



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

19183



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION



CONFERENCE ON
ECOLOGICALLY SUSTAINABLE
INDUSTRIAL DEVELOPMENT

Copenhagen, Denmark, 14-18 October 1991

Distr.
LIMITED

ID/WG.516/6
23 August 1991

ORIGINAL: ENGLISH

IPP

INDUSTRY INITIATIVES IN ACHIEVING
ECOLOGICALLY SUSTAINABLE INDUSTRIAL DEVELOPMENT

Working paper No. III

Prepared by

the UNIDO Secretariat

Contributions to this document have been made by Dr. G. Winter of the German Environmental Management Society, (BAUM), Hamburg, Dr. R.G.A. Boland (Consultant) and Mr. T. Davis, International Network for Environmental Management.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This document has been printed on environmentally friendly paper.

This document has not been edited.

Contents

Explanatory notes	<u>Page:</u>
I. EXECUTIVE SUMMARY	07
II. BACKGROUND	08
A. Ecologically sustainable industrial development and the present paper	08
B. Ecologically sustainable industrial development and clean technology	09
C. Cleaner production and the approach of this paper	10
D. Realities of the competitive industrial world	10
E. Special factors in developing countries	10
F. Underlying assumptions of experienced industrial managers	11
III. COSTS AND BENEFITS OF CLEANER PRODUCTION	12
A. General comments	12
B. Costs	13
C. Benefits	14
D. Selected examples and enterprise initiatives	15
E. Opportunities for building a special cleaner production capacity	16
IV. ROLE OF FINANCIAL INSTITUTIONS	17
A. General comments	17
B. Commercial and merchant banks	17
C. National development banks and financial bodies	18
D. International development banks	18
E. Special environmental financial institutions	18
F. Selected financial initiatives	19
G. Opportunities for building a special cleaner production capacity	19

V.	CONSTRAINTS FOR SMALL- AND MEDIUM-SIZED ENTERPRISES	20
A.	General comments	20
B.	Selected samples of initiatives of small- and medium-sized enterprises	22
C.	Opportunities for building a special cleaner production capacity	23
VI.	ROLE OF TRANSNATIONAL CORPORATIONS	23
A.	General comments	23
B.	Selected transnational initiatives	24
C.	Opportunities for building a special cleaner production capacity	25
VII.	NEED FOR HUMAN RESOURCE DEVELOPMENT	26
A.	General comments	26
B.	Selected examples of human resource initiatives	27
C.	Opportunities for building a special cleaner production capacity	28
VIII.	RELATIONSHIPS OF INDUSTRY WITH GOVERNMENT AND PUBLIC INSTITUTIONS	28
A.	General comments	28
B.	Selected examples of government and public institution initiatives	29
C.	Opportunities for building a special cleaner production capacity	30
IX.	ROLE OF NATIONAL INDUSTRIAL FEDERATIONS, CHAMBERS OF COMMERCE, TRADE UNIONS AND NGOS	30
A.	General comments	30
B.	Selected examples of initiatives of these organizations	31
C.	Opportunities for building a special cleaner production capacity	32

X.	INDUSTRIAL EXPERIENCE OF R&D, MANAGEMENT AND TRAINING METHODS	33
A.	Research and development hardware: technology	33
B.	Selected examples of R&D hardware initiatives	34
C.	R&D software: management and training methods	35
D.	Selected research and development software initiatives	36
E.	Opportunities to building a special ecologically sustainable industrial development and cleaner production capacity	37
XI.	CONCLUSIONS	37
XII.	RECOMMENDED ACTION FOR UNIDO	38
XIII.	NOTES	40

Explanatory notes

BAUM German Environmental Management Association
BCSD Business Council for Sustainable Development
CFC chloro-fluorocarbon
CP cleaner production
EPA Environmental Protection Agency (of the United States of America)
ESID ecologically sustainable industrial development
ICC International Chamber of Commerce
IPCS International Programme for Chemical Safety
IEO Industry and Environment Office (of UNEP)
ILO International Labor Organisation
INEM International Network for Environmental Management
ISO International Standards Organization
SME small- and medium-sized enterprise
TNC transnational corporation
UNCED United Nations Conference on Environment and Development
UNEP United Nations Environment Programme
WHO World Health Organization

I. EXECUTIVE SUMMARY

The major sources of pollution and users of natural resources are energy producers, industry, transportation, agriculture and consumers. The present paper concentrates on industry but the issues addressed are profoundly affected by problems beyond its scope, for example, population growth, poverty and disenfranchisement and trade issues.

The basic concept of Ecologically Sustainable Industrial Development (ESID) requires industrial activity to mimic eco-systems in a closed loop where waste becomes a resource for the next link in the loop. Nature teaches that ecological balance is only achieved by a high level of inherent process efficiency and integration between the different organisms or links in the eco-system. Similarly, ESID will be achieved when our processes become inherently efficient and the economic actors "connect" with the next actors in the loop.

Clean technology and cleaner production (CP) - the "hardware" - are the main practical and technical goals to be achieved. Better environmental management, including training and environmental audits, - the "software" - is equally important.

In light of the above, UNIDO and its member governments are urged to:

1. set, as an overall goal, the establishment of cleaner production as the norm by the year 2000 and that ESID (i.e., closed loop with low/zero waste) becomes the norm by the year 2020;
2. cooperate with local and global, governmental and non-governmental institutions and especially with developing countries' governments and with business associations in sharing the task of spreading ESID;
3. promote a fair regulatory framework conducive to ESID and cleaner production which sets precise goals without prescribing the exact methods to reach them, and leaves it to industry to achieve these in the most efficient and economic manner;
4. create incentives for ESID in the marketplace through appropriate taxation and fiscal instruments fostering the internalization of business costs related to resource/energy consumption and pollution;
5. set a good example by requiring all publicly-owned enterprises, public service companies and administrations to uphold the same standards as are demanded from the private sector;
6. ensure that transnational corporations implement the same environmental standards worldwide as in their home markets (given that they are in fact higher);
7. employ focused strategies to solve the environmental problems of Small- and Medium-Sized Enterprises (SMEs) worldwide, including those in the informal sector of developing countries which cannot be reached by traditional means;

8. take advantage of the contacts and know-how of business associations, chambers of commerce, trade unions and special business sectors such as accounting, insurance and banking (banks in particular through their widespread networks can reach otherwise hard-to-reach SMEs);
9. launch an information campaign to show that in many cases even in the short-term, cleaner production and pollution prevention can pay and that they are conditions for the long-term survival and success of a company;
10. promote awareness in business of the need for ESID through education, sensitization and training (e.g., the ICC Business Charter for Sustainable Development). As political, psychological and managerial problems will be harder to solve than the technological ones, motivation through the power of examples and case studies is of highest priority;
11. promote awareness in society and consumers of the need for sustainable development through education, sensitization and training from kindergartens to high schools, technical and business schools to universities;
12. promote the development of R&D relating to cleaner production and ESID by all corporations, and specifically remove hurdles faced by smaller SMEs and individual inventors.

