JAPAN INTERNATIONAL COOPERATION AGENCY

INDUSTRIAL DEVELOPMENT BOARD OF CEYLON,
MINISTRY OF INDUSTRIAL DEVELOPMENT,
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

STUDY (AFTER CARE) ON INDUSTRIAL SECTOR DEVELOPMENT (ELECTROPLATING AND WASTE WATER TREATMENT) IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

(SUMMARY)

FEBRUARY 1997

UNICO INTERNATIONAL CORPORATION
FUJI TECHNOSURVEY COMPANY, LIMITED

TOKYO, JAPAN

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INTRODUCTION

Introduction

This report is the report of the Study (After Care) on Industrial Sector Development (Electroplating and Waste Water Treatment) in the Democratic Socialist Republic of Sri Lanka.

The study was, based on a request made by the Government of Sri Lanka, conducted under the agreement between Industrial Development Board of Ceylon (hereinafter referred to as "IDB") and Japan International Cooperation Agency (hereinafter referred to as "JICA") in March 1996, entitled "Scope of Work for the Study (After Care) on Industrial Sector Development (Electroplating and Waste Water Treatment) in the Democratic Socialist Republic of Sri Lanka".

The study consists of field surveys followed by additional investigation and analysis in Japan; the first field survey was between August 11 and September 14, 1996, and second field survey between November 13 and 30, 1996. This document is the final report compiling the results of the study.

It should be noted that the field surveys and subsequent work have been successfully conducted with the close cooperation and assistance of many parties involved. In particular, the study team acknowledges special support and cooperation extended by the counterparts of Industrial Development Board, including Chairman H.M.V. Jayasinghe, throughout the process including the selection of enterprises for visiting and other necessary arrangements.

1. BACKGROUND OF THE STUDY

In 1991, the Government of Sri Lanka requested the Government of Japan to conduct a study related to an industrial sector development promotion plan and an industrial park development plan, focusing on the fostering of metalworking industries, with the goals to promote the export-oriented industries and strengthen industrial structure as a whole. In response, JICA conducted a study in 1992/93 on promotion of exports and investment, the fostering of metalworking industries, and the development of industrial parks. The study proposed construction of an industrial park for metalworking industries and the establishment of a foundry and electroplating center. In August 1993, the Government of Sri Lanka requested the Government of Japan for official assistance related to the establishment of a foundry and electroplating training center. In February 1994, JICA sent a preliminary study team on a foundry and electroplating technology upgrading plan. The study team found the establishment of the training center to be difficult and instead proposed a project using existing factories under jurisdiction of IDB. In September 1995, the Record of Discussions (R/D) on

project-based technical assistance in the field of foundry technology was signed. As for electroplating technology, the Government of Sri Lanka decided to request a development study for project planning to strengthen and improve electroplating and waste water treatment technologies, and made an official request in December 1995. In response, JICA sent a preliminary study team to Sri Lanka in March 1996, and the Scope of Work (S/W) was signed by the two governments.

2. OBJECTIVE AND SCOPE OF THE STUDY

The objective of the Study is to study the current state of electroplating industries in Sri Lanka and major problems facing them, and develop a plan to improve electroplating technology and propagate waste water treatment technology and systems.

The Study is designed to cover the following items under the agreed S/W:

1) Review and field surveys on the present situation of electroplating industries in Sri Lanka,
2) Review and field surveys on the present situation of environmental pollution in Sri Lanka,
3) Identification of problems and issues of the electroplating industries in Sri Lanka,
4) Identification of appropriate technologies for the electroplating industries in Sri Lanka,
5) Formulation of programmes and projects for the dissemination and improvement of electroplating and waste water treatment technologies of electroplating industries in Sri Lanka, and
6) Measures to be taken by the Government of Sri Lanka to upgrade electroplating technology.

3. ORGANIZATION OF THE STUDY TEAM

This Study was conducted by a consortium organized by representatives of Unico International Co., Ltd. and Fuji Technosurvey Co., Ltd., consisting of the following members:

Kiko Nagasawa	Leader/general	Unico International
Syunsuke Araki	Electroplating industry /environmental measures	Unico International
Boshin Ro	Electroplating technology	Fuji Technosurvey

Hiromu Kanematsu	Electroplating technology	Fuji Technosurvey
Minoru Toyonaga	Waste water treatment technology	Fuji Technosurvey
Shozo Nasu	Electroplating solution/waste water analysis	Fuji Technosurvey
Takeshi Sekoguchi	Environmental evaluation	Unico International

The following members of IDB provided assistance for the study team as counterparts:

S.L.P. Stambo	Chief Engineer
H.F. Nanayakkara	Deputy Chief Engineer
K. Sethuramalingam	Acting Deputy Chief Engineer
A.M. Karunaratne	Assistant Director (Planning)
M.Y. Gunasena	Superintendent, Electroplating
J.S.C. Kumarasinghe	Industrial Extension Officer, Electroplating
Chandani Edirisinghe	Laboratory Assistant, Electroplating

The Study was commenced in July 1996 and completed in February 1997. In August and September, November 1996, and February 1997, field surveys and discussion with Sri Lanakan counterparts were conducted.

1. Industrial Development Policy in Sri Lanka

1. Industrial Development Policy in Sri Lanka

1.1 Economic Overview

(1) The economy of Sri Lanka has been growing steadily since 1990, and attained by the average growth rate of GDP at 5.5% between 1990 and 1995, with GNP per capita of US$709 and the inflation rate of 7.7% in 1995. The balance of payments maintained a surplus up until April 1995, but deteriorated thereafter due to the decline in foreign investment triggered by the deterioratation of public order and frequent labor disputes.

(2) The manufacturing sector has been increasing its share of GDP steadily and is now a cornerstone of the country's continued economic development. Within the sector, the factory industry and small industry show significant growth compared to the processing of traditional agricultural products.

(3) Analysis of industrial output reveals that textiles, apparel, and leather products hold a dominant share, followed by food, beverages, and tobacco, chemicals, petroleum, rubber, plastic products, and non-ferrous metal products. There are no statistics on electroplating products. Nevertheless, two sectors related to electroplating operation - basic metal products and fabricated metal products, machinery and transport equipment - account for a meager 4.4% of total industrial output.

(4) The growth of industrial production is expected to slow down in 1996 to a rate slightly below that of the previous year, partly due to frequent power outages caused by the shortage of rainfall and partly due to the special levy for the maintenance of public security which has discouraged production activity.

1.2 Industrial Development Policy

(1) Basic policy

Major goals of Sri Lanka's economic policy are as follows:

1) To reduce the fiscal deficit by cutting government expenditures to 3～4% of GDP by 2000,
2) To reduce the inflation rate to an annual 5% (government's mid-term target),

3) To utilize private initiatives for infrastructure development, such as power plant construction, by the BOT/BOO method,
4) To further promote privatization efforts, and
5) To target the annual growth rate of 8%.

Note that economic policy is based upon the underlying philosophy "to eradicate poverty and promote privatization" which is consistent with the past policies.

Major goals of industrial policy are summarized as follows:

1) To devise economic policy based upon experience of Asian countries which have achieved high economic growth,
2) To aim at environmentally friendly, sustainable economic development by good macroeconomic management,
3) To provide an open and transparent legal framework and a market-friendly investment climate to the private sector,
4) To further pursue the improvement of efficiency in the industrial sector by continuous implementation of trade liberalization policy,
5) To assist the establishment of efficient small and medium scale enterprises for broad-based industrialization and employment growth,
6) To educate and train abundant labor force with technologies and skills required for industrialization and diversification as government project for further expansion of employment opportunities,
7) To restructure related government authorities and organizations to help disseminate standards for pricing, quality, delivery, other aspects of products required in international markets, and raise current standards to desirable levels,
8) To support and encourage non-polluting industries of varying sizes in rural regions from regional development perspective, and
9) To place priority to promotion of the agro-based industry as well as production and processing of agricultural products.

(2) Related authorities and organizations

As a result of ministerial reorganization in November 1994, the Ministry of Industrial Development (hereinafter referred to as "MID") is now assuming responsibility for industrial promotion, development, and fostering in Sri Lanka.

The following committees have been established under the Industrial Promotion Act, No.46 of 1990

1) Industrialization Commission

The commission consists of secretaries of ministries related to industrial development, including MID, as well as Governor of the Central Bank and Director General of the Export Promotion Board and so on, providing advice related to industrial policy, ensuring the development of a mechanism for industrialization, formulating plans for development of industrial infrastructure and service, and providing comprehensive information on products and markets.

2) Advisory Council for Industry

In addition to the commission members, the council members include representatives of industrial associations such as the chamber of commerce and industry, private enterprises, and universities. Its responsibilities are to discuss the issues related to government policy for industrial promotion, and to provide advice to the competent minister concerning the effects of government policies implemented for industrial promotion.

3) Regional Industry Service Committees

To promote rural industries, the Minister of Industrial Development selects a region or regions for industrial development and establishes the Regional Industry Service Committee. The committee is responsible for formulation of industrial promotion plans and programmes, and the planning of services and facilities required to promote industries.

(3) Industrial Development Board of Ceylon (IDB)

1) General background

IDB was established under the Ministry of Industries & Scientific Affairs in 1969. It was transferred to the Ministry of Tourism and Rural Development in 1986 and was primarily responsible for rural industrial development. In 1994 it was placed under MID.

2) Purpose

The primary purpose of IDB is summerized in the following three points.

(a) To promote the establishment of new enterprises and the development of existing enterprises in the small and medium scale industry,

(b) To create a policy environment conducive to the development of the small and medium industries (SMIs), and

(c) To achieve progressive self-reliance in finance.

3) IDB's organization

IDB has a total of 634 employees. Major divisions include Technical service, Engineering, Rubber Product Development, Technical Information Service, Planning, Corporate Management Service Center, Marketing, Industrial Estate, and Regional Development.

4) Finance

IDB's financial sources consist of government subsidies, foreign grants, and internal funds obtained from its own revenues. IDB is authorized to use its funds at its own discretion.

In 1995, IDB received a government subsidy amounting to Rs. 84 million and earned Rs. 28 million from service activities (accounting for 25% of all the funds). It reported a deficit of Rs. 65.7 million.

5) Recent moves

(a) IDB is mandated by the government to establish self-financing capability by 2000. It is now considering a reform proposal focusing on restructuring of operational departments. The latest restructuring proposal (to be finalized by the end of 1996) is summarized in Figure 1-1.

(b) Under the government policy, IDB is engaged in productivity improvement initiatives. It has just started the 5S initiative. It has already established IDB Productivity Committee and appointed facilitators.

(c) Technical assistance has started for a foundry of Engineering Department by experts assigned by the Japanese government.

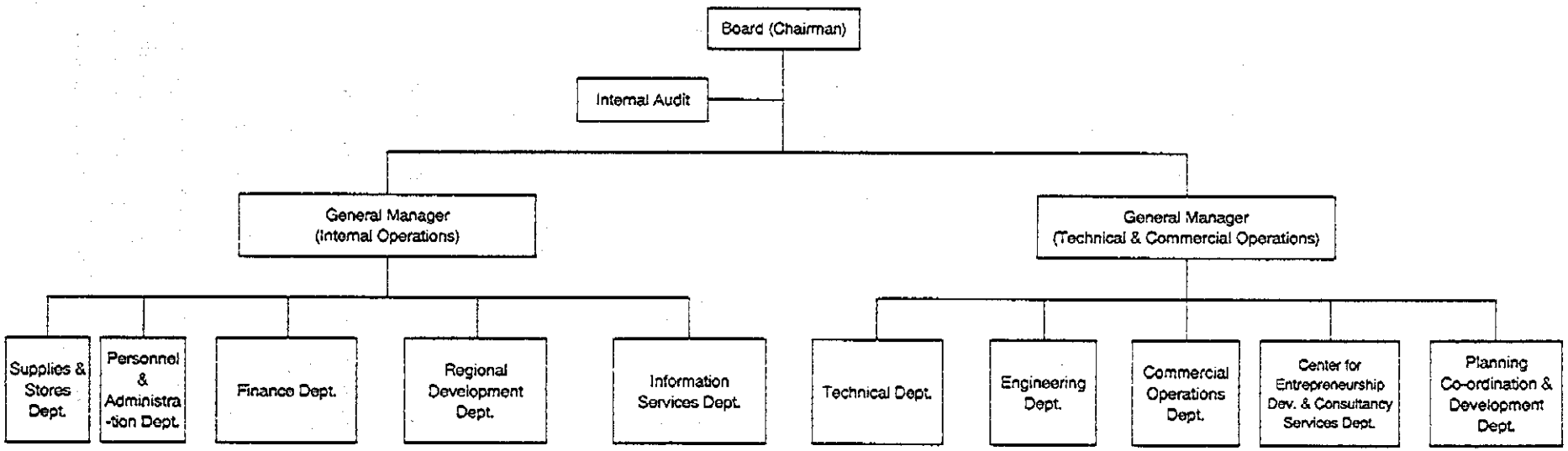

Figure 1-1 (1) THE LATEST IDEA OF RE-ORGANIZATION IN IDB

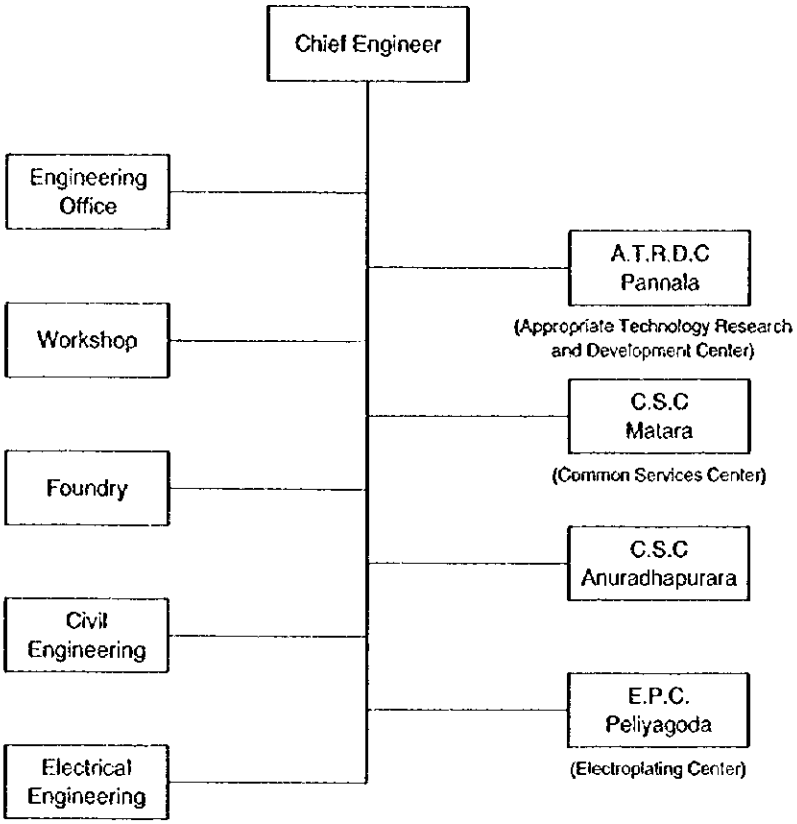

Figure 1-1 (2) THE LATEST IDEA ON ORGANIZATION OF ENGINEERING DEPARTMENT

(4) Industrial development policies

Industrial development policies currently implemented are those announced by MID in November 1995 as the "New Industrialization Strategy," and their major differences from the previous one are summarized as follows:

1) Encouraging private sector participation in infrastructure development under BOT/BOO arrangements,
2) Development and promotion of small and medium scale industries,
3) Encouragement of productivity improvement,
4) Encouragement of R&D and technical innovation, and
5) Encouragement of backward integration of the apparel industry.

To support financing which is the most difficult task for SMIs, the government established the Small & Medium Industry Loan Scheme in 1979 with the assistance of the World Bank and Asian Development Bank. The scheme has been actuated four times in total (SMI I~IV). The government is now prepared for SMI V and negotiations with financing organizations are under way.

2. Environmental Policy and Issues in Sri Lanka

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2.1 Government's Environmental Policy

(1) Environmental laws and policy

The National Environment Act, as amended in 1988, was enacted under the provisions of the constitution related to environmental preservation and serves as the basic environmental law in the country. In October 1991, the Ministry of Environment and Parliamentary Affairs (the then competent ministry) announced the "National Environmental Action Plan (1992~96)" which identified major issues in twelve areas, such as natural resources, including water, land, minerals, coast, and forest, urban and industrial pollution, education, and culture, and specified corrective actions, priorities, budgets, and competent authorities.

Under the action plan, Central Environmental Authority (hereinafter referred to as "CEA") formulated a Corporate Plan and is implementing it with assistance of related authorities and organizations.

(2) Environmental policy and CEA

Under the amended environmental law of 1988, CEA is vested with broad power and authority as a leading government organization in the field of environmental administration, serving as the organization to review Environmental Impact Assessment (EIA) reports and issue environmental protection licenses, and the organization to finalize environmental standards.

The agency delegates power and authority for regulatory duties covering designated low polluting industries. However, the electroplating industry is classified as one of high polluting industries and is under the jurisdiction of CEA.

(3) Environmental protection license and Environmental impact assessment

According to a public notification, all persons or entities in Sri Lanka are prohibited to dispose wastes which may cause environmental pollution unless an Environmental Protection License (EPL) is obtained from the agency and complies with standards set forth in an applicable law.

An implementation body of a designated project is required to submit to a government authority which has approved the project the Initial Environmental Examination Report (IEER) or the Environmental Impact Assessment Report (EIAR) for approval. There is no specific law or provision covering the electroplating industry, but projects by most industries except for the service industry are designated.

(4) Loan programme related to pollution control

The interest-free loan programme providing a maximum 10 million Rs. per project has been in operation under the name of "Pollution Control and Abatement Fund (PCAF)" since April 1995, through five banks led by the National Development Bank (NDB).

2.2 Environmental Standards and Issues related to the Electroplating Industry

(1) Environmental standards

The following environmental standards are currently in force:

- General Standards for Discharge of Effluents into Inland Surface Waters
- Tolerance Limits for Industrial Effluents Discharged into Land for Irrigation Purpose
- Tolerance Limits for Industrial and Domestic Effluents Discharged into Marine Coastal Areas

Environmental standards related to effluent set forth acceptable levels equivalent to dilution of effluent by eight times. In practice, however, actual figures are not specified.

For effluents by designated industries, special standards are established. In the areas of electroplating and fused-zinc plating, proposed standards for the metal finishing industry were issued in 1992. Table 2-1 compares effluent standards applicable to the metal finishing industries in Sweden and France, general standards and proposed standards for the industry in Sri Lanka, and general standards in Japan.

Table 2-1 STANDARDS FOR DISCHARGE OF EFFLUENT (mg/l)

Component	Sweden	France	Sri Lanka		Japan
			(general)	(proposed)	(general)
Cd	0.1	0.2	0.1	0.2	0.1
Cr^{6+}	0.1	0.1	-	-	0.5
CN (free)	0.1	0.1	-	-	-
CN (total)	1	1.2	0.2	1.0	1.0
Pb	1	0.2	0.1	1.5	0.1
Cr (total)	1	2	0.1	-	2.0
Cr^{3+}	-	-	-	1	-
Ni	-	1	3	1.5	-
Cu	1	2	3	1	3.0
Zn	2	5	5	1.5	5.0
Fe	2	5	-	-	10
Al	2	5	-	-	-
F	15	-	2	-	15
Oil	5	10	10	10	5/30
S.S.	10	50	50	50	200 (250)
COD	150	250	250	250	160 (120)
pH range	6.5 - 9	6 - 8.5	6 - 8.5	6 - 9	5.8 - 8.6

(2) Environmental issues

Environmental pollution caused by the electroplating industry mainly originates in discharge of effluents containing toxic or hazardous substances.

In the copper, gold and silver plating as well as the zinc plating processes, toxic CN compounds are used as the plating bath. In many countries, the zinc plating process has been partially converted to non-CN bath, whereas CN bath is still used throughout the industry in Sri Lanka. The chrome plating process uses another toxic substance, hexavalent chrome, in the plating bath. Hexavalent chrome is also used in the chromate plating process. Also, the electroplating process discharges acid and alkaline used for pretreatment, Fe, Cu and metals and oil dissolved in the pretreatment solution, Cu, Ni, Zn, Cr and other heavy metals in the plating solution, dissolved oil, reducing agents in the solution, and BOD and COD sources including organic matters.

Examples of environmental pollution caused by waste water from electroplating factories are abundant; fish killed by waste water discharged to rivers; contamination of well water through permeation; and soil contamination withering rice plants. In particular, toxic substances such as CN, Cr^{6+}, and Cd have a high risk of causing serious pollution including human health problems.

While the industry is small in size and thus discharges a relatively small amount of toxic substances, they are diluted in natural environment or do not cause a serious problem. As the industry grows in size, much more toxic substances are discharged and can pollute the environment extensively and cause serious problems.

3. Current State and Issues of the Electroplating Industry and IDB Electroplating Center

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3.1 Current State and Issues of the Electroplating Industry

(1) Current state of the electroplating industry

In Sri Lanka, there are approximately 80 electroplating units, of which 40 are classified as micro cottage industry, and others are considered to have facilities and equipment to perform sufficient electroplating operations. The study team conducted field surveys at 21 units except for micro-cottage industry. (The map in the next page indicates geographic distribution of the units surveyed). The units surveyed are classified by their process and enterprise size into the following three types:

Group 1: Units which have the electroplating process as part of an entire process line to manufacture their own products. (Factory size is relatively large, and in Sri Lanka, they are classified as medium or large enterprises. Products include safety pins, farm sprayers, packaging materials, and metal furniture.)

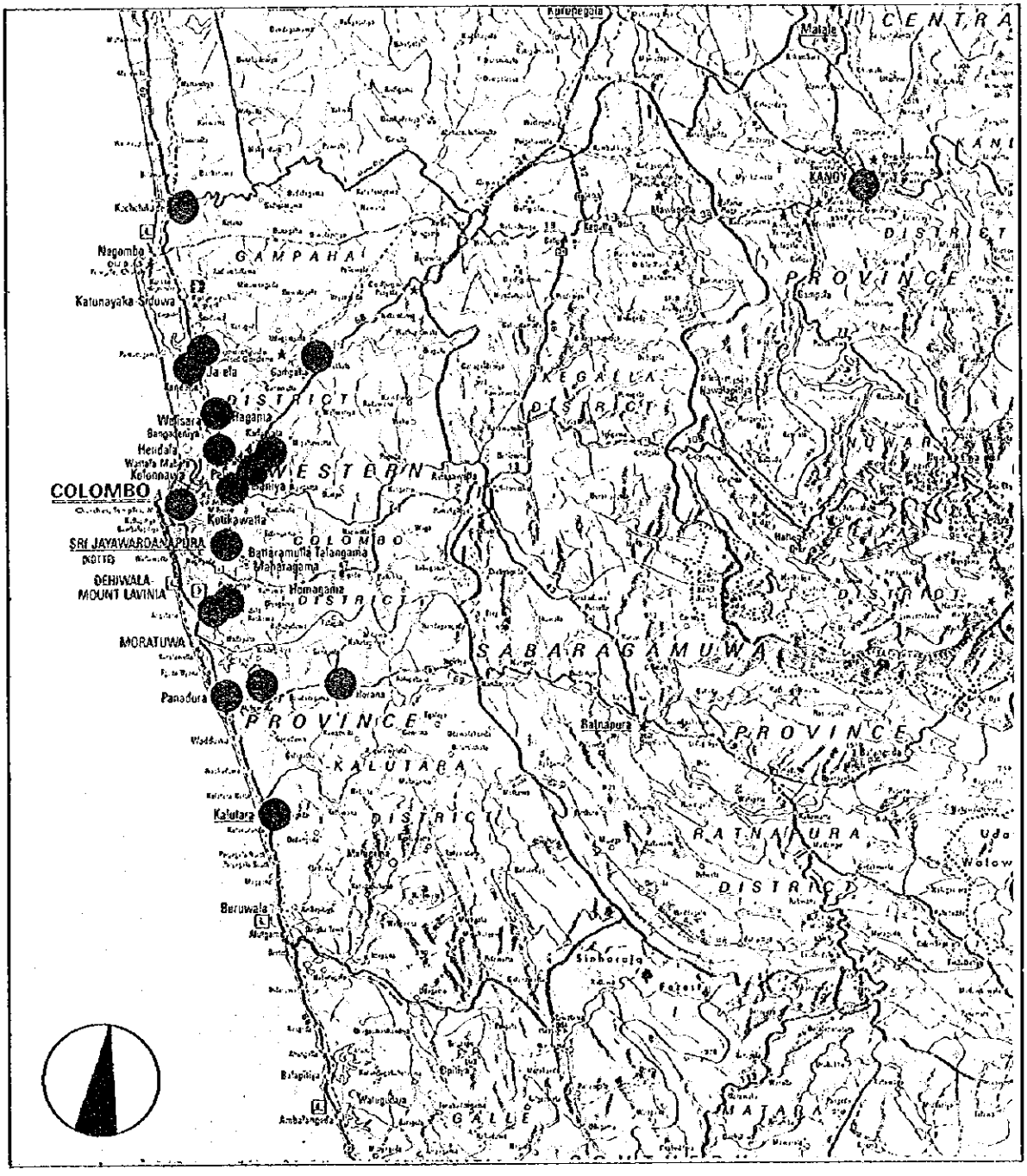
Group 2: Units which manufacture ornaments or automotive and motorcycle parts, including the electroplating process. (Some of them are also operating parts dealers and/or repair shops, located outer city areas or rural areas.)

Group 3: Units which are specialized in electroplating parts or ornaments on contract with parts suppliers or manufacturers, located in commercial districts of urban areas. (Very small size to be generally categorized as platers or plating shops.)

All of the above units are small in terms of size of electroplating operation, and 3~5 workers are engaged in the process including polishing.

Judging from the above, the electroplating industry in Sri Lanka has not reached at critical mass so as to be considered as an independent industry subsector. MID and IDB recognize the current state of the electroplating industry, and the government believes that the electroplating industry is needed for quality improvement of metalworking products made in the country and strongly desires its fostering and development.





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LOCATION MAP OF THE ELECTROPLATING UNITS VISITED BY THE STUDY TEAM

(Four units in Colombo city are expressed by one point)

(2) Issues of the electroplating industry

Major issues related to the electroplating industry in the country, as obtained from related government authorities and organizations, and electroplating units, are summarized as follows:

1) The lack of concern about the quality and performance of local products in the market keeps the electroplating industry at its present level.
2) As locally produced metalworking products which require electroplating are limited in number and type, while reliable electroplaters are not present, manufacturers have their own plating equipment and carry out plating operation.
3) The current financial condition does not allow the industry to invest in pollution control equipment which does not generate profits.

3.2 Current State and Issues of the Electroplating Units

(1) Current state

1) The dominant types of plating carried out by the units are copper, nickel, and chromium. Copper plating is mostly done by copper cyanide bath, while zinc plating is solely done by using cyanide bath. Chromium plating is mostly decorative plating.
2) The units mainly plate repair parts and components for motorcycles and automobiles, while some plated parts that are incorporated into their own products. It is evident that the operating rate of plating baths is very low, as only a small number of lines were observed to be operation during the field survey.
3) Most units and workers do not understand basic electroplating technology. Plating operations mostly rely on the empirical judgment of field workers. As a result, their level of technology is very low. On the other hand, the market requirements are mainly concerned with appearance, not quality, thus discouraging quality improvement.
4) There is lack of knowledge of waste water treatment. Most units do not feel the need for reduction of environmental loads by their effluents and are little motivated for investment in treatment facilities.

(Note) To provide an overall view of electroplating operations, the bright nickel plating process which is carried out worldwide is shown in Figure 3-1.

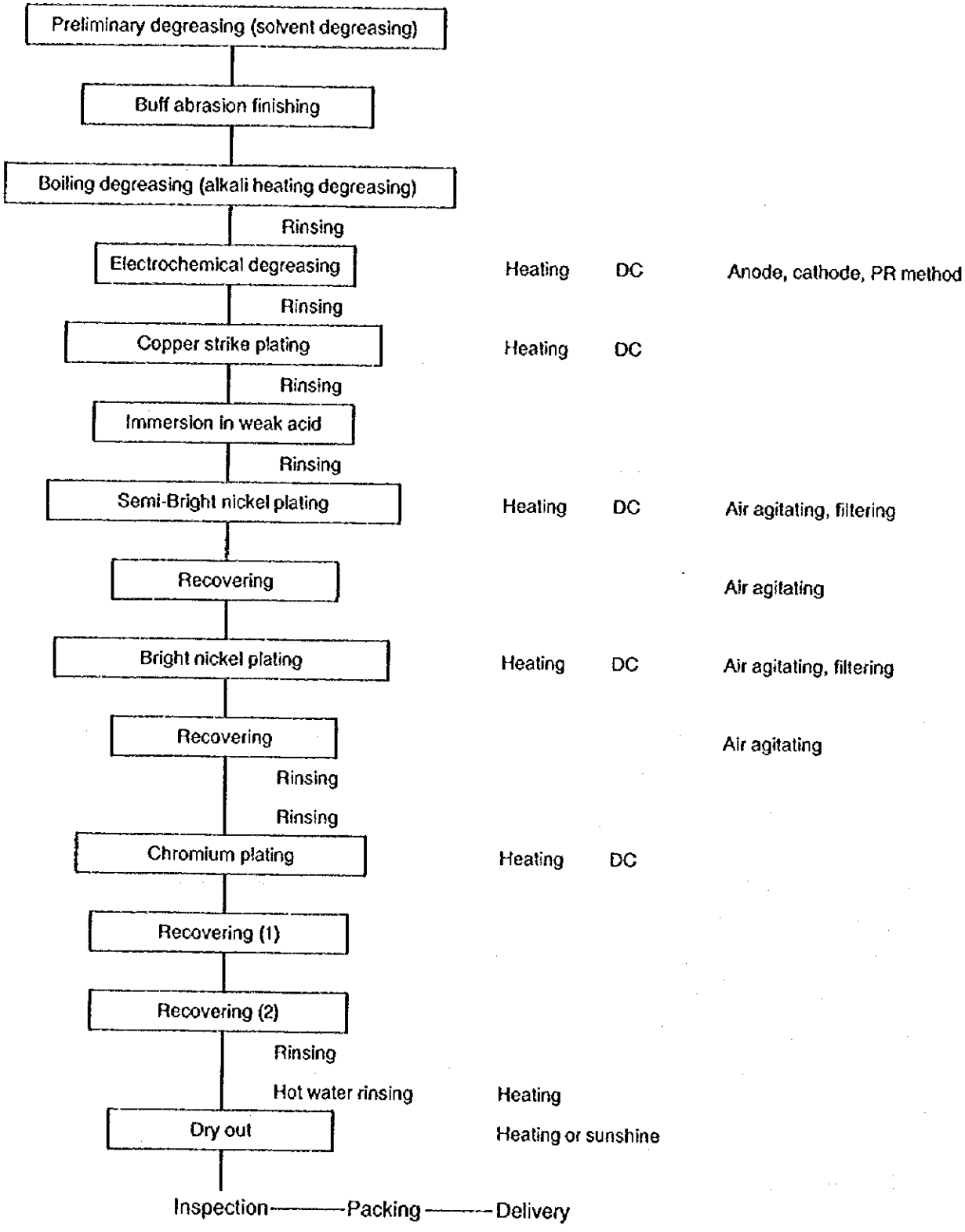

Figure 3-1 WORKING PROCESS OF NICKEL-CHROMIUM PLATING

(2) Major issues

Given the current situation of electroplating units, major issues facing them are summarized as follows:

1) Electroplating technology

(a) There is the lack of demand for quality in the market, which is interested in appearance and price, discouraging quality improvement.

(b) There is the lack of knowledge on basic electroplating techniques, including the proper setting of current density and control of plating bath.

(c) Plating baths are not analyzed on periodical bases and their concentrations are generally low. Plating baths are contaminated because no filter is used.

(d) Bare copper wires are used to hang products in a plating solution. Only one unit uses plating racks, and most units do not feel the need for use of plating racks.

(e) Pretreatment is not sufficient to ensure high plating quality; in particular electrolytic degreasing is not done.

(f) Dull nickel plating followed by polishing is the widely accepted plating process, and bright nickel plating is rarely used.

(g) Most units wash plated products by sprinkling water from a bucket or hose, discharging the plating solution freely without recycling.

(h) Plated products are inspected for external appearance only, and no tests such as thickness and corrosion resistance are conducted.

2) Waste water treatment

(a) While the electroplating industry is designated as a high-polluting industry and is required to obtain environmental protection license, only a few units actually obtained a license.

(b) While most unit owners feel the need for proper waste water treatment, there is an apparent lack of knowledge on effluent standards and treatment technology. As treatment facilities do not produce any profits, the owners do not feel the pressing need for investment.

(c) No efforts are made to reduce waste water in the rinsing process that is a direct source of waste water, such as by reduction of the plating solution to be discharged into the rinsing tank by recovery of the solution, and reduction of water consumption for rinsing. No separation into cyanide- and chromium-based waste water is carried out.

(d) Most units do not treat waste water in any manner. Treatment carried out by a few units is not done properly. At present, waste water is diluted by waste water from other sources or is permitted to permeate into the ground. In future, there will be a high risk of serious environmental pollution, such as health damage by toxic substances contained in waste water

and contamination of ground water by waste water which enters the soil.

3) Recommended areas of improvement

(a) Improvement of rinsing process and work

Recovery of plating solution, multi-stage rinsing, and classification of waste water according to type

(b) Implementation of systematic waste water treatment

Installation of treatment facilities or connectivity to centralized treatment system

(c) Improvement of plating process and work

Proper setting of current density, use of plating racks, filtering and air agitating, and proper control of concentration and temperature of plating bath

(d) Improvement of pretreatment process and work

Dipping degreasing and electrolytic degreasing

(e) Implementation of quality control based on product inspection

Measurement of thickness, corrosion test, and management and utilization of collected measurement data

In addition, general areas of improvement are listed as follows:

- To raise awareness and understanding of electroplating and waste water treatment technologies,
- To improve the working environment (in particular, a dusty environment should be avoided in plating shops), and
- To provide training for workers (proper work procedures and practices of field workers constitute the first step of quality improvement).

3.3 Current State and Major Issues related to IDB Electroplating Center

(1) Current state of IDB electroplating center

1) Purpose of establishment

The center operates under supervision of the Engineering Department and its primary purpose is to teach and disseminate electroplating technology to the electroplating industry and to improve electroplating technology in Sri Lanka. It was established around ten years ago and is located in Peliyagoda, remote from the IDB headquarters.

2) Manpower and equipment

The center has a total of 13 staff, including 3 technical staff and 7 workers. It has a polishing shop, a plating shop, a laboratory, a chemical/equipment warehouse, and an office. Its plating and waste water treatment lines were installed at the time of the center's establishment. Equipment requires repair and upgrading due to deterioration and poor maintenance, but it is capable of performing standard plating operations.

3) External activity and contract work

The center holds a two-day training course three or four times annually, provides technical consultation service for electroplating units, and performs contract plating work for outside companies by using its own equipment and manpower. In 1995, it earned RPs.500,000 from contract work, which accounted for one third of the center's annual expenditures of Rps.1.5 million.

(2) Major issues facing the center

Major issues facing the center are summarized as follows:

1) At present, the center is not fully capable of leading the industry in plating and waste water treatment. It needs to obtain technical and management capabilities by training experts who have the ability to apply basic plating and waste water treatment technologies to field work and who are capable of providing technical guidance and consultation to the industry and its people.

2) Need for improvement of practical skills of technical staff and retraining of workers
   - Technical staff should excell at practical skills so that they can help improve work capabilities and apply knowledge to field work.
   - Training of workers needs to be conducted in the form of OJT (on the job training) so that they can work according to proper procedures.

3) The center must become a technology model for electroplating and waste water treatment technologies in terms of quality, productivity, and environmental protection.

   Major issues
   - Dull nickel plating and polishing for glossing
   - Little pretreatment is carried out.
   - The basic plating process and work procedures are not complied with; no activation treatment and air agitation are performed; and no plating rack is used.
   - Plating conditions and plating thickness are not specified to workers.

- Plating bath is not properly controlled (creating a problem of the composition and temperature of plating solution), and no filtration of the plating solution is carried out.
- Recovery of the plating solution and reduction of rinse water (counter-flow rinsing) are not carried out.

4) The center should promote standardization of technology and work, and should become a model for productivity improvement. The 5S activity should be initiated to promote proper housekeeping and other important practices.

5) Equipment maintenance is not properly carried out, and no formal maintenance system has been established.

4. Target Setting for Proposals and Recommendations

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4.1 Current State of the Electroplating Industry

This study aims to improve technology levels of the electroplating industry in the country and promote proliferation of waste water treatment technology. At present, the industry is very small in size and has yet to develop into a full-fledged and independent industry. The immaturity of the metalworking industry limits electroplating demand, preventing the industry from becoming an important support for industrial development as a whole. The market has low requirements for quality and electroplating technology levels, so that there is little motivation for improvement. However, if metalworking products are to be made in Sri Lanka as intended, the electroplating industry, as long as it has the current level of technology, will hinder attainment of this objective. In view of this development objective it is necessary for Sri Lanka to acquire electroplating technology suitable not for present products but the new ones to result from industrial development.

From the environmental point of view, the electroplating industry handles toxic substances, such as cyanide and chromium, and discharges acid and alkali waste water. At present, most electroplating shops in the country do not treat waste water properly. In particular, small shops rinse plated products in a scouring bath and discharge waste water without treatment. Since their discharge is small in volume as well as discontinuous, toxic substances contained in the waste water have not created serious damage. At the same time, however, in the absence of monitoring by a public organization, they do not face any pressure to invest in waste water treatment facilities. Nevertheless, it is a fact that industrial waste water currently discharged contains toxic substances with much higher concentration levels than permissible by effluent standards, and there is a high risk of pollution caused by substances that accumulate over time, such as chromium. Furthermore, the increase in electroplating work anticipated as concomitant with industrial growth will cause an increase in the amount of waste water which, for environmental protection reasons, cannot be discharged without treatment.

4.2 Target Setting for Proposals and Recommendations

As mentioned before, the lack of waste water treatment by the electroplating industry has presumably produced an environmental problem, for which few control measures have been taken. On the other hand, quality requirements of the market provide little incentive to

upgrade electroplating technology but if no improvement is made, electroplating technology will not contribute to the improvement of industrial products, and will become a bottleneck for industrial development in future. The current state of the electroplating industry and its desirable direction in Sri Lanka is shown in Figure 4-1.

In recognition of the current and pressing issues, the electroplating industry should focus on two goals, quality improvement and reduction of environmental loads. To enable individual factories to work toward the goals, process improvement is essential at each unit, and IDB Electroplating Center must play a key role in providing technical assistance for individual manufacturers and the electroplating industry as a whole. For IDB to fulfill this role, it must first improve its own technical capability to the extent that will enable it to lead the industry. The study team discussed with the counterpart in Sri Lanka on target setting for the industry and IDB's role, and has agreed on proposals and recommendations to be made under the study, as follows:

Target setting for proposals and recommendations

To help the electroplating industry reduce environmental pollution loads and improve product quality through process improvement.

- Waste water treatment: To disseminate waste water treatment technology enabling compliance with environmental standards (including future standards) in the country.
- Electroplating technology: To improve electroplating technology so that it will not become a bottleneck for development of the metalworking industry.

Proposals and recommendations made by the study:

To realize the target levels for the study, recommendations are to be made in the following areas:

- Methods of technical guidance and dissemination to be performed by IDB Electroplating Center for waste water treatment and electroplating technologies
- Upgrading plan for waste water treatment and electroplating technologies of IDB Electroplating Center
- Policies and measures to be taken by the related authorities and organizations

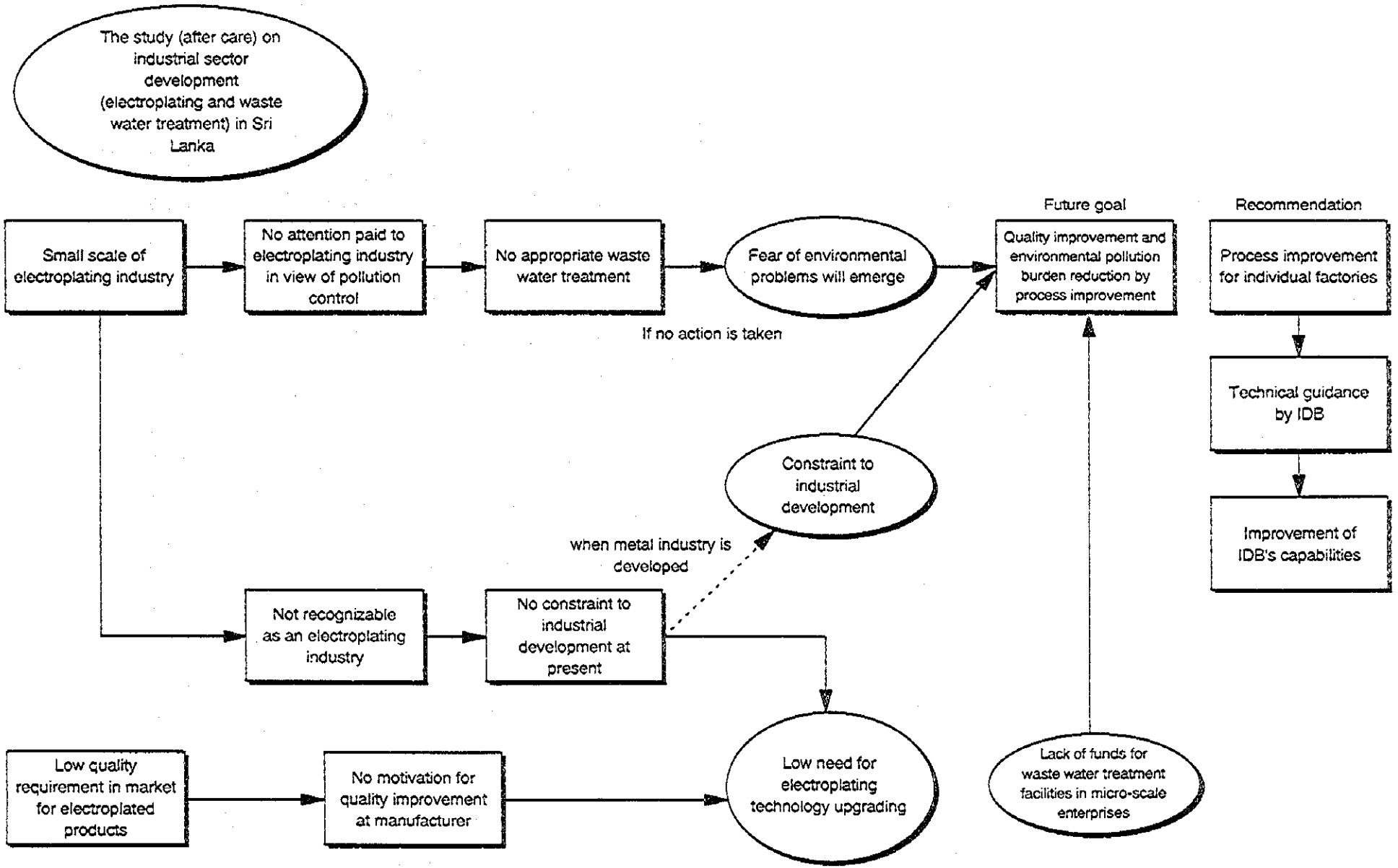

Figure 4-1 CAUSAL RELATIONS REPRESENTING THE CURRENT STATE OF THE ELECTROPLATING INDUSTRY AND ITS DESIRABLE DIRECTION

4.3 Promotion of the Metalworking Industry

To promote the electroplating industry, diversification of metalworking products which require electroplating as well as improvement of their quality and performance are essential driving factors for technological upgrading, aside from efforts to overcome problems facing the industry itself.

The electroplating process is principally one of metal finishing processes. To promote the electroplating industry, therefore, the rational approach is to promote the metalworking and machinery industries (or attract them from other countries) which would create domestic demand for parts and components, followed by gradual localization of the parts industry including the electroplating industry based on industrial plating service. The following propositions for promotion of the metalworking industry have direct impacts on the future of the electroplating industry.

(1) A basic approach is to help the industry make to be adaptive to domestic demand

Sri Lanka, although having low cost, relatively highly educated labor force that offer a potential advantage for industrial development, is not endowed with favorable conditions to foster the metalworking industry. At present, metalworking is performed by a number of industries including processors of construction materials, household products, and other products which mainly serve the domestic market. Few of them are related to the electroplating industry and require high-level industrial electroplating.

As the economy grows and the standards of living of the general population rises in future, demand for consumer products which are imported will rise rapidly. The government's industrial policy, however, can encourage domestic production of such goods. The domestic industry will grow, starting from assembly of imported parts, and will gradually source locally produced parts as specialized parts suppliers emerge. To achieve this goal, parts manufacturers must learn production technologies as well as production control techniques, in addition to receiving support from the government, that would encourage their growth.

The industry supported by domestic demand can be fostered and can become capable of succeeding in competition with imported products, with occasional government assistance as required and through its own efforts.

The fostering of the metalworking industry in the country will take some time, and a traditional approach to start from products serving domestic demand seems to be justifiable.

(2) It is not feasible to attract parts industries alone

Domestic demand can help the assembly industry emerge, but without the assembly industry, it is difficult to establish and maintain the parts industry. Generally, the assembly industry and the parts industry are closely related. Under the relationship, parts suppliers must meet various requirements of assembly manufacturers in terms of quality and delivery, not to mention price. Generally speaking, parts suppliers take a conservative view about overseas operation and are not likely to invest alone, or without direct cooperation by their customers.

For these reasons, it is difficult for Sri Lanka to attract parts suppliers who will export all of their products. A possible solution is to develop an environment to allow free movement of people, goods, and capital with in short distance. Furthermore, contract electroplating for foreign manufacturers is more difficult than the attraction of parts suppliers. Products to be plated have been processed to final shape and need to be protected during transportation by careful packaging. Packaging and transportation costs become higher than other costs, close to the plating cost itself, and this makes it an unattractive option for foreign manufacturers to subcontract electroplating to Sri Lankan companies.

5. Final Goals for the Electroplating Units and IDB Electroplating Center

5. Final Goals for the Electroplating Units and IDB Electroplating Center

5.1 Final Goals for the Electroplating Units

(1) Future target setting

Future targets for electroplating units to achieve are twofold; reduction of environmental pollution loads and process improvement. In consideration of the potential environmental impact of the electroplating industry, priority should be given to the improvement of the rinsing process and installation of waste water treatment facilities.

1) Improvement of the rinsing process
   Recovery of plating solution, multi-stage rinsing, and process line modification

2) Installation of waste water treatment facilities
   Installation of self-contained treatment systems at individual units
   Centralized treatment for small units (accompanied by organization of a trade association)

3) Improvement of pretreatment and plating processes (use of bright plating technology)
   Dipping and electrolytic degreasing, control of current density, use of plating racks, filtration and air agitation, and proper control of concentration and temperature of plating bath (establishment of bright nickel plating technology)

4) Establishment or improvement of product inspection system
   Process control based on proper testing equipment and data

(2) Present measures to be taken

Since the final goals are far from the current situation, present measures to be taken are established to focus on issues that require immediate attention. In particular, for waste water treatment of small units, present measures to be taken need to focus on work for centralized treatment of cyanide salt and chromium which seriously affect human health.

For medium-sized units

1) Multi-stage rinsing
2) Installation of waste water treatment facilities
3) Use of plating racks

4) Filtration and air agitation

For small units

1) Improvement of the rinsing process (installation of rinsing tank)
2) Fractional storage of waste water (installation of receiving tanks for different types of waste water)

5.2 Final Goals for IDB Electroplating Center

(1) Roles of the center

Clearly, it is very difficult, if not impossible, for individual plating units to make the improvements recommended above on their own. The establishment of a joint venture with a foreign partner and obtaining technical assistance from overseas are effective in principle, but this is not practical for a majority of units. Relying on a domestic organization for technical assistance and guidance seems to be the most feasible and logical solution. And IDB can act as such organization, capable of playing a leading role in such efforts, by representing the industry's viewpoint and condition.

(2) Final goals

To fulfill its roles, the center needs to become an organization having highest technical capabilities in the areas of plating and waste water treatment technologies, and to be responsible for research and development, testing and inspection, and promotion and assistance. In particular, its proper future goals are summarized as follows.

1) To have technology and skills sufficient to play a leadership role in raising levels of electroplating and waste water treatment technologies at electroplating units, and use them effectively.
2) To have sufficient resources to disseminate electroplating and waste water treatment technologies to electroplating units (ability to provide technical guidance, consultation, testing and inspection, and training).
3) To have the ability to develop and maintain electroplating technologies which can satisfy quality requirements and methods for plating that change with industrial development (i.e., electroplating technology must not become a bottleneck for development of entire industry).
4) To maintain close relations with companies and organizations inside and outside the country to collect technical and market information on a worldwide basis and keep abreast of latest technological trends.

6. Technology and Skills Improvement Plan for IDB Electroplating Center

6. Technology and Skills Improvement Plan for IDB Electroplating Center

6.1 Technology and Skills Improvement Plan for IDB Electroplating Center

(1) Overview of the technology and skills improvement plan

IDB Electroplating Center is expected to play a leading role in improving the levels of electroplating technology in Sri Lanka. To fulfill the role, the center must first overcome the above problems and improve its own technology, skill levels and technical guidance capabilities. A technology and skills improvement plan for the center was established; it has four categories, namely dissemination of waste water treatment technology, the upgrading of plating technology, the organizational and functional enhancement, and the improvement of day-to-day activities. Individual components of the plan are summarized in Table 6-1.

Table 6-1 TECHNOLOGY UPGRADING PLANS FOR IDB ELECTROPLATING CENTER (Waste Water Treatment and Electroplating Technologies)

Dissemination of waste water treatment technology	
Upgrading plan for waste water treatment technology at the electroplating center	(1) Learning of basic waste water treatment technology Learning of waste water analysis and measurement techniques (2) Establishment of waste water batch treatment technology
External activities of the center	(3) Promotion and public education on waste water treatment technology (4) Technical assistance and technology transfer (5) Promotion of model plant construction plan (6) Research and study on effluent discharge by the industry and proposal of revised effluent standards (7) Establishment of waste water batch treatment technology training courses
Upgrading of Electroplating Technology	
Upgrading plan for electroplating technology at the center	(8) Upgrading of basic electroplating technology (9) Upgrading of bright nickel plating technology (10) Establishment of electroplating product inspection and measurement technology (11) Learning of maintenance technology
External activities of the center	(12) Reorganization of technology training courses (13) Comparative evaluation of electroplating products made in and outside of the country (14) Technical assistance and technology transfer
The Center's Organization and Function-Strengthening	
Organization and function-strengthening plan	(15) Strengthening of technical staff (16) Additional staffing and function (17) Strengthening of means of communication
Upgrading for day-to-day Activities of the Center	
Day-to-day activity improvement plan	(18) Collection of technical information (19) Continuous training of workers (20) Day-to-day practice of production management and equipment maintenance

6.2 Dissemination of Waste Water Treatment Technology

(1) Learning of basic waste water treatment technology and waste water analysis and measurement techniques

The current production facilities are not suitable for experimental use of basic and application technologies for finding optimum plating conditions and other purposes. A bench plant of laboratory scale, capable of plating and waste water treatment operations, will be installed within the center to enable the staff to learn field operations on an empirical basis. Temperature controllers for plating solutions, analytical instruments and testing equipment for experimentation using the bench plant, and measuring instruments for effluents will also be provided. Some of equipment brought by the study team are included in the equipment list. They are used on a daily basis and need to be maintained in good operating condition all the time.

(2) Establishment of waste water batch treatment technology

The existing facilities will be modified into a batch treatment system which stores waste water by separating them into three types, cyanide, chromium, and acid/alkaline. New equipment will be added as required.

Since it is difficult to accurately predict the amount of discharge after installation of the new system as the discharge will decrease due to process improvement, a modification plan should be made after the discharge is estimated.

(3) Promotion and public education on waste water treatment technology

(4) Technical assistance and transfer of waste water treatment technology

The center is expected to educate the industry on importance of waste water treatment as well as treatment technology, methods and costs. Activities include the workshop using laboratory equipment and provision of extension service to individual plating units.

(5) Promotion of model plant construction plan

The model water treatment plant will be installed at a plating unit where plating work is carried out at a continuous pace, thus producing predictable waste water in terms of quantity and quality. The center will promote the plan and provide technical support.

(6) Research and study on waste water discharge by the industry and proposal of revised effluent standards

Investigation of current practice of waste water discharge by plating units helps the government implement its environmental policy and contributes to healthy development of the industry.

(7) Establishment of waste water treatment technology training courses

In addition to current training courses emphasizing electroplating technology, training courses on waste water treatment technology will be newly offered.

6.3 Upgrading of Electroplating Technology

(8) Upgrading of basic electroplating technology

The bench plant is designed to perform a variety of experiments despite having relatively simple configuration. Technical staff will be able to learn basic technology in commercially applicable forms through a wide range of jobs from basic experiments to troubleshooting, development, and prototyping.

(9) Upgrading of bright nickel plating technology

Learning bright nickel plating technology will help the staff to understand the fundamentals of electroplating technology as a whole. Basic technology so learned can be applied to non-nickel plating technologies, allowing the introduction of advanced plating technology. To perform bright nickel plating on a commercial basis, the installation of filters and counter flow rinsing tanks, the adoption of plating racks, and implementation of air agitation are essential, and the existing facility should be modified for this purpose. Also, the process layout will be modified to form a continuous line from pretreatment onward, in order to reduce the amount of waste water discharge.

(10) Establishment of electroplating product inspection and measurement technology

To improve plating quality, product inspection and data recording play an important role. Also, control of plating bath entails accumulation of data collected and analyzed on a periodical basis. Provision of necessary testing equipment and measuring instruments, and the establishment of inspection and measuring technologies are vital to proper quality control.

(11) Learning of maintenance technology

Plating technology depends upon proper maintenance of plating equipment. In addition to the securing of a maintenance budget, the center should be capable of manufacturing plating racks and welding PVC as part of daily operations.

(12) Reorganization of skill training courses

In addition to training courses currently conducted by the center, a new training program will be offered to teach more advanced skills including practical training based on the bench plant.

(13) Comparative evaluation of electroplating products made in and outside of the country

Samples of electroplating products, both local and foreign, will be collected and evaluated, and the results will be made known to the electroplating industry in order to recognize its technology levels. Also, draft national standards for plating quality will be prepared.

(14) Technical assistance and transfer of electroplating technology

Technical guidance will be provided to domestic enterprises, concerning basic plating theory and rational work based on the basic process and equipment, and technology so developed will be transferred to enterprises wishing to introduce it.

6.4 Organization and Function-Strengthening Plan for the Center

(15) Strengthening of technical staff

(16) Additional staffing and function

At present, the center has three technical persons. Under the plan, one chemist and one maintenance technician will be added.

Maintenance work should be conducted on a daily basis, in parallel to plating operation. PVC welding technology should be introduced to enable the repair of plating bath. The center should also be capable of making plating racks as well as minor repair and modification.

The proposed staffing plan is shown in Figure 6-1.

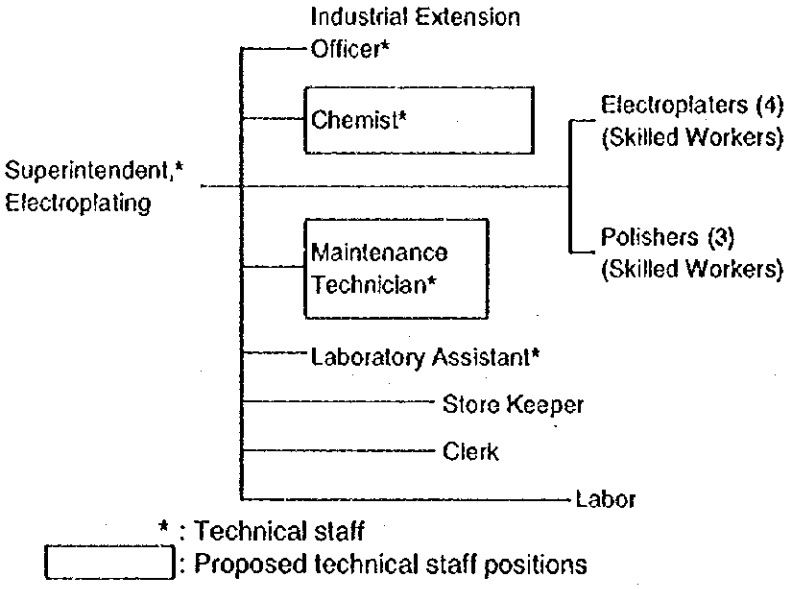

Figure 6-1 ADDITIONAL STAFFING FOR THE ELECTROPLATING CENTER

(17) Strengthening of means of communication

As the center is relatively remote from the IDB headquarters, various devices are required to maintain close communication between them, including an additional telephone line, a facsimile machine, and a motor vehicle.

The vehicle will be stationed at the IDB headquarters or the center and will be used for transportation between the two facilities as well as external activities at present and in future. Closer communication between the IDB headquarters and the electroplating center is expected to positively affect awareness and concern of the center's employees and help invigorate the center.

6.5 Improvement Plans for Day-to-day Activities of the Center

(18) Collection of technical information

Access to information on worldwide trends in plating technology will be ensured through subscription to literature and magazines, attendance at international conferences, and the exchange with societies and academic circles in and outside the country.

(19) Continuous training of workers

The technical staff is expected to play an important role in upgrading skill levels of field workers. Education and training should be repeatedly carried out in the form of OJT (on-the-job-training) focusing on practical training until target skill levels are attained. Training should be conducted on a continuous basis according to technological advancement.

(20) Day-to-day practice of production management and equipment maintenance

IDB is now engaged in the productivity improvement initiatives. It is recommended that the center start the 5S initiative including promotion of housekeeping. Work standardization and manual preparation should also be promoted. The work management system should be improved, including the issuance of work instruction sheets for effective communication.

Equipment should be maintained and inspected on a daily basis, while ensuring early repair under a formal budget (prior to failure in future). The center should serve as model facilities in the areas of production management and equipment maintenance.

7. Policies and Measures to be taken by the Related Authorities and IDB

7. Policies and Measures to be taken by the Related Authorities and IDB

7.1 Ministry of Industrial Development (MID)

(1) Policy for fostering the metalworking industry

Efforts to promote and foster the electroplating industry will not produce results without diversification of plating materials as well as improvements in quality and performance. The first step is to foster and promote the metalworking industry.

In this connection, it is recommended to initiate promotional measures for the electroplating industry mentioned in Part 3 "Metalworking Industry" of "Report on Study of Industrial Sector Development and Promotion Plan" conducted by JICA in 1992. This study has examined how the proposals are reflected in government policy. Although the ministry responsible for industrial promotion was changed from MIST to MID, related departments have been studying the report and have been partially implementing proposals related to industrial development policy.

(2) Support for IDB

IDB, as a core organization responsible for implementation of industrial promotion policy, is required to render a wide range of services, some of which cannot be carried out by operational departments operating on a self-financing basis or can only be implemented by non-operational sectors. If IDB continues to provide these services, it will require large manpower and financial resources, so that it will need the committed support of MID even after the establishment of the self-financing capability.

Also, MID is expected to assist IDB in offering its views to government on behalf of the electroplating industry.

7.2 Central Environmental Authority (CEA)

(1) Environmental administration considering the current state of the industry

Environmental policy and standards in Sri Lanka are well developed. In practice, however, they are too strict to reflect the actual situation in the country. In fact, most factories in the electroplating industry do not comply with existing standards and are left intact. Environmental administration should give some consideration to the stage of industrial development and should not unduly impede it by establishing, enforcing or relieving

environmental standards according to the actual state of individual industries.

(2) Review of effluent standards and its proper application

Environmental standards should be established at a level that most industries can reach with some effort and should be gradually raised according to the level of compliance. In fact, in many cases strict regulations which are practically impossible to comply with do not lead to the improvement of the environment. For instance, general environmental standards in Sri Lanka set uniform standards for inland water. However, more detailed and reasonable standards reflecting local conditions need to be established, except for toxic substances which must be strictly controlled for protection of human health.

In particular, it is desirable that relief measures take into account actual environmental impact. For instance, effluent standards for heavy metals may be exempted for factories which discharge a small amount of effluent (below a certain level), and an upper limit for discharge of heavy metal on an annual basis may be permitted for large factories with high discharge, except for those discharging toxic substances, such as CN and Cr6+, which must be subjected to certain effluent standards, no matter how small it is.

(3) Reinforcement of the loan programme

The pollution Control and Abatement Fund (PCAF) has been widely accepted, and 70% of the total fund have been expended during the first six months. This is important evidence that most enterprises, while realizing the need for environmental protection, cannot afford to do so due to financial constraint. Considering the fact that international financial institutions and industrialized countries give increasingly high weight to environmental protection and preservation as an important area for financial support, the country will be able to obtain additional funds from these institutions and governments to continue PCAF if it explains the country's commitment to environmental protection and the need for financial assistance.

(4) Enforcement of laws and regulations

While the need for environmental protection is widely recognized, individual enterprises are not familiar with procedures and standards they must comply with.

Efforts should be made to make environmental standards known to all the industrial circles, thereby to encourage them to obtain environmental protection license.

7.3 Industrial Development Board of Ceylon (IDB)

(1) Need for unleashing its full potential

While IDB is only one organization implementing industrial promotion policy in the country, it was allowed during the period of nine years in the past to perform only a small portion of the duties mandated to it under the Industrial Development Law. This seems to have adversely affected industrial development. Further, this suggests the importance of a consistent organizational structure for policy implementation bodies like IDB, which would assure the effective execution of its policy, while drastic organizational changes may result in undue restriction on its activities.

(2) Formulation of self-reform programme reflecting SMI's voice

IDB is currently developing a self-reform programme to accomplish the objective of attaining self-financing capabilities and building an efficient organization. While IDB appears to weigh the results of hearings, decisions, and discussions inside IDB, it needs to hear from its users, particularly small and medium scale industries, their opinions and views on IDB's service and practice, based on which the reform proposal which leverages IDB's role should be developed.

(3) Evasion of competition with private enterprises

While IDB is pursuing the goal of being self-financing, it is desirable to avoid any activity which would compete with or exert pressure on the private sector in the course of business conducted by its operational division as part of duties mandated to IDB. IDB is expected to introduce advanced technology and have it incorporated into new products, which are manufactured and sold by its operational division, thereby to raise awareness on quality and performance in the domestic market. If any domestic enterprise wishes to manufacture and sell the product, IDB should initiate technology transfer and technical support, which would contribute to industrial promotion, while raising public confidence and providing the raison-de-etre of IDB itself.

(4) Discussion with CEA on environmental regulations to be applied to electroplating industry

IDB would do well to discuss with CEA the step-by-step application and/or mitigation of the proposed standards, taking the current state of the electroplating industry into account.

8. Proposals and Recommendations

8. Proposals and Recommendations

8.1 Promotion Programmes for the Electroplating Industry

Based on the proposed improvement plan for IDB Electroplating Center mentioned in Chapter 6, and recommended measures to be taken by related organizations and IDB, as identified in Chapter 7, proposals and recommendations for promotion of the electroplating industry are described as follows. The present study has revealed that the upgrading of IDB's technology and skill levels as an organization leading the industry is imperative for effective promotion of the industry. It is recommended, therefore, to promote the upgrading of the center's technology and skills, as a formal programme, with cooperation by related authorities and organizations.

(1) Programme to upgrade technology and skills of IDB Electroplating Center

Promotion of the electroplating industry needs to be realized at the initiative of IDB, which must and can play a critical role. While the programme will be planned and implemented under the leadership of the electroplating center, it should preferably be promoted with assistance and collaboration of related authorities and organizations including MID and CEA in order to maximize its effect.

(2) Promotion of the electroplating industry as part of industrial development policy

Promotion of the electroplating industry is closely associated with promotion of the metalworking industry and industrial promotion policy. In this context, MID, which is making efforts to promote the metalworking industry, is expected to support and foster the programme to upgrade IDB Electroplating Center's technology and skills, so as to ensure that the electroplating industry will not become a bottleneck for industrial development as a whole.

(3) Environmental policy in concordance with industrial promotion

While the electroplating industry is still small in size and thus has not become a serious environmental threat, it has high potential to become one, which cannot be underestimated. Development of the electroplating industry hinges upon its ability to treat waste water properly. In this conjunction, CEA must be continually aware of the center's technology upgrading programme and its progress, particularly regarding propagation of waste water treatment technology, and is expected to take flexible policy measures that take into account the realities and growth potential of the industry.

8.2 Upgrading Programme for Technology and Skills of IDB Electroplating Center

"Upgrading programme for technology and skills of IDB Electroplating Center", that is proposed as a core promotion programme for the electroplating industry, is outlined as follows.

8.2.1 Prerequisites for implementation of programme

In proposing the plans to be implemented by IDB, the study assumes the following prerequisites to be fulfilled and considerations to be made.

(1) Use of existing facilities and equipment

Existing facilities and equipment located at IDB Electroplating Center in Peliyagoda will be used for the programme. Before the use, these facilities and equipment will be partially rehabilitated, including the upgrading, repair, addition, and/or layout modification, rather than overall renewal. The process and equipment improvements being contemplated require space for improvement. Therefore it is recommended to reconsider the need for existing equipment, and remove or dispose that which is not needed or is not practical to repair.

(2) Additional staffing and functional strengthening

In consideration of proposed strengthening of technical staff and organizational and functional enhancement in (15) and (16) of 6.4, the minimum additionally required technical staff will be engaged. While electroplating service by the center on a contract basis will bring meaningful benefits through technical improvement and increased revenues, it is recommended to manage the center's service by separating it into technical upgrading/guidance and electroplating work. Under this arrangement, workers will mainly be engaged in the latter. On the other hand, technical staff will be responsible for both jobs, which need to be differentiated clearly. To prevent technical guidance from being neglected, related costs for chemicals, consumables, and maintenance should be recorded separately for each of the two categories as far as is practicable.

8.2.2 Upgrading programme for technology and skills of IDB Electroplating Center

(1) Outline

Tasks and targets for the proposed programme to upgrade waste water treatment and electroplating technology of IDB Electroplating Center and to disseminate them, are shown in Table 8-1.

Table 8-1 UPGRADING PROGRAMME FOR TECHNOLOGY AND SKILLS OF IDB ELECTROPLATING CENTER

Objectives		Programme goals
Dissemination of waste water treatment technology	Upgrading plan for waste water treatment technology at the center	To enable the center's technical staff to consider and establish appropriate waste water treatment conditions. To ensure that electroplating is carried out in such method to minimize effluents from the plating process. To ensure that waste water treatment is carried out in compliance with conditions set by technical staff.
	External activity plan for the center (dissemination of waste water treatment technology)	To promote implementation of an optimum waste water treatment plan in the electroplating industry
Upgrading of electroplating technology	Upgrading plan for the center's technical capabilities	To enable the center's technical staff to consider and establish appropriate plating conditions. To ensure that electroplating is carried out in compliance with conditions set by technical staff. To ensure that inspection data on electroplating products are recorded and used for process improvement
	External activity plan for the center (dissemination of electroplating technology)	To promote the upgrading of electroplating technology to meet demand of the metalworking industry.

The action plan of the upgrading programme is shown in Table 8-2. For the content of each project refer to the items in Chapter 6.

Table 8-2 ACTION PLAN FOR UPGRADING PROGRAMME FOR TECHNOLOGY AND SKILLS OF IDB ELECTROPLATING CENTER

Objectives		Projects	Equipment upgrading plans	Goals	Remarks
Dissemination of waste water treatment technology	Upgrading plan for waste water treatment technology at the center	Learning of basic waste water treatment technology	Procurement and replacement of laboratory equipment and analytical instruments	Learning of basic technology related to waste water treatment	6.2 (1)
		Learning of waste water analysis and measurement techniques	Procurement and replacement of analytical instruments for effluent	Learning of measuring method for waste water analysis data, and application of accumulated data to process improvement	6.2 (1)
		Establishment of waste water batch treatment technology	Improvement of existing waste water treatment equipment	Implementation of waste water treatment in compliance with effluent standards	6.2 (2)
	External activity plan for the center (dissemination of waste water treatment technology)	Promotion and public education on waste water treatment technology		Education on importance of waste water treatment and knowledge on waste water treatment method to the electroplating industry	6.2 (3)
		Technical assistance and technology transfer	Workshops using model equipment	Teaching of adequate treatment technology to plating shops	6.2 (4)
		Model plant construction plan	Installation of a model waste water treatment plant at a selected plating shop which conducts work on a continuous basis	Teaching of mainstream treatment technology to the electroplating industry	6.2 (5)
		Research and study on effluent discharge by the industry and proposal of revised effluent standards		Research and study on current state of waste water treatment, development of proposed effluent standards which are enforceable, and proposal to CEA	6.2 (6)
		Establishment of waste water treatment technology training courses		Guidance and training on waste water treatment practice	6.2 (7)
Upgrading of electroplating technology	Upgrading plan for the center's technical capabilities	Upgrading of basic electroplating technology	Construction of the bench plant	Understanding of basic electroplating technology and plating conditions	6.3 (8)
		Upgrading of bright nickel plating technology	Upgrading and rehabilitation of existing equipment, Manufacturing of plating racks, Improvement of plating process lines	Learning of adequate plating technology and skills through practical experience in bright nickel plating technology	6.3 (9)
		Establishment of electroplating product inspection and measurement technology	Plating thickness gauge Adhesion testing equipment Corrosion testing equipment	Learning of electroplating product inspection technology, and application of accumulated data to process improvement	6.3 (10)
		Learning of maintenance technology	Plating rack production tools PVC welding equipment	Learning of basic maintenance technology	6.3 (11)
	External activity plan for the center (dissemination of electroplating technology)	Reorganization of technology training courses	Use of the bench plant	Retraining of plating engineers and workers with advanced knowledge and skills	6.3 (12)
		Comparative evaluation of electroplating products made in and outside of the country		Compilation of inspection results on the basis of sampled electroplating products to encourage recognition of current technology levels	6.3 (13)
		Technical assistance and technology transfer		Guidance to plating shops for technological upgrading	6.3 (14)

(2) Implementation schedule for programmes and equipment costs

The above promotion programmes will be implemented within a five year period which is divided into two phases. The first phase (3 years) will focus on upgrading of the center's technology levels and implement priority items. Based on the results of the first phase, the second phase (2 years) will concurrently implement the technology upgrading plan and the technical guidance and dissemination plan. Table 8-3 shows priorities for the programmes, preliminary implementation schedule, and equipment cost estimates.

Table 8-3 PROPOSED IMPLEMENTATION SCHEDULE OF UPGRADING PROGRAMME FOR TECHNOLOGY AND SKILLS OF IDB ELECTROPLATING CENTER

Objectives	Projects	Priority	Schedule (0 – 3 – 7)	Estimated equipment upgrading costs (thousand yen)	Technical support activities
Upgrading plan for waste water treatment technology at the center	Learning of basic waste water treatment technology	AA			Training, consultant
	Learning of waste water analysis and measurement techniques	AA		513	Training, consultant
	Establishment of waste water batch treatment technology	A			(Consultant)
External activity plan for the center (dissemination of waste water treatment technology)	Promotion and public education on waste water treatment technology	A			
	Technical assistance and technology transfer	A			
	Model plant construction plan	B			(Consultant)
	Research and study on effluent discharge by the industry and proposal of revised effluent standards	B			
	Establishment of waste water treatment technology training courses	B			(Consultant)
Upgrading plan for electroplating technology at the center	Upgrading of basic electroplating technology	AA		2,018	Training, consultant
	Upgrading of bright nickel plating technology	AA		3,310	Training, consultant
	Establishment of electroplating product inspection and measurement technology	A			Training, consultant
	Learning of maintenance technology	A			Training, consultant
External activity plan for the center (dissemination of waste water treatment technology)	Reorganization of technology training courses	B			(Consultant)
	Comparative evaluation of electroplating products made in and outside of the country	B			(Consultant)
	Technical assistance and technology transfer	B			
			Total	5,841	

Training: Overseas training
Consultant: Technical guidance by expert (key items)
(Consultant): Expert advice

(3) Foreign technical assistance

Needless to say, the proposed programmes must be promoted under IDB leadership. In some cases, however, efficient implementation and better results can be expected from foreign technical assistance, such as overseas training and instruction by foreign experts.

1) Overseas training of technical staff

The center's technical staff members have received training in the U.K. or India at the time of employment. Since then, they have had few opportunity to come in contact with new technology. Technologies they have learned are outdated. They need to learn basic plating technology as well as waste water treatment technology. At the same time as new technical staff is added to the center, it is recommendable to provide the existing technical staff with practical training at industrial research institutes in other countries. This will increase the effectiveness of instruction by foreign experts and will accelerate the pace of technological upgrading.

2) Instruction by resident foreign experts

To achieve the primary objective of the programme, i.e., the upgrading of IDB's technical capabilities, in an efficient manner and within a relatively short period of time, instruction by experts from industrialized countries is strongly recommended. Such instruction should cover practical knowledge and know-how with an emphasis on basic technology. It should be noted, however, that training of field workers and external activities need to be carried out under strong leadership of IDB, while foreign experts will only provide advice and suggestion.

Table 8-4 lists items for which foreign technical assistance is desirable.

Table 8-4 RECOMMENDED AREAS OF FOREIGN TECHNICAL ASSISTANCE

Types of technical assistance	Items	Method/period/number of personnel
Overseas training of technical staff	Training items • Learning of basic electroplating and waste water treatment technologies • Including field tour on electroplating and waste water treatment operations at factories	To be conducted at industrial research institutes in industrialized countries, which have similar function to IDB. The training programme will last 3~4 months per person and should preferably cover 2~3 persons over an extended period of time to avoid overlapping.
Instruction by foreign experts	Items • Basic waste water treatment technology • Waste water analysis and measurement techniques • Waste water batch processing technology (design and operation) • Basic electroplating technology • Bright nickel plating technology • Product inspection technology (application to process improvement) • Technology related to plating racks (design and manufacture) Focusing on training of basic technology for technical staff	During the first year, it is recommended to provide two-week instruction at an interval of a few months. Meanwhile, details of facilities and equipment required for instruction (specifications, location to be installed, and actions required by the Sri Lankan counterpart) will be studied and prepared for installation. Then, two experts will be assigned for around two years.

(4) Principles of programme implementation

The following principles need to be complied with when implementing the promotion programme:

1) Operating expenses for the center, including chemicals and other consumables, labor, and maintenance, must be specified in a formal budget.
2) The implementation schedule is assumed to take the minimum practical period, which can be extended in keeping with the staff's ability and budget allocation, provided that continuous and sincere efforts are made to accomplish the goal of attaining knowledge of the required technology.
3) As demand for electroplating varies with economic change and technological advancement, the programme should be flexibly implemented by reviewing and revising priorities as required.
4) The programme must be implemented under the leadership of IDB, including technical

assistance where it is expected to involve active participation in and cooperation by foreign experts.

8.2.3 Recommended continuous activities as routine work

The following activities should form the basis of efforts to improve and maintain technology and skills, but are not widely practiced at present. They should be incorporated into the center's day-to-day operation plans and should be conducted on a continuous basis.

(1) Collection of technical information

Developing countries are apt to introduce latest technology, but leave intact existing problems or obstacles. It is critical to keep abreast of world technology trends and evaluate latest technology from its merits to the country and industry.

(2) Training of workers

Since the center is expected to play a leading role in disseminating technology to the industry, work conducted at the center must be at the highest level achievable in the country. The center should also provide a show case of worker training. As will be the case elsewhere as well, although globally applicable training methods are in place, their effect cannot be maximized without due consideration having been given to conditions peculiar to the country and society. Naturally, workers may resist a major change in work procedures and practices to which they are accustomed. Technological upgrading of the center cannot be assured unless there is an environment or mechanism to enable technical staff to provide workers with continuous training on a daily basis, in order to keep pace with technological advancement.

(3) Production management and equipment maintenance

The center must become a model facility for production management and equipment maintenance. In particular, it should develop the ability to provide technical assistance in these areas by making prototypes and performing electroplating work on a contract basis. Also, to increase productivity of the entire industry, it should cooperate with private enterprises that are making innovative efforts in production management. Finally, safety and health of workers are other important aspects to be taken care of on a daily basis.

8.2.4 Plans to be implemented after the programme

To ensure the full-fledged growth of the electroplating industry, the following plans need to be promoted. These plans should be implemented when the proposed programmes have made progress and produced tangible results.

(1) Promotion of centralized waste water treatment plan (support for industry-wide cooperative efforts)

It is very difficult for smaller units to install waste water treatment equipment at their own facilities, and centralized treatment is a realistic and optimum solution. Any such efforts, however, involve various management problems in addition to technical ones. To overcome them, individual enterprises must be organized so as to mobilize collective efforts. In particular, organizational efforts of enterprises that are willing to participate in centralized treatment are a prerequisite to the plan's promotion. In this connection, IDB is expected to provide support for organization of individual plating units in addition to technical aspects of centralized treatment.

(2) Introduction of non-polluting plating technology

Pollution control is not merely treatment of harmful substances. Equally important are efforts to reduce the discharge of effluents by reducing the use of chemicals and recycling plating solution. Furthermore, a new zinc plating bath process using no cyanide or low concentration of cyanide needs to be considered, although the non-cyanide process is difficult to introduce until bright nickel plating technology is fully adopted.

(3) Introduction of advanced plating technologies

The center is contemplating introduction of hard chromium plating and non-electrolytic plating. In fact, demand already exists in the country for these methods of plating. To ensure the high quality required in these advanced plating processes, however, various intricate plating conditions, such as involving plating racks and arrangement of electrodes, must be controlled. They are more complex than those applicable to bright nickel plating technology. This is the reason why this report emphasizes the need for establishing bright nickel plating technology, which is the prerequisite to introduction of advanced plating techniques.

Finally, chromium plating needs to be conducted in a room separated from that for nickel and zinc plating processes, so that it should be introduced in the context of the overall expansion plan for the center.

8.3 Recommendations to MID

(1) Support for the technology upgrading programme for IDB Electroplating Center

As the metalworking industry develops, it is important to foster the domestic electroplating industry so as to allow it to keep pace with the metalworking industry and not to become a bottleneck. It is recommended that MID, as IDB's supervising organization, support IDB's operational divisions to implement the technology upgrading programme for IDB Electroplating Center in its manpower and financial aspects, while providing ongoing support for IDB's activity.

(2) Promotion of the metalworking industry

Apart from fostering of the electroplating industry, successful growth hinges upon development of the metalworking industry. Healthy growth of the metalworking industry creates a powerful drive for demand for better electroplating and higher technology levels, which induces modernization of the electroplating industry. Thus, MID needs to focus on promotion of the metalworking industry as part of its ongoing industrial promotion policy, which can be fully justified on the basis of its positive repercussion on the electroplating industry.

8.4 Recommendations to CEA

(1) Environmental policy in concordance with industrial production

While the electroplating industry is still small in size and thus has not become a serious environmental threat, it has high and not-to-be-underestimated potential to become such a threat. Development of the electroplating industry must be accompanied by its ability to treat waste water properly. In this conjunction, CEA must be well aware of the center's technology upgrading programme and its progress, particularly propagation of waste water treatment technology, and is expected to apply regulatory measures by taking into account the objectives of environmental protection and potential contribution of the electroplating industry to industrial promotion, and work with IDB to promote appropriate waste water treatment practice in the industry.

(2) Establishment of viable effluent standards for the metal finishing industry as a whole

Present environmental standards are uniformly applied regardless of chemical consumption or discharge by individual units. To maximize the effect of regulatory measures by setting standards to which units can comply with reasonable efforts, flexible enforcement of environmental standards is recommended, e.g., exemption of enterprises smaller than a certain size. In this context, effluent standards for the metal finishing industry, which is currently being drafted by CEA, seem to contain unduly strict provisions and lack indispensable ones. It is recommended that CEA consults with the industry and/or IDB to establish enforceable standards.

(3) Expansion of the loan programme related to pollution control

The loan programme currently underway, which uses the Pollution Control and Abatement Fund, is small in size and has not been used by the electroplating industry. Once the industry starts to install waste water treatment facilities, an increasing number of units will demand public loans. To accomplish the goal of pollution control initiated by the industry, therefore, the issue cannot be left to the Ministry of Finance and Planning. It is recommended that CEA and MID monitor the development of the loan programme and take steps to achieve a reasonable increase of the budget for the fund, while advising the industry to leverage the programme for quick proliferation of waste water treatment in the industry.

8.5 Recommendations to IDB

(1) Need for coordinated self reform efforts

IDB is now making committed efforts for self reform, which are highly evaluated, provided that the reform plan reflects the needs and wants of small enterprises it serves.

(2) Non-competition with private enterprises

IDB, as a government organization, should not provide service which may compete with or exert undue pressure on private enterprises. Thus, it should confine its activities to those which would serve the interest of helping private enterprises and their development, e.g., introduction and dissemination of advanced technology and products.

(3) Discussion with CEA on environmental regulations to be applied to electroplating industry

IDB should discuss with CEA on the step-by-step application and/or mitigation of the proposed standards, taking the current state of the electroplating industry into account.

9. Conclusion

9. Conclusion

(1) Current state of the electroplating industry

1) The electroplating industry in Sri Lanka is fairly small and far from reaching a level recognizable as a self-driving industrial sector. The metalworking industry is also underdeveloped and creates minimal plating demand, and the market does not demand high quality from plated products.

2) There is no plating unit that treats its waste water properly by using appropriate treatment facilities. A large number of them do no treatment at all. As a result, effluents discharged from electroplating units contain pollutants above concentration levels permitted by CEA's environmental standards, but they have not caused a serious problem due to the small amount of discharge.

3) Electroplating technology of the industry has lagged behind the world level. Dull nickel plating followed by buffing is the mainstream technology adopted by the industry. The lack of quality awareness in the market discourages aggressive process improvement. There is a lack of knowledge of basic electroplating and waste water treatment technologies.

(2) Major issues facing the electroplating industry

1) Major issues facing the electroplating units are the improvement of the rinsing process, introduction of waste water treatment, the improvement of the plating and pretreatment processes, and product inspection (introduction of quality control practice).

2) Major issues related to IDB Electroplating Center are low technology levels of technical staff, the lack of training for workers, and insufficient ability to provide technical service for the industry.

(3) Final goals

1) In discussion with IDB, it was decided to make the focus of recommendations on two goals, namely reduction of environmental pollution loads through process improvement, and the upgrading of electroplating technology and quality improvement.

2) Future targets for electroplating units are reduction of discharge load, formalization of the waste water treatment process, and the upgrading of electroplating technology.

Reduction of discharge load will be accomplished by improving the rinsing process (control measures at source), while waste water treatment facilities will be installed at individual factories. For small units, centralized treatment should be considered.

The upgrading of electroplating technology, while the plating process plays a central role,

involves the improvement of the entire process including pretreatment and rinsing processes. In particular, introduction and adoption of bright nickel plating technology (serving as key technology for future diversification) is essential.

Present measures to be taken are the improvement of the rinsing process, incorporation of the waste water treatment process, the use of plating racks, and filtration and air agitation, which will constitute the first step toward the future goals.

3) IDB Electroplating Center is mandated to raise technology levels of the entire electroplating industry through technical assistance. To fulfill such a role, the center must develop itself into an organization having highest technical capabilities in the areas of plating and waste water treatment technologies, and assume responsiblity for research and development, testing and inspection, and promotion and assistance.

(4) Upgrading programme for technology and skills of IDB Electroplating Center

1) For the industry to attain the prescribed future goals, it is imperative that IDB Electroplating Center, as the leader and propagator of industrial technology in the country, must improve its own technological capabilities. For this purpose, the programme to upgrade technology and skills of IDB Electroplating Center is proposed.

2) The programme must be promoted under the leadership of IDB, the efforts of which can be significantly enhanced by technical assistance from industrialized countries.

(5) Recommendations to related authorities

1) MID is recommended to step up efforts to promote the metalworking industry, and support IDB itself and the programme to upgrade technology and skills of IDB Electroplating Center.

2) It is recommended that CEA pursue environmental regulation in concordance with industrial development, optimized application of regulatory measures, and effective dissemination and enforcement of environmental standards. In addition, CEA should work with the Ministry of Finance and Planning and other competent ministries to expand the loan programme for pollution control-related investment.

3) Recommendations to IDB include efforts to maintain consistency of IDB's service, the development of the self-reform plan in consideration of the needs of its users, and self-restraint to avoid undue competition with private enterprises.