, biological treatment and incineration have been adopted.

The first goal was to ban wastes dumping; the second step should favour recycling to the utmost, i.e. the recycling of wastes generated by the very industry or a group of industries for it is the best recommendation for industrial solid wastes control.

In terms of industrial wastes recycling there was a significative progress in the fertilizers industries which incorporate even the sludges generated by waste treatment systems in the productive process.

As regards industrial wastes treatment/disposal technologies, landfarming by Petrobrás - RPBC and incineration of organochlorides generated by Rhodia should be pointed out. According to the data gathered COSIPA (steel maker) still maintains a significative share of industrial solid wastes, e.g. 860,438.1 tons/year dumped on the land.

For the effective control of fugitive dusts, the industries in the area, particularly in Vila Parisi, were individually requested to implement plans for minimizing their source emissions.

Fugitive dusts control results basically from: paved roads cleaning, maximum paving of vehicle circulation roads, permanent wetting of powdered material piles, application of chemical stabilizers on the ground to keep soil moisture and progressive increase of the green belt.

According to what has been stated above, we can see that the primary control program achieved 90% of the sources initially registered and now duly under control. Among all the industries that have been registered, COSIPA presented the largest number of sources to be controlled. Along the whole period of the program, COSIPA's condition was critical as a result of a still more serious crisis involving the whole Brazilian steel industry. In spite of the big investment made by COSIPA, there is still a need for 30 million dollars to conclude its part in the environmental pollution primary program.

Together with the advance of the control on conventional pollutants, the control on the toxicity of industrial liquid effluents must start out early. The same applies to the preliminary evaluation of hazards in industrial plants and pipes in urban areas that should go on in order to minimize the risks of environmental accidents.

2.5. Mining: The CVRD Case

CVRD, a state-owned company was established in 1942. Its mission encompasses the production, processing, beneficiation, handling, transport and marketing of raw material and intermediate goods for the transformation industry at national and international levels. It carries out activities derived from diversified sectors, as a result from the expansion of its original business. Several business units are made up of associated and subsidiary companies active in the iron ore, pellets, manganese, gold, bauxite, aluminum, timber and wood pulp.

In Brazil the company operates in 7 Brazilian States: Pará, Maranhaao (Amazon region), Bahia, Minas Gerais, Espirito Santo, Rio de Janeiro (northeast and southeast regions) and Mato Grosso (central region).

CVRD has progressively grown with the expansion of the iron ore mining which led to the diversification of activities, mainly in the mineral-metallurgy field. This diversification of activities aims at decreasing the vulnerability that is part of investments based on a single product and yet generate resources for new investments.

The Company operates in an extremely competitive international market in the mining field. The production logistics which encompasses mining, transportation, industrial beneficiation and shipping, thus assumes an important position, as the low unitary value of the product - iron ore - and CVRD's peculiar geographical situation are totally unfavorable when compared to the main consumer markets, among which Japan is the leader. Considering competition's (Australia and Africa) advantage as to their geographic situation, it is important to mention that its commercial strength have been quality and reliability in the production and supply of the product.

Beginning with a modest goal of 1,5 million tons/year, only achieved in 1952, CVRD has developed its position in the national and international scenery as a result of a continuous improvement in productivity and a persistent effort in the technological and commercial areas. Own-production and purchase of iron ore mineral and pellets reached, in 1980, a volume of 73,3 million tons; 81,6 million tons in 1985, reaching in 1989 the significant production of 101,7 million tons.

Mineral activities demand the implementation of an extensive infra-structure network including the construction of railroads, highways, water supply, electricity, telecommunications and other, that will allow not only the operation of mines but also will stimulate progress and development in the neighboring areas. Investments in infra-structure, geological and technological research and mining installations demand a high amount of financial resources, conferring to the activity high economic risks.

2.5.1. Environmental Issues: Genesis and Evolution

Operating in the mining area in Southern Brazil, since the forties, environmental sound technologies were not available. During two decades the Company depleted natural resources and caused pollution through its industrial installations. In 1956, a first experience was launched in the environmental area. The Company acquired Atlantic forest-covered land in the southeast region of Brazil, in Linhares, in the State of Espirito Santo to extract wood for railroad sleepers. After a few year this property reached 13,7 thousands hectares of native forest, to which 8 thousand hectares of interfered forest were added, totalling 21,7 thousand hectares of the Company's private conservation unit.

In 1967, with the discovery of Carajás, CVRD started its activities in the Amazon. In the seventies socioeconomic environmental and ecological works contracted during the feasibility stage of the Carajás project. During this same period in the South System represented by the mines in the State of Minas Gerais and by the port terminal of Tubaraao in the State of Espirito Santo the first achievements aiming at the economicity of products and stabilization of sloping banks as well as pollution control along the Vitória-Minas railroad were created.

With the decision to build Carajás in 1980 two policies were adopted: the first sets up an independent advisory board known as GEAMAM (Environmental Study and Advisory Group) which meets to advise corporate management on environmental matters; the second enables the setting up of environmental in-house commissions, formerly planned for seven units of the group.

From 1980 to 1985, during the implementation of the Carajás Project, efforts were carried out in the areas of feasibility, basic project, implementation and operation of projects in the Amazon. Based on the relative success and achievements, other superintendencies and associated companies promoted the creation of departments to deal with environmental issues. Nowadays the Superintendency for Environment and Forestry Products coordinates 17 Environment Departments. Over the past eight years, from 1980 to 1988, CVRD has invested some US$660 million dollars in various environmental engineering projects.

What began informally, with small units with as many as eight technicians, is now an organization of 770 persons involved with environmental issues managing around 700 thousand hectares of private natural preservation areas in the diverse Brazilian ecosystems. This large area being destined to scientific research, conservation and use of natural resources. Its is worthy of note that environmental activities are classified in two distinct categories: corrective actions applied to the majority of its projects requiring environmental attention and preventive actions. Of the US$660 million invested in the environmental matters during the past eight years, 53% were for corrective actions and 47% for preventive actions.

For 1990 to 2000, it is expected to set up an program for environmental activities concerning three areas: handling of natural resources, environmental engineering; and research to provide conceptual information for the improvement of environmental policies. There are 200 projects and around US$660 million to be invested in ten years program to be submited for financing to international agencies. The environmental problems faced most often by the group are: a) those concerning mining and products

industrialization , such as aluminum, copper, wood pulp and timber; b) environmental and socio-economic impacts in its industrial plants, on air, water, soil and population. These environmental problems occur in areas of Atlantic Forest, Amazon Rainforest, shrublands (caatinga) and humid areas such as the Pantanal. Thus, it was necessary to develop an adequate technology to provide envronmental engineering efficiency to suit the peculiar conditions of diverse ecosystems which exist in a country as wide as Brazil. A problem frequently faced is how to convey to its areas a cohesive action with the efficiency standards usually obtained by the Company in its activities.

In the case of Carajás, situated in the heart of a native forest region, the construction of a railroad and its operation brought to its area of influence uncontrollable problems, such as land speculation and rural violence. In a recently established frontier, population settled in the area lives in either extreme poverty or counting on meager financial resources. This leads to the practice of deforestation, itinerant agriculture, exploitation of the soil and fuelwood production. The fuelwood supply local pig iron smelters, in a chaotic and precariously controlled process.

Government agencies that should have accomplished efforts for an ordained occupation of this wide region did not attain their objectives. As a result the Company copes with the depletion of its image since the solution for these problems in medium term is clearly out of its physical and political area of action. By not suspending immediately the supply of raw material (iron) to these predatory industrial activities the Company increases its responsibility in participating in the flagrant destruction as its natural resources in its are of indirect influence.

2.5.2. Strategy Adopted and Action

The environmental engineering technology available, strives to secure a policy of balanced management of natural resources, thus avoiding exploitation at unreasonable levels. By adopting a strategy that takes into consideration the economic aspect of the natural reserves, it is possible to mine without exhausting and obtain profits in a long-term economic activity and control pollution. The environmental consciousness has been growing steadily among the management of CVRD during the last decade, showing results in two areas of the Brazilian humid tropic: Atlantic Forest and Tropical Rainforest. This effort was made possible through the collaboration of Brazilian and foreign specialists and support of national and international organizations. The Company believes that basic inventory research and preventive measures will broaden the knowledge on natural resources, thus controlling potential pollution sources in the various sectors of productive activity.

By adopting a decentralizing policy, the environmental departments control preventive and corrective pollution activities in all the operational areas of CVRD and its associated and subsidiary companies.

Technologies adopted by environmental engineering concerning iron ore, aluminum, copper, manganese and gold use national processes when available and international ones, in the form of joint-ventures with Japanese, American, Canadian, English and Italian groups that are related to CVRD. Among these, the following could be mentioned: NIPPON STEEL, ALCAN, SHELL and ITALIPIANTI.

In the forest area, the majority of knowledge on reforestation and natural resources research, derives from the Brazilian scientists and research groups. A relevant complementary support was provided by international scientists from environmental agencies such as CWS (Canadian Wildlife Service), ICBP (International Council for Birds Preservation), WWF (World Wildlife Fund), NY Botanical Garden, Kew Garden, various American, European, Australian and Eastern universities, as well as world-wide research centers.

2.5.3. Output of the Adopted Strategy and Measures Taken

Considering that in the last two decades (1980-1990 1970-1980) the CVRD Group spent US$4,976 billion and that for the 1900-2000 period an additional US$4,656 billion is forecast, it is commendable that 12% of this total (US$600 million) was directed to environmental matters, without interfering with the Company's competitivity in an ever-demanding market.

The Company's efforts can be measured by its concern to improve staff qualification (that require constant training and specialization), totalling 770 technicians and other categories thus classified: 9% graduate personnel, 52% medium level education and the remaining of field personnel. The diversified economic activities performed by the CVRD Group involves some 35,000 personnel, constantly reevaluated in order to direct their technical capacity to manage sophisticated projects, using national technology available and foreign whenever new technologies are required for certain tasks.

In the case of patents, only one has been registered by CVRD. It concerns a product known as dextrine, in water solution, for the aspersion on iron ore that is carried by the wind in railroad transport freight-cars, which has been adopted by the EFVM (Vitoria-Minas Railroad). Wind erosion leads to operational wear-down of railroad equipment, besides compromising the environment with dust and silting during the rainy season along the railroad. Some 1,26% of the cargo in each freight-car was lost during each trip before this procedure was established. After the iron ore mineral is superficially sprinkled, the water evaporates leaving a protecting film that reduces dispersion by wind. This system has been in operational routine for the last ten years and the investment made to set up this procedure paid for itself after the first year of implementation, not to mention the benefits derived from it.

In house technology development is just one element of the technological strategy of the firm. In several joint-ventures, the company "tropicalized" technologies received by foreign partners, such as NIPPON STEEL, aluminum enterprises from ALCAN and SHELL. The gold, manganese, paper and wood pulp technologies were originated in Brazil.

2.5.4. Lessons and Perspectives

The environmental impact on the area of influence of the Carajás Railroad were detected and handled, by engineering and management of natural resources as well as with regard to the structure of activities in human resources. The setting up of a Scientific Committee to advise the Company during its activities was a useful starting point. Scientific environmental studies carried out by the country's Scientific Community and international

institution reached positive results for the institutional management of the problem. The setting up of permanent environmental teams in the sites was fruitful. The strategy to foresee a preventive environmental policy was pertinent. (In the case of Carajás 6,5% of the project budget was invested in environmental purpose).

The company's senior management, technicians and employees concern with environmental issues has grown during the last ten years. A genuine compromise is fundamental in all the Company's actions and expansion plans. Operational policies for the transportation of environmentally unsound goods (i.e. pig iron obtained from native forest charcoal) were not correct and coherent with the environmental policy in use. Nowadays studies are being done in order to decrease the pressure on the native forest outside its area of influence. Through studies with the World Bank (ESMAP) and by designing massive reforestation projects that include plantations to extract raw material demands for fuelwood among other uses of the region could be met.

Based on the Carajás experience the Brazilian policy for the industrialization of mineral is unsatisfactory. Whether because of human pressure on the vegetation coverage, or by results presented by regional human resources projects. These projects concerns small land owners and farmers as well as indigenous communities.

In the case of new frontiers regions, regional negative structural forces increased social tension, urban and rural violence, without any mechanism to diminish these impacts. Programs aimed at low income population, revision of the land use and ownership process are issues that still demand a policy for regional activities.

In the institutional field, the regional environmental agencies still lack technical, human and financial resources. These resources are needed to carry out their role of controllers and supervisors. During the phase of implementation, technical training was offered to the teams from the environmental agencies, responsible for supervising the project. The follow up, involvement and supervision made by the project's financing agencies would have been indispensable to its evaluation policy, to suggest the necessary intervention from the government.

Other sectors such as energy, petroleum and by-products, and private sectors designed and started ways for an environmental policy in their sectors, impelled among other factors by the implementation of Carajás.

Communities settled in the area of influence of projects in new frontiers should be supported by programs that will ensure their stability in areas near the project. The externalities of projects such as Carajás were totally uncontrolled by the company the set it up. The company was not legally nor institutionally responsble for the indirect area of influence. Negotiations with other sectors were not effective.

Grand projects will always require a great interdisciplinarity. Social scientists, economists, anthropologists and other specialists from the socioeconomic field should be included to provide support through specially designed programs, to the communities involved. A interinstitutional management capability is also needed.

In the case of the Brazilian indigenous communities, land and public health are indispensable to their decent survival, as well as respect for their variegated traditions and culture. To increase and disseminate environmental information and knowledge is another goal to be met, as these needy populations have no voice to demand their needs, thus receiving unsatisfactory treatment.

3. FINDINGS ON INDUSTRIAL ENVIRONMENTAL MANAGEMENT AND THE CAPITAL GOODS INDUSTRY

A growing awareness on the relevance of environmental issues has been an important starting point. Environmental impact assessment and management experience in environmental issues have made it possible to achieve fruitful results. Political determination, regulatory mechanisms, technology access, and transparency are, on a regional basis the determinant factors of success.

Proactive firms approach the environmental dimension as part of their overall strategy incorporating it into the marketing and production targets. Technologies for environmental response and for production are closely related. A new process induces investments in clean technology which may lead to greater industrial efficiency. Such technological integration result from ecological responsibility, innovation, quality and search for effectiveness. R & D internal capabilities become then a competitive advantage to the company. R & D encourages technological innovation and environmental awareness.

Recruitment and training of skilled environmental personnel as well as collaboration with universities, research institutions, R & D laboratories is the way to adopt an innovative posture needed to reconcile economics and environment. Human resources is the critical factor for such comprehensive strategy.

Organizational units (i.e. Scientific Committee, Environment Department, Natural Resource Department) concerned with environmental issues are instrumental for the problem definition, structuring, execution and monitoring of impact assessment studies as well as for solution implementation. Companies have allocated a specific percentage of their earnings for the development of environmentally sound technologies. Through joint venture, they may also obtain the needed technology, especially if they maintain a long-term relationship with their suppliers. When resources for investment are limited, financial mechanisms are searched to provide technological transfer and equipment acquisition to facilitate environmental policy implementation.

Capital Goods Industry have been requested to participate in the problem definition and solution implementation. The paper and pulp industry, energy sector, mining, chemical and steelmaking industries have been under pressure to develop new equipment and processes. Such opportunity is considered by some firms as a challenging and welcomed new strategic business area.

Community participation and environmental education oriented to secondary school students is necessary for the building up of a new mentality concerned with environment and development. In many areas specific to developing countries (i.e. tropical forests) technology is not ready and available. Endogenous technology should be then developed through cooperation with local scientists, research groups, engineering firms and capital goods

industries. Cooperation among developing countries is desirable to facilitate such development.

Entrepreneurs, senior managers, technicians, workers, and staff should be commonly aware of the environmental priority of the company and the means to implement it. Environmental impact studies should be seen as planning tools and means for the improvement of the management of natural resources. Their integration with engineering studies favours the deepening of knowledge on expansion projects and operation activities. Large projects require a comprehensive interdisciplinary capability including social sciences to approach correctly the human dimension associated to the projects.

Periodical evaluation, based on environmental indicators is, among all other measures, the one which brings the best practical results. Ex-ante and ex-post evaluations of environmental issues are the means to induce the search of new technologies for environmental issues.

The above-mentioned findings based on the four cases show that when an advanced state of development is reached, human resources can be developed and financial resources can be obtained to face-pro-actively-environmental issues. It is clear, in all the cases, that: the priorities were well defined and the successful effort was related to competitive conditions as demand conditions and related support infrastructure.

Public awareness was critical to induce strategic changes in the corporate posture. Such change was however possible because of the development and availability of managerial and technical capacities based on qualified human resources. Such resources made possible the technology appraisal and transfer through an investment programme. The availability of financial mechanisms did facilitate the company's decision to launch a major reconversion project toward clean technologies. Specialized organizational units provided the company structure the needed input to modify the decision making process and include the "green" gene in the process.

At the government level an institutional framework is needed to design regulatory mechanisms as well as to implement them. Environmental education is the main instrument for the building up of a new mentality toward an environmentally sound development where technological innovation has a major role to play. An "innovation strategy" is of importance to reduce resistance and move established systems in this new direction, in the benefice of the present and future generations.

4. ENVIRONMENTAL AWARENESS, ECONOMIC DEVELOPMENT AND THE CAPITAL GOODS INDUSTRY

The issue of environmental deterioration is unquestionably one of the major concerns facing mankind as this century draws to a close. The capital goods industry has a major role to play to respond to such concern. Several factors have helped to raise awareness of the importance of the environment, among which the following are central:

(a) development of the chemical, steel, fertilizer and petrochemical industries, which have a high degree of potential for polluting the environment;

(b) acute income and population concentration caused by the process of urbanization that results from the economic model and industrialization methods used in developing countries. This model leads to the expansion of agglomerations of substandard dwellings without minimum sanitation or environmental infrastructure. The social perverseness of this situation has increasingly come to the attention of organized groups within society;

(c) low levels of public health coverage, particularly as regards basic sanitation, in the developing countries, creating the conditions for certain diseases to remain endemic, while others associated with environmental deterioration actually become more widespread;

(d) medical advances that have eradicated several diseases and identified specific effects of pollution which were previously overlooked;

(e) increasingly frequent environmental disasters due to indiscriminate use of certain products and raw materials, such as mercury for gold minning and to intensive use of fuelwood, or cattle raising and farming on land where the soil is unsuitable;

(f) improvements in the well-being of part of the population, with a consequent change in the demand for leisure, leading to perception of the shortage of appropriate locations for this purpose in towns and cities;

(g) deficiences in economic theory, wich fails to define the environment as a scarce resource to be treated as such by the market, thus contributing to the spread of pollution to the extent that the entire population is affected.

Many environmental problems have no respect at all for the frontiers between regions or countries. Examples are forest fires in tropical forests, the cholera epidemic spreading to other countries, CFC emissions, aggravation of the "greenhouse effect" by burning of fossil fuels, and so on.

The scope of these problems raises the need for actions with and equally broad scope, involving not only local authorities and national governments but co-ordinated efforts by several countries to find a common solution. Such joint efforts require political will of the countries in question, as well as financial backing particularly when relations between the developed and developing worlds are involved.

The developing world is enormously lacking in every sphere of basic infrastructure from health, education, sanitation, transportation to food, housing, and communication. To illustrate this, studies show that for Brazil to attain the current standard of living in Southern Europe it would have to invest US$ 6 billion a year in social programmes and projects for 15 years, in addition to existing investment programmes.

In view of the transnational nature of many environmental problems and the amount of funds required to solve them, there must be international co-operation through economic incentives and disincentives. In principle, such mechanisms can vary in kind, from international environmental funds and regional development funds to external debt conversion, subsidies and grants. It is worth raising two issues common to these mechanisms and relevant to the possibility of promoting Environmental Sound Technologies-EST.

The first has to do with the developed countries willingness to pay applying Pollution Prevention Programs (PPP) at world level, so that the developing countries can reduce damage to the environment. The second is related to the fact that a large part of the environmental deterioration in the developing countries is an effect of their dual internal structures, in which a majority of the population is under the poverty line. In these cases, it is necessary to discuss the political possibility of reduction of such dualities through reorganization of these economies.

The principle that "the polluter pays", as defined by the OECD, implies that the polluter must assume the cost of the pollution-reducing measures. This means that there must not be any transfer of resources from the state to the polluter, for the solution of environmental pollution problems, and that the polluter must cover such costs.

This principle is highly important in the development of environmental policy, owing to a number of factors among which the following are worth highlighting:

- The gap between private and social costs can be narrowed;

- Pollution control methods are likely to be introduced more quickly;

- Adoption of non-polluting technologies may be encouraged;

- The psychological effect will be positive, in that society will tend to increase its awareness of the monetary and material value of the environment.

As environmental awareness increases among significant segments of society there is an increase in pressure for solutions to environmental problems, ranging from demands that companies control emission and reduce pollution, to more radical proposals aiming at zero growth and the conservation of resources.

However, the relevance of the problems faced by developing countries, involving not only the environment but also employment, health, education, transportation, sanitation etc., makes it senseless to adopt conservationist-reductionist approaches. On the contrary, in view of these problems it is essential to opt for a strategy of growth integrated with protection of the environment. The capital goods industry in Latin America has a major role to play in implementing such strategy.

5. BIBLIOGRAPHY

CHUDNOVSKY, Daniel - La Competitividad de la Industria Argentina de Máquinas Herramientas y el Acuerdo de Integración con Brasil. (Versao Preliminar). UNICAMP, Projeto "Desenvolvimento tecnológico da Indústria e a Constituiçao de um Sistema Nacional de Inovaçao no Brasil". Campinas, 1990. (39 p).

CRUZ, H. Nogueira da, SILVA, M. Augenio da - A Situaçao do Setor de Bens-de-Capital e suas Perspectivas. UNICAMP, Projeto "Desenvolvimento tecnológico da Indústria e a Constituiçao de um Sistema Nacional de Inovaçao no Brasil". Campinas, 1990. (97 p).

FINDLEY, Roger W. - Pollution Control in Brazil - Ecology Law Quarterly, vol. 15, no 1, 1988, p.1-68.

FREITAS, M.L. Davies de - Corporate Strategy, Environmental Management and Technology Transfer: The CVRD Case Study. In: Brazilian Experiences on Management of Environmental Issues: Some Findings on the Transfer of technologies, UNCED, Research Paper no 1, July 1991.

GALLI, L.F. - Hydroelectricity Generation, Environmental Management and Technologies Development: The CESP Study Case. In: Brazilian Experiences on Management of Environmental Issues: Some Findings on the Transfer of technologies, UNCED, Research Paper no 1, July 1991.

GOLDEMBERG, José - Energy and Environmental Policies in Developed and Developing Countries. Energy and the Environment in the 21st Century, March 26-28, 1990, Massachusetts Institute of Technology, Cambridge, Massachusetts, p. 69-100.

GOLDEMBERG, José - How to Stop Global Warming, Technology Review, vol. 93, no 8, November/December, 1990, p. 25-31 (80 p).

HAHN, Robert W. - Meeting the Growing Demand for Environmental Protection: A Practical Guide to the Economist's Toolchest. The World Bank Seminar on Urban Air Pollution, June 20-21, 1990. American Enterprise Institute, Washington, D.C. - 24 p.

LAPLACE, M.F. - Diagnóstico da Indústria Brasileira de Máquinas-Ferramenta. (Versao Preliminar). UNICAMP, Projecto "Desenvolvimento Tecnológico da Indústria e a Constituiçao de um Sistema Nacional de Inovaçao no Brasil". Campinas, 1990. (74 p).

MARCOVITCH, J. - Industrial and Technological Modernisation in Brazil: Stagnation and Prosperity. Geneva, Switzerland, Labour and Society, IILS/ILO, 16/3 1991.

MARCOVITCH, J. - Estratégia Tecnológica na Empresa Brasileira. In: Gerenciamento da Tecnologia: Um Instrumento para a Competitividade Empresarial, Sao Paulo, Brasil, Editora Edgard Blucher Ltda., 1992.

PHILIPPI JR., A. - Controle de Poluiçao Ambiental: Implantaçao de Sistema de Financiamento. Sao Paulo, 1987. (Tese de doutorado apresentada ao Departamento de Saúde Ambiental da Faculdade de Saúde Pública da Universidade de Sao Paulo).

PIASECKI, B. & ASMUS, P. - In Search of Environmental Excellence - Moving Beyond Blame. New York, Simon & Schuster Inc., 1990.

SLONGO, L.A. - Environmental Issues and Riocell's Technological Strategy. In: Brazilian Experiences on management of Environmental Issues: Some Findings on the Transfer of Technologies, UNCED, Research Paper no 1, July 1991.

ZULAUF, W.E. - Industrial Pollution Control in Cubatao. In: Environmental Issues: Some Findings on the Transfer of Technologies, UNCED, Research Paper no 1, July 1991.

BID/PNUD. Nossa Própria Agenda. Comissao de Desenvolvimento e Meio Ambiente da América Latina e do Caribe. Brasília, Linha Gráfica Editora Ltda, 1990. 241 p.

Eco-Strategies for the 1990's. World Link, vol. 4, no 1, January/February 1991, p. 16-17.

GOVERNMENT OF CANADA. Canada's Green Plan - In Brief. A summary of Canada's Green Plan for a healthy environment. 30 p.

Projeto ABIMAQ-SINDIMAQ/FINEP - Política Industrial para a Indústria de Máquinas e Equipamentos no Brasil. Sao Paulo, Dezembro/1990. (83 p).

THE WORLD BANK/Policy, Planning and Research Staff, Infrastructure and Urban Development Department. Janis Bernstein - Alternative Approach to Pollution Control and Waste management: Regulatory and Economic Instruments. May, 1990. 44 p.

UNCED - Brazilian Experiences on Management of Environmental Issues: Some Findings on the Transfer of Technologies. Research Paper no 1, July 1991.

UNIDO. Industrial Operations Technology Division. Department of Industrial Operations - Implementation of Technical Co-operation in Various Sectors of Industry. Presentation by Mrs. A. Tcheknavorian-Asenbauer, Director. 19 January 1990. 30 p.

UNIDO - Industry and Development - Global Report 1990/91. Vienna, 1990.

UNITED NATIONS WORKSHOP ON CREATIVE FINANCING FOR ENVIRONMENTALLY SOUND TECHNOLOGIES. Belem Declaration 1990. Belem, PA, Brazil, 2-7 December 1990. 41 p.

WORLD RESOURCES INSTITUTE. Promoting Environmentally Sound Economic Progress: What the North Can Do. Robert Repetto. April 1990. 21 p.

WORLD RESOURCES INSTITUTE. Technological transformation for Sustainable Development. A Public Research Agenda. NSF Grant # ENG-9011639. January 1991.