The UNIDO action plan details the above recommendations and should be put into operational terms. UNIDO is urged to:

- take stock of available experience, information and material, matching these with perceived needs and noting discrepancies;
- use, adapt and further develop available material and experience, foster the spread of approaches which have proven themselves, promote the rapid and unbureaucratic distribution of useful information and training and;
- where necessary, help develop information, assessment methods and indicators in those areas where they are most lacking (e.g., focus on developing countries, environmental audits and accounting).

II. BACKGROUND

A. Ecologically sustainable industrial development and the present paper

The present paper has been prepared as a contribution to the UNIDO Conference on Ecologically Sustainable Industrial Development. It describes in practical operational terms some current industrial initiatives for building a special capacity for ESID within each country, mainly by the promotion of cleaner production technology.

This special capacity must deal with both installing new equipment and processes, and operating them; it must also deal with the technical and management problems of cleaner production. While it is clear that the problems relating to the technical side are not all solved, for example, the lack of widely commercially available non-chloro-fluorocarbon-based technologies, there seems to be less of a problem of technology, but more of management. How can industrial managers and workers in older industries be persuaded that clean, or at least cleaner production is viable in their

industry, country and enterprise, and then how can they be helped to achieve it? There are also often political problems which prevent, or at least delay, the introduction of such technologies.

For example, in 1991 a bilateral development agency promoted a new process to recycle toxic chromium salts, traditionally used to tan animal hides into high quality leather goods. The process was adapted for one enterprise at a cost of about US\$50,000. It reduced chromium sludge discharges by 99 per cent and produced a return on investment to the enterprise of about 20 per cent per annum after tax. However, other tanning enterprises in that country were reluctant to adopt the new cleaner production technology. It seems that environmental and tax regulations were not rigorously enforced and there were few penalties for toxic discharges; thus enterprise managers were unwilling to risk their limited funds on this new investment. Efforts by the bilateral agency to introduce the proven cleaner production process into similar enterprises in a neighbouring country were rejected because the media had associated the new process with the first country, which was not on good terms with the second country. Strong efforts by the bilateral agency to introduce the proven cleaner production process into a third nearby country were delayed until the agency would finance new local studies to ensure that the process was compatible with the industrial practices of that country. 1/

B. Ecologically sustainable industrial development and clean technology

In 1979, clean technology was defined by the Commission of the European Economic Community as fulfilling three distinct but complementary purposes:

- (a) Less pollution discharged into the natural environment (water, air, and earth);
- (b) Less waste (low waste and non-waste technology);
- (c) Less demand on natural resources (water energy and raw materials).

This definition refers to any technical measures taken to reduce or eliminate at source the production of any nuisance, pollution or waste, and to help save raw materials, and other natural resources. It involves the treatment of pollutants, recycling, retrofitting, energy conservation and installation of equipment that uses air, water or land resources efficiently. In practice, it tends to produce "end-of-pipe" rather than genuine pollution prevention solutions. 2/

In 1991, the new concept of clean technology focuses on optimal products and optimal processes with pollution prevention and resource conservation, and new products that satisfy currently unmet needs. Since technology is a process of constant improvement, the concept of optimal products and processes will be continually redefined. Processes will move towards zero waste/pollution and products will be managed during their whole life cycle from material extraction, manufacturing, use and disposal.

The obstacles to such optimization are at a market level (insufficient incentives), at regulatory level (unenforced standards), at sectoral level (slow growth sectors pollute the most) and at an enterprise level (resistance to change).

C. Cleaner production and the approach of this paper

A more modest objective than ESID is cleaner production, for which industry, together with the agricultural and public-service sectors, can take responsibility. In both developed and developing countries, there is scope for "clean" production as a practical and profitable reality for new, expanding industries; and "cleaner" production as a viable option for older, stable industries. However, the institutional will must be available for governments and financial institutions to create appropriate rewards and penalties for the ESID/CP concept as a better alternative than unrestricted economic industrial development. Cleaner production involves new processes and new products prodded by the internalization of environmental costs as charges in the enterprise.

L. Realities of the competitive industrial world

Business certainly causes extensive pollution in the process of industrial development, but it is sometimes blamed unfairly for environmental pollution and waste of natural resources caused by poverty, population, agriculture, political conflicts or natural disasters. Although some major companies have subcontracted "dirty" production to smaller companies or overseas subsidiaries, there seems to be no limit to the potential for holding business responsible for adverse environmental impact. Responsibility for factory pollution, has expanded to the wider concept of responsibility for raw materials and products.

Thus the competitive industrial world is full of business and environmental uncertainties and determined by hard economic facts. It makes no concession to the industry or enterprises that fail, regardless of their environmental policies. Therefore, despite the ecological rhetoric on environmental issues, industry is more strongly influenced by such factors as cash flow, market share, profit and business survival. Also, most regulated standards for the environment, such as industrial health and safety standards, do not depend upon scientific facts, but more on public beliefs and political or industrial bargaining, very often long-term effects are unknown.

Some countries like Sweden are actually planning for low/zero pollution in selected industries by the year 2000; 3/ and yet, since many energy/mining resources are not renewable, low/zero resource depletion does not seem to be viable. However, as the energy of the sun is for all practical purposes infinite, it is conceivable that future technology could develop new forms of energy and renewable resources, such that these concepts could become viable.

One example of the impossible becoming possible was of a lake in Canada that had been severely polluted by industrial waste. Scientists predicted that rehabilitation in less than a century was unlikely, however, with new technology, the lake became viable again for aquatic life, within 15 years. 4/

E. Special factors in developing countries

In the difficult economic conditions of many developing countries, industry has special problems. The major industrial enterprises in such countries are often nationalized public companies with a record of political rather than economic management, which provide a history of chronic losses. 5/

In some developing countries, both nationalized and private industry often have such worn-out or technologically outdated equipment that they would probably not survive under international competition. With cheap labour, protected markets, little environmental regulation and only limited cash for new investment, short-term survival of the enterprise is more important than dealing with the longer term environmental issues. 6/

Over the last 30 years, many such developing countries have suffered extensive environmental destruction, even from well-meaning industrial development projects, promoted and financed by international agencies, bilateral donors and the international banking community. The objective of such projects has been economic development, for which negative environmental impact has been considered to be an unavoidable side effect. This experience has not contributed to the relationship of mutual trust between developing countries and financial institutions, which is essential for resolving environmental problems. 7/

It is also recognized that prices in international trade with developing countries have been determined without regard to resource maintenance or rehabilitation, resulting in severe loss of bio-diversity and of the natural resource base of some countries.

Environmental pressures and standards are currently much lower in developing countries than in the industrialized world. Transnational corporations have only recently begun to support higher ESID/CP standards wherever they operate. Some developing countries perceive new regulations for cleaner production as disguised trade barriers to protect the market share of Western/Northern industry, to keep third world industry from competing. This perception of mistrust must be recognized when seeking to encourage ESID/CP in developing countries, which do not yet have the necessary institutional capacity or resources, and yet are very alert to possible economic exploitation by industrialized countries.

Case: After many years of pressure from environmentalists, especially in industrialized countries, Brazil, the world's largest developing country debtor (US\$ 122 billion), dropped its long-standing opposition to debt-for-nature swaps in June 1991 and planned to convert up to US\$ 100 million per year. Debt-for-nature swaps had been previously resisted because they had been viewed as a way in which foreign (i.e. Western) environmental groups might acquire too much influence on the policies concerning the rainforest of Brazil, which until recently had encouraged, rather than prevented, rainforest destruction. 1/

F. Underlying assumptions of experienced industrial managers

Industrial experience has convinced many managers that:

- (a) Environment is the responsibility of government, not business;
- (b) Some environmental degradation is inevitable in certain types of industrial development, especially in older industries;
- (c) Business survival is more directly related to cash flow, market share and profit than to business or environmental ethics;

- (d) Environmental protection, like industrial health and safety, is best handled by legislation, regulation and rigorous enforcement, not by appeals to business ethics.

Such attitudes may not survive with the new generation of younger industrial managers of the 1990s for whom ESID may have special value.

III. COSTS AND BENEFITS OF CLEANER PRODUCTION

A. General comments

The ideal industrial system would transform energy and materials into goods, with the highest efficiency in industrial production approaching the limits imposed by the laws of thermodynamics. As much material and energy as possible would be recovered from process wastes and from post-consumer refuse. Such a system would also prevent the release of hazardous substances such as chlorinated hydrocarbons and toxic heavy metals. Although this ideal has yet to be reached, proven technical and managerial approaches can already deliver big gains in the efficiency of industrial production. 8/

Further advances may result from the study of biological systems because many approach this ideal. Whole eco-systems form series of highly efficient closed and interlocking cycles or loops where materials are constantly recycled (e.g. the water cycle, the carbon and nitrogen cycles).

In some new industries, low or zero waste is becoming increasingly viable. In older industries cleaner production may be the only current practical alternative, however, the concept of cleaner production changes rapidly with technological development. Enterprises in the 1990s may achieve levels of cleaner production considered impossible in the 1980s, provided continuing investment is available.

If governments charge full environmental costs to enterprises by means of specific pollution taxes and penalties, and give grants for special cleaner production activities, the costs/grants become "internalized" into enterprise accounting, motivating profitable cleaner production.

Are there limits to cleaner production? Should the enterprise consider its suppliers' and customers' environmental impacts as part of its cleaner production responsibility? Cleaner production is relative, and in many cases, developing countries, even quite advanced ones, may sometimes be prepared to relax their regulations in order to attract major foreign investment. 9/ Do business and government really value cleaner production for itself or for other reasons? A case in point would be the following:

Case: Business - The chief executive of a petroleum corporation introduced in 1987 the SMART (save money and reduce toxics) programme encouraging ideas from every employee to eliminate waste; by 1991 it had reduced hazardous waste by 60 per cent (compared with 1986) and saved about US\$10 million. 10/

B. Costs

Some cleaner production options require little or no new cash investment and are applicable to existing facilities in all enterprises, in both developed and developing countries. They simply involve good production engineering and housekeeping with management and workers taking a new creative interest in resource utilization improvements (reduction of energy, water and materials use); waste stream separation; effective monitoring; pollution prevention; waste recycling and disposal; improved operating routines; and tightening supplier requirements for quality and environmental impacts. Cleaner production can lead to cost savings and a whole range of ideas for improvement in materials, processes, products and pollution, with the know-how adapted to local needs of small- and medium-sized enterprises.

For investment in cleaner production in new facilities, the costs include: costs of cleaner production equipment, possibly higher than that of traditional equipment; all the usual problems in a new technology; lost time in researching availability; installation problems; initial production inefficiencies; unexpected side effects; maintenance and break-down costs; risk that new non-polluting materials may be less effective and more costly; risk that new pollution/resource utilization standards may still not be achieved by the new technology; loss of market share due to production delays; market risk in a possible product change; and risk of market change that could make the new technology irrelevant to new needs.

For investment in cleaner production with older industries, the costs include investment in retrofitting old production facilities for waste reduction and recycling and many of the above problems as well as the possibly serious financial losses from scrapping older plant. For older industry, especially in developing countries with limited cash resources, the higher initial costs of cleaner production may be a poor economic alternative to continuing with the old production system and keeping environmental impacts confidential while avoiding bankruptcy. If other companies' activities survive with "dirty production", pollution prevention may not pay in that case.

Cleaner production can result in a cleaner product which could lead to a market-share advantage, either in local or export markets in which case failure to adopt cleaner production results is an "opportunity loss" i.e. the loss of profits that could have been gained.

C. Benefits

The initial benefit for the enterprise from cleaner production is increased economic return from:

- (a) Saving, - direct saving from energy, resources, time etc.;
- (b) Profits, - direct benefit from improved competitive products and local/export market share, because greener processes/products give an edge to market competitiveness and meet new environmental standards of customers in many countries;
- (c) Saving, - indirect saving from reduced gaseous, liquid and solid wastes, if they can be recycled and sold or result in lower disposal costs; and

- (d) Saving, - indirect saving due to reduction of risk from: avoidance of environmental taxes, legal damage suits and pollution penalties, claims and pressures.

Other benefits include:

1. Management, - improved creative management with "openness" as part of corporate environmental policy, with negative impacts are no longer being "secret" but open to facilitate resolution;
2. Resource utilization, - pressures and standards for using air, water and land resources more efficiently, may lead to new cost reductions not envisaged under old production processes;
3. Integrated pollution control, - whereby one pollutant is not converted to another, can also bring risk reduction and improved community relations;
4. Easier compliance, - with stringent national and international environmental standards which increasingly become decided at regional and global political levels;
5. Production efficiency, - in energy economy and better utilization of materials, waste reduction and recycling;
6. Public image, - the advantage of a public corporate profile as "an environmentally responsible company" which strengthens the enterprise's ability to defend itself against environmental pressures;
7. NGOs, - when the enterprise can relate even to aggressive environmental NGOs then there is a general risk reduction, which can ensure its survival in the future;
8. Environmental audit, - can become a management tool rather than a threat; it can ensure that top management is properly informed on environmental activities, results and potential; this could begin with an environmental management audit and proceed to a full annual external environmental audit from the following year;
9. Employment, - enterprises that are environmentally responsible companies find it easier to attract new younger staff and workers of high calibre, many of whom simply will not work for a "dirty" company; 11/
10. Labour relations, - improve when the company health and safety programme in the workplace begins to include the community where the wives and children of the workers live. This demonstrates a "solidarity of common human values" shared by management and workers;
11. Survival, - informed care for the eco-system provides better corporate control on its own survival in the community, region and country; and
12. Market access, - assured access to existing export markets and customers. Some major companies now do "supplier audits" and refuse to use suppliers that fail to practice cleaner production. Again some countries may preclude import of products that do not meet specified cleaner production standards.

D. Selected examples of enterprise initiatives

1. India: Harihar Polyfibers in India, developed a technology to recycle process waste in the synthetic fibre industry and recover hydrochloric acid and caustic soda for re-use, with significant cost savings. The same company also achieved reduced oil consumption with heat control technology which also improved product quality. 12/

2. UK: Blue Circle Cement - introduced the LINKman expert system which monitors the cement kiln to achieve optimal coal utilization and reduces NOx emissions from 500 ppm to 200 ppm. Investment of US\$400 million for savings of US\$750 million p.a. 13/

3. Brazil: The Companhia Siderurgica Pains steel mill introduced cleaner production with improved rolling mill, water/gas treatment and charcoal handling systems; it was reported that the new systems reduced waste of clean water/air and yet reduced charcoal consumption, to achieve savings of US\$1.5 million per year and avoiding 1000 ha. of trees cut per year. 14/

4. Denmark: Haldor Tospoe developed the SNOX process to recover sulphur and nitrogen oxides from power station flue gases, leading to no waste water, slurries or solids and a marketable by-product of sulphuric acid; it took special care to ensure that the technology actually worked in other enterprises/countries; this enabled successful export marketing of SNOX to Holland, Taiwan, Italy and USA. 15/

5. Tanzania: Rehabilitation of its electrostatic precipitators by the Portland Cement Factory was reported to produce a significant reduction of air pollution and to lead to cost savings of about US\$8,000 per day. 14/

6. UK: ICI has a new cleaner production policy to reduce its waste generation by 50 per cent by 1995 with investment of about US\$300 million per annum which is about 20 per cent of the capital budget. The plan is threatened by the need to improve short-term earnings. 16/

7. Zambia: The Chilanga Cement Co. installed two dust cyclone arresters and filters between its kiln and chimneys which resulted in a cleaner working environment (less dust emitted), higher productivity, less welfare expenses, less corrosion of equipment and net savings of US\$40,000 per year. 16/

8. USA/USSR: The Princeton Moscow Trading Corp. has made an agreement with the City of Moscow to collect and shred used tires in the US, ship them to the Soviet Union and use the recycled rubber in road resurfacing. This process which has already been used in Newark, NJ is a good example of "waste" being turned into a useful "resource" elsewhere. 17/

9. France: Renault and Peugeot, France's two large vehicle manufacturers, have separately teamed up with several specialized recycling companies to recycle metals, plastics, tires, oils, other car fluids, batteries and other components of cars. They started early in 1991 two-year pilot-projects and if successful intend to extend this programme to completely recycle all their turned-in cars by the year 2000. 18/

B. Opportunities for building a special cleaner production capacity

Taking advantage of cleaner production in creating environmentally efficient production processes involves: improved production engineering and housekeeping; substituting toxic production process materials; changing manufacturing processes; recovering materials, water and energy from waste streams for re-use or re-sale to other enterprises; identifying process opportunities with such management tools as: environmental audit, monitoring, worker incentive schemes, and even allocation of full environmental waste treatment/disposal costs to production units, to motivate cost savings.

To take advantage of cleaner production in creating new product opportunities, companies need a new product capability to minimize environmental impacts at each stage of the life cycle, and yet to ensure adequate product quality. This involves: research into new product needs; willingness to replace existing products; new ways for product renewal and repair; new product design for reduced material content and increased recycling potential; new responsibility for product materials, process, use and disposal; and new forms of cooperation with customers, competitors, suppliers, governments and NGOs.

The cost and benefits of cleaner production depend upon the industrial sector, country and enterprise. Cleaner production is usually easier and more profitable for newer expanding industries. Older stable, neglected, "dirty", unprofitable enterprises, which exist in many countries, have harder cleaner production decisions to make if they are to survive increasingly severe environmental regulations.

For small- and medium-sized enterprises in developing countries, it has been found that improved "production engineering housekeeping" can have a significant cleaner production effect without major investment.

In a highly competitive environment, perhaps Annual External Environmental Audits for all major companies is the best way for cleaner production problems and potential solutions, to come to the attention of top management. However, up to 1991, relatively few companies had actually implemented effective overall cleaner production, pollution prevention and waste minimization programmes, let alone strategies for the new concept of "optimal products and processes" for ESID. Thus the current opportunities for cleaner production improvement are almost unlimited, in both developed and developing countries. An example of a total approach would be the following:

Case: Ernst Winter & Sohn developed and adopted an integrated system of environmental business management for the whole organization at every level. Many of the cleaner production opportunities developed in the company, seemed applicable to enterprises in both newer and older, larger and smaller industries. The EEC therefore helped to finance a book to illustrate the system with text and comprehensive practical checklists: "Business and the Environment". 19/

IV. ROLE OF FINANCIAL INSTITUTIONS

A. General comments

Investment in new technology and equipment can generally lead to cleaner production, thus the availability of investment financing can be critical. Commercial banks and financial institutions have taken little interest in cleaner production or the environmental impact of the projects they finance, because they have not been major financial risks. The important negative environmental impact of older environmentally degrading companies may perhaps be linked to their lack of credit-worthiness.

With increasing political environmental pressures, the risk of financial failures due to environmental causes is much higher than ever before. However, until a pollution disaster arises, business (and finance houses) still tend to concentrate on the risks from competitive national and international markets.

Major banks and financial institutions have begun to recognize a need for the "green image" of an environmentally responsible company to attract young staff of high calibre. They are taking more interest in environmental compliance, and in measuring environmental risk. Environmental Impact Assessment is an established regulatory tool for assessing the environmental impacts of new major projects, but it has been often criticized for poor quality and it lacks "follow up" mechanisms for assessing the subsequent environmental and financial risk of the project during operation.

Although annual financial audit of major clients is required, the finance houses wonder if they "dare" ask clients for annual external environmental audit which would alert them to new major financial risks. However future EEC directives on Environmental Impact Assessment may soon make annual external environmental audit as normal as financial audit, and will bring benefits both to lenders and borrowers.

B. Commercial and merchant banks

The usual criteria for commercial bank lending relate to: purpose, personal relationship of trust, profitability and payback. The major risk is business failure, which can be provoked by environmental issues, e.g., "secure" land values can be suddenly diminished by pollution.

Increasing environmental regulation, public and NGO pressures on all parties involved in projects that have negative environmental impacts, has forced banks to begin to consider the "green" aspects of new project financing. Thus the image of the bank makes it reluctant to finance heavily polluting projects without some effort towards cleaner production. A case in point:

Case: In 1989/91 in the EEC, major banks provided financial support for two major geographical projects: one for a car testing area and one for nuclear waste reprocessing; both had completed Environmental Impact Assessments and all the legal steps and obtained official approval. However after considerable investment of funds, they were stopped by political pressures (the NIMBY syndrome: not in my back yard) from environmental protest groups. This resulted in severe financial losses for the companies and increased risk for the banks. 1/

Some banks in the EEC are beginning to recognize the risk and to offer a range of environmental services to their customers including: environmental data banks, advice, training etc., thus reducing risk from environmental factors. 20/

C. National development banks and financing bodies

Government-sponsored development banks and other funding bodies already have employment, social and political objectives in financing industrial development projects. They could finance ESID and CP special projects which cannot meet the criteria for commercial bank lending. Such development banks are beginning to employ professional environmental management staff who are able to give advice on cleaner production projects and influence borrowers to give more thought to these issues.

D. International development banks

Until well into the 1980s, the international development banks (World Bank, African Development Bank, Inter-American Development Bank and Asia Development Bank) gave little attention to the environmental impacts of their activities. They employed mostly economists and accountants with only a handful of environmental specialists; thus economic industrial development was the key lending criteria.

However many projects brought such unexpected severe pollution and uneconomic use of environmental resources that now they seriously screen future investment projects for environmental risk and encourage ESID and CP. They have expanded their professional environmental staff extensively, which indicates a change of real priorities. Newer institutions, such as the London-based European Bank for Reconstruction and Development (see example below) are taking environmental concerns into account from the very beginning.

Case: The World Bank started in November 1990 the Global Environmental Facility with financial commitments of \$1.5 billion over 3 years (representing 2 per cent of total commitments) to spend on programmes which positively affect global environmental quality. This year's programme focuses on bio-diversity. The first working meeting in May 1991 allotted US\$214 million for 15 environmental projects and another US\$59 million for technical support. UNDP plays a key role in identifying potential projects and local NGOs are envisaged to benefit from project financing. 21/

E. Special environmental financial institutions

Several special institutions exist which directly or indirectly finance environmental projects which may not meet the criteria for commercial lending. These include the EEC COMETT programme, which funds a range of industrial research and environmental pilot projects, and the Budapest Regional Environmental Center, which supports the activities of environmental NGOs in Eastern Europe through financial, logistical and technical assistance.

F. Selected financial initiatives

1. Indonesia: The State Minister of Environment and Finance urged bankers to support the governments AMDAL (ESID/CP) policies, because 75 per cent of the funds used to develop industry were provided by the banks. One major bank responded by assigning a senior officer to introduce environmental conditions as part of major bank lending agreements; however they reported that it was difficult to follow compliance, due to lack of environmental law enforcement. 22/

2. International: The World Bank approved US\$340 million financing for Poland to improve the efficiency of bulk-heat supply to domestic and industrial users and exploit natural gas resources instead of coal. The World Bank policy on financing waste management projects in developing countries is shifting away from technological issues towards an evaluation of the policy framework needed for successful resource recovery systems. This clearly recognizes that for cleaner production, management is a far more important problem than technology. The World Bank's 1992 World Economic Report will focus on environmental issues. 21/

3. USA: Bankamerica Corporation is the first U.S. bank to adopt a set of environmental principles in January 1991 including a special effort to find and support enterprises that are seeking cleaner production. The bank created a unit of Environmental Policies and Programmes and established a senior management team to monitor progress. 23/

4. France: Since 1990, the Banque Populaire du Haut-Rhin finances at preferential rates cleaner production projects for SMEs which are previously professionally evaluated by an eco-counselor as to their effects on air, water and solid waste. 24/

5. India: the World Bank's first Asian loan devoted exclusively to environmental protection was made in 1991. The US\$124 million loan and an additional credit of US\$31.6 million will finance a programme designed to reduce chemical pollution from older plants in the dye, fertilizers, pharmaceuticals, pesticides and petrochemical industries. The programme includes strengthening the capacity of monitoring agencies and building waste-treatment facilities in industrial parks for SMEs. 1/

6. International: The European Bank for Reconstruction and Development's first loan to former centrally planned economy country (June 1991) was a US\$50 million loan to the former regional branch of the Polish National Bank in Poznan. This loan will be used by municipalities and enterprises in 10 cities to improve energy efficiency and reduce dependence on high-sulfur coal by replacing coal-fired boilers by gas-fired boilers. 25/

G. Opportunities for building a special cleaner production capacity

The role of financial institutions can go beyond helping environmentally responsible companies into creating the financial environment that promotes cleaner production. They could provide the full range of environmental services (data banks, advice, audit, training seminars), develop a range of environmental educational publications and encourage cleaner production by preferential lending arrangements.

Financial institutions, especially private ones, should be more aggressive in promoting innovations and the capacity of small businesses to expand if their processes are more environmentally benign.

Financial institutions could, in partnership with development agencies, jointly fund ESID and CP projects (50 per cent grant, 50 per cent loan) in developing countries; this would bring the discipline of commercial financing to development projects and it could particularly sponsor the rehabilitation of older industries, or even its restructuring along environmentally friendlier lines, i.e., help it to undergo "eco-restructuring."

In the longer term, they could use "debt-for-nature swaps" to provide national development banks with financial resources to finance ESID/CP projects by buying up discounted debt instruments on the market and returning them to the issuing country to allow local financing of environmental projects.

They could encourage client companies to adopt both a financial audit and a simple annual external environment audit as useful management tools for the management of ESID/CP.

Finally, in their long-term interest, these institutions should encourage environmental management education in universities, technical colleges and business schools by funding and other appropriate assistance.

V. CONSTRAINTS FOR SMALL- AND MEDIUM-SIZED ENTERPRISES

A. General comments

SMEs can be confronted by different problems depending on their location (developed or developing country), their activity (industry, retail, services) their size, (small, medium or artisans), age, legal status, capitalization, management structure (owner-manager, employed manager) and ownership structure (individual or corporate/institutional ownership).

It is often forgotten that in many countries SMEs as a whole carry more economic weight than large companies whether in terms of employment or production. SMEs employ more people and consistently create more new jobs, train more young employees, produce and innovate more. From a historical point of view, SMEs form the economic tissue and in some countries (e.g. Germany) have been the backbone of the economy. Most of today's large companies started out as small-scale ones.

The particular problems of SMEs are often overlooked. This is often because SMEs are not well enough represented in economic fora. Their owners very often manage the enterprise and they cannot absent themselves from their business and have no time to defend their interests at the local, national or international level.

SMEs in developing countries are confronted with all the problems faced by their counterparts elsewhere with the added difficulties inherent to the fact that many of them belong to the informal sector. The high transactions costs associated with the regular economy, often the consequence of large but inefficient bureaucracies and cumbersome procedures, and a lack of training in fundamental business concepts hinder the full integration of SMEs into official markets. This leads to a loss of governmental overview and control. Once again, the problems are ones better solved through education of national and local authorities so that the conditions are created to unleash the creative power of individual initiative through SMEs.

Case. The city of Cairo (10 million inhabitants) after failing to introduce a Western-style garbage collection system because of infrastructure and financial problems, belatedly decided in 1990 to help the traditionally despised Zabbaleen to modernize their operations. The Zabbaleen are Cairo's more than 50,000-strong traditional garbage collectors and recyclers belonging to the informal sector. More than a dozen new Zabbaleen SMEs now operate commercially. 26/ This successful example of the reintegration of people and de facto SMEs previously belonging to the informal sector and of providing a highly efficient and flexible service deserves to be imitated.

SMEs are in many cases family enterprises where the owners wish that their children one day take over the business. Their long-term thinking makes them often more receptive to a business policy which protects the environment for the benefit of future generations. By contrast, professional managers of large companies are tempted to give highest priority to the maximization of short-term profits to ensure the renewal of their contract.

SMEs are also often "one person shows" where the owner manages everything including environmental issues. This explains why in many SMEs, the owners, in spite of great efforts, can do much less for the environment than they would wish. SMEs may know that they pollute "just a little" (or a lot) but because there are so many, they may collectively do severe environmental damage which is tolerated because the community needs employment. Cases have arisen in the EEC where a few small pulp/paper factories created a pollution problem for a whole region; and similarly where one SME waste oil spillage polluted the drinking water supply for a city. So even single SMEs may at times cause as much environmental damage as major industrial enterprises.

Many SMEs are recent enterprises (specializing in high technology) which are dynamic, innovative and competitive in national and export markets. They can react much faster than larger companies to both market and cleaner production opportunities; but their critical constraint is shortage of finance which is often a function of their successful rapid expansion. In fact, it was SMEs such as these which, by their pilot projects, gave the decisive push for the present environmental management movement.

But the vast majority is still dependent on old technology; they have the risk of short-term failure, and thus long-term planning is often irrelevant. They have no great political power to defend themselves from environmental pressures so they prefer to avoid public attention.

Some SME enterprise managers may not even see the cleaner production problem. Even in Germany - where environmental issues have become deeply ingrained - 30 per cent of managers are not familiar with the environmental regulations that they are supposed to comply with. 27/ For them environmental concern leads to costs with no benefits; and thus their strategy is minimal compliance with the legal health, welfare and environmental standards. Managers in these enterprises often feel that cleaner production investment is not economic or viable for their limited operations and that the pollution they create is too small to be of significance.

Strict enforcement of even existing environmental standards could well force many enterprises into bankruptcy; thus non-enforcement is a must to them. Fortunately for them, there is less pressure from the press, and NGOs on such small enterprises.

For their possible cleaner production projects, such enterprises may well have too little access to adequate investment capital, adequate patent rights, protected markets, international sources of information and materials etc. This may well make potential cleaner production investment too difficult and uneconomic for serious consideration.

B. Selected examples of initiatives of small- and medium-sized enterprises

Examples that can be presented to illustrate the success of individual SMEs in both developing countries and in European transitional economies include the following:

1. India: Confrontation with higher energy costs has motivated hundreds of SMEs to use the technology of anaerobic digestion of sugar cane waste, to produce methane for their local energy needs. 28/
2. Botswana: With difficulty in material supply, UNIDO assisted an SME to develop a small-scale labour-intensive plant to produce moulded fibre newsprint from recycled newspaper and agro-waste which had previously caused severe pollution.
3. China: UNIDO, with Belgian support, assisted Xing Guand Plastics Recycling Factory to develop a complete pilot unit for recycling of plastic wastes. The unit will enable it to use 40 per cent recycled raw materials.
4. Zambia: Ndola Lime Works introduced two rotary kilns and technology changes in lime making, which led to improved output and efficiency, lower costs, cleaner working areas, fewer accidents and resulted in savings of US\$52,630. 29/
5. Holland: Sericol introduced a process to use water-based printing ink, comparable with existing solvent-based ink, leading to high speed radio-frequency drying and complete elimination of solvent waste and pollution. 30/
6. Zambia: By installing dust collecting equipment and using treated effluents to wash and soak hides, the Asaria Leather tanning company ended up with a cleaner process, a cleaner work environment, was less harassed by neighbors and saves US\$28,000 a year. 14/
7. Madagascar: Brick manufacturers in Antsokay-Toliaba substituted firewood, previously obtained in the Southern part of Madagascar where forests are sparse and constituted of rare species, by mineral coal. The new method of spread-out combustible charge saves US\$78,000 per year and preserves South Madagascar's environment. 14/
8. India: A textile mill in Bombay increased the collection rate of the caustic soda from its mercerizing wash waters from 75 per cent to 85 per cent and the recovery rate from 81 per cent to 90 per cent by more efficient washing, better filtration, correcting leakage and seepage and other corrective measures. Net savings of 415 kg of caustic soda per day led to expected savings of 684,750 Rupees/year. 12/

C. Opportunities for building a special cleaner production capacity

Low cost cleaner production with good production engineering and housekeeping is viable for most of these enterprises. For SMEs in developing countries, whose critical concern is often short-term survival, and which have little need to comply with environmental regulations, the motivation for cleaner production may be more difficult to stimulate.

With new industry and technology and international market competitiveness, cleaner production can offer advantage to some aggressive small- and medium-sized enterprises, which might well create "role models of cleaner production" for others to follow. Pilot projects for cleaner production could be set up in different industries to motivate other SMEs. They will only be credible if they are successful and followed by profitable companies well-known and respected in the industry.

Since the key problem in cleaner production is management rather than technology, development agencies need better knowledge of SME problems and more direct relations with SMEs. They need a deeper understanding of SME problems in different regions and industries, because there are no universal cleaner production solutions.

VI. ROLE OF TRANSNATIONAL CORPORATIONS

A. General comments

Transnational corporations (TNCs) can and do make a major contribution to cleaner production. Being considered as environmentally responsible companies is vital for the continued success of such major enterprises, as they are under public scrutiny by the media and NGOs. However, they have the financial resources, and often the political power to defend themselves and, most importantly, to gain time in meeting new environmental standards.

Many TNCs have formally accepted the various environmental guidelines developed by EC, UNCTC, OECD, ICC and the CMA's CARE programme. They also are pioneers in integrating environmental concerns in quality assurance systems, i.e., in a Total Quality Management system. However they still resist annual external environmental audit which would professionally certify their compliance. In industrialized countries trade unions are slowly becoming environmental pressure groups to force TNCs into annual external environmental audit. 30/

Most TNCs have current data on their environmental impacts through sophisticated internal Environmental Management Audits, but with some exceptions they usually keep the results very confidential. 31/ However they receive the continued attention of the international news media and NGOs, and they are motivated over time towards cleaner production if only to reduce these pressures.

In the past some corporations, prodded by the NIMBY (not in my back yard) phenomenon, helped to export "dirty" technology to developing countries where it could still be used without constraints. 4/ Furthermore, in the past, some major enterprises sub-contracted "unacceptable" processes and products, to overseas SMEs which escape public attention and criticism. This is becoming increasingly less acceptable to the public which is demanding that international TNCs apply, as a minimum, environmental standards set up in their home countries, wherever they operate.

B. Selected transnational initiatives

1. Union Carbide - after the Bhopal disaster the corporation became a model environmentally responsible company with comprehensive environmental policies, high-level management responsibility, increased environmental staff and resources, audits etc. 1/

2. Monsanto established in 1988, a goal to reduce toxic air emissions by 90 per cent by 1993 and has stated its goal for itself, its contractors and suppliers and shippers as "Zero spills. Zero releases. Zero incidents. Zero excuses!!" 32/

3. ICI, Union Carbide, Kodak and DuPont - are among many firms that now tie a portion of their managers' compensation to their environmental performance. Dupont - has a policy to retrain every year every employee (including the Chairman) on cleaner production issues. 1/

4. Aracruz Cellulose - Brazil's largest paper and pulp producer applies the high Swedish standards. 1/

5. Ford - requires all local suppliers in developing countries to improve both industrial product quality and processes. Through its procurement policies, it is a major influence for cleaner production on its suppliers. 1/

6. Reynolds Metal - pioneered aluminum recycling by buying beverage cans and other products from consumers. By 1991, it had recycled four billion pounds of aluminum. 33/

7. ICI - has increased up to seven times the internal charges for dumping chemical wastes from its biggest manufacturing site, to put pressure on managers to reduce waste from production operations. 31/

8. Procter & Gamble - sub-contracts its waste disposal but audits each contractor annually to ensure that no negative environmental impacts reflect badly on its image; the "opportunity" cost of such impacts is relevant. 1/

9. Waste Management Inc. - has formed cooperative recycling ventures with Du Pont, (plastics), American National Can (metal), Stone Container (paper containers), Smurfit Paper (newsprint) to combine talents, reduce risks and link supply and demand in the recycling area. 34/

10. Del Monte's pineapple plant in the Philippines sells its pineapple waste for use as cattle feed for US\$50,000 a year, thereby also avoiding more than US\$55,000 a year in hauling costs for a total benefit of more than US\$ 105,000 per year. 14/

11. Otto Versand, one of the world's largest mail-order companies, had its German catalog products and operations in Hamburg environmentally checked by the consumer/environmental organisation AUGE and banned many products which did not meet its standards. 35/

12. Norsk Hydro UK, the British affiliate of Norway's largest chemical, oil, fertilizer and light metals group, audited all its operations in 1990 for environmental performance and had its internal assessment externally audited by Lloyds Register and published. The corporate parent includes a comprehensive environmental report in its annual report as now do most large chemical companies. 36/

13. Bayer AG, one of the three German chemical conglomerates, is doing research on biological pest control and genetically engineered plants more resistant to diseases etc. to reduce its dependence on its herbicide and pesticides product line and anticipate growing demand for less harmful plant protection products. 1/

C. Opportunities for building a special cleaner production capacity

The International Chamber of Commerce (ICC) in Paris formulated the "Business Charter for Sustainable Development" which supports the goals of cleaner production and ESID with a strong emphasis on management commitment. Prepared in cooperation with the German Environmental Management Association (BAUM) and the Global Environmental Management Initiative (GEMI), the Charter was officially launched at the Second World Industry Conference on Environmental Management (WICEM II) in 1991. It has been adopted by many transnational corporations as the standard code of behaviour for transnational environmental policies and operations throughout the world.

It has also been endorsed by many international organisations (including UNIDO and UNEP) and signed by hundreds of companies and industrial associations throughout the world. Further commitment to and, above all, implementation of the Business Charter worldwide will show how serious industry is about cleaner production.

The Business Council for Sustainable Development set up to advise the UNCED Secretariat on business issues - with the support of 50 international business leaders - is conducting research on many aspects of sustainable development, including "optimal processes and products" for transnationals as role models for ESID.

Now that transnational corporations set global environmental policies and standards for themselves, they should stimulate promotion and transfer of ecologically sound practices and production to their industry and suppliers in developing countries and help educate SMEs in the intricacies of total quality management. They have the cash resources, standards, management experience and the R&D capacity to do so. They also wield immense political influence in certain developing countries which could be used to promote, rather than hinder, fair legislation and regulatory enforcement for cleaner production and ESID.

To prevent a backlash from indigenous industry which might condemn what it perceives as attempts to impose standards only TNCs can reach, TNCs should make gestures of goodwill by offering to share non-competitive expertise (e.g., on total quality management systems) and contribute to "openness" on environmental issues by requiring their international subsidiaries to make public the summary reports on their internal Environmental Management Audits.

The motivations are usually to provide for long-term survival and security, deter increased government regulation, take advantage of environmental "tax-breaks", reduce the risk of massive legal damage claims on

the holding company for damage done by subsidiaries (such as was the case after the Bhopal accident); and to demonstrate that good long-term business implies environmentalist business management with cleaner production.

The interest of transnationals in cleaner production has not come about by simple benevolent concern; it has been profoundly influenced by the major malpractice and disasters in recent years which have resulted in claims against them for millions and sometimes billions of dollars. Perhaps this experience will provide strong economic motives to ensure that the public demands for ESID and cleaner production will be realized.

TNCs can use their powerful economic and political resources to seek in the longer-term environmentally optimal products and processes while in the shorter-term, promote new attitudes towards ESID and cleaner production in the difficult economic conditions of many developing countries.

Vii. NEED FOR HUMAN RESOURCE DEVELOPMENT

A. General comments

UN experience has shown that training is the critical success factor in every technology transfer project. For managers and workers at every level, this training involves not merely new knowledge, but new practical skills and perhaps new attitudes.

In introducing new standards for health and safety of workers, WHO/ILO experience has shown that it may take generations of industrial managers to overcome a tradition of minimal concern. Similarly, in introducing new standards of cleaner production, many experienced industrial managers may well be reluctant to make changes in proven technology and proven organization, to introduce cleaner production.

Thus, there is a need for specific human resource development within each enterprise when introducing cleaner production into an industry or target group. However the precise training needs may be different for each country, industry and enterprise. This is especially significant in developing countries, where there may be no environmental training in schools, technical colleges and universities.

Even recently, major business schools did not cover environmental issues in their programmes; they regarded them as a low priority, compared with finance, marketing, organization, management information systems, technology management etc. Even courses in the management of technology included little data on cleaner production.

Company training should include ESID and CP concepts, not only as special courses, but as part of the established management development programmes as all functions have an impact on the management of cleaner production.

Some training for industrial managers in environmental management audit and annual external environmental audit would contribute to cleaner production, as well as to the efficiency and effectiveness of such audits, which are becoming critical management tools. Managers could receive special experience as members of an audit team of another unit or company; it would stimulate new ideas for cleaner production and perhaps also contribute to "openness" rather than secrecy about environmental problems.

Industrial associations can perhaps coordinate resources for development of training materials and packages for use by their members and also, where appropriate, for developing countries.

B. Selected examples of human resource initiatives

The following are examples of successful initiatives in the human resources area:

1. Packages - ILO/UNEP developed an environmental management and cleaner production series of five-volumes for developing countries. A supporting text book will be available in 1991. 37/
2. Project Copernicus - has been set up by the Conference of European Rectors, to introduce environmental training into 400 schools, universities and technical training colleges throughout the EEC. 38/
3. BAUM - In Germany, BAUM (the German Environmental Management Association, member of INEM, the International Network for Environmental Management) approaches human resources development for cleaner production by involving workers, supervisors and managers in the training process for environmental concern. Its philosophy is to make the company "environmentally intelligent" by involving the Human Resources department and the Worker's Council in the realization of the company's environmental strategies. 39/
4. UN - Industry cooperates with UNIDO, UNEP/IEO, ILO and other UN bodies for training programmes for CP and ESID in many developing countries.
5. Eco-Conseil - Industrial companies and local authorities in France are supporting the training institute Eco-Conseil in Strasbourg which trains environmental advisers mainly for municipal authorities. The demand for these environmental counsellors outstrips the supply. 1/
6. Business Schools - The European Business School at Schloss Reichartshausen (Rheingau, Germany) set up, in 1987, a chair for environmental management. In 1990/91, two other major international business schools (International Institute for Management Development in Switzerland and the European Institute of Business Administration in France) set up chairs for environmental management, financed by major corporations which have a special interest in ESID and CP. Thus environment will (slowly) begin to be a part of all future MBA and executive programmes. 1/
7. Materials - Shell International makes its environmental training materials available to any enterprise seeking training assistance. 1/
8. Students - AIESEC, the world's largest student organisation - including 40,000 business students in 170 countries - devotes, since 1989, many of its conferences and publications to the interplay of environmental issues and their impact on business practices. 1/

C. Opportunities for building a special cleaner production capacity

In developing countries all industrial development projects financed by banks or development agencies need a component for cleaner production training. Such training for managers and workers can often be done with local institutes, business schools etc. to stimulate a value system for practical cleaner production in the country. To ensure that the values of managers, their families, acquaintances and society in general reflect the tenets of ESID, it is important to find creative ways to foster the underlying principles of sustainable development, for example by using locally popular mass media.

Training initiatives in cleaner production are only just beginning to grow in volume and popularity. Some companies are reluctant to share new training materials on cleaner production with other companies because of confidentiality and high investment cost. Yet, most companies share CP/ESID materials freely as a service to their industry.

Much management training is often rather ineffective in inducing change. After the course, there is no research on practical "outcomes". In addition to the normal criteria used to evaluate, there should be - three, six or 12 months after the training ended - feedback whether it actually made a difference in operations.

Many organizations are producing cleaner production training materials including: UNIDO, ILO, UNEP/IEO, ICC, BAUM, US EPA etc. which are available for use in developed and developing countries. How efficient ("doing things right") and how effective ("doing the right things") current training activities and materials are - especially in developing countries - remains to be researched.

VIII. RELATIONSHIPS OF INDUSTRY WITH GOVERNMENT AND PUBLIC INSTITUTIONS

A. General comments

Industry and government have a common objective in seeking industrial development for economic growth and employment for labour. However, industry and government often have conflicts on the standards and timing of regulations for environmental protection.

In countries where large sectors of industry are run by nationalized public companies, government policies for ESID/CP are often not supported by private industry. This is because for decades such public enterprises may have been managed with other objectives than for industrial efficiency or return on investment alone. This is often the case in Africa and was also true of centrally planned economies. 5/ Thus government policies for ESID/CP will only be taken seriously by private industry when governments can actually demonstrate cleaner production in their own public companies, railways, post office, military and other public services.

The government-industry relationship expressed through employers' organizations, industrial associations, and chambers of commerce has, since 1989, become receptive to the concept of more demanding cleaner production i.e. waste prevention, especially for new industries where new investment is concerned. However with old industries, the government is more tolerant of negative environmental impacts and encourages less demanding cleaner production i.e. waste recycling and pollution reduction to "acceptable levels".

With increasing political pressures for environmental concern in the European Community, industry concentrates on providing advice on legislation and time horizons that are "realistic" and yet allow to move towards the standards of EEC directives.

Negotiations on a particular pollutant material sometimes (but not always) seem to follow a curious life cycle: environmental impact, industrial denial, further research, industrial agreement on the danger but no acceptance because of inability to change, lack of viable substitutes, danger of destruction of the industry, loss of employment. This is followed by further research and international evidence that alternatives are viable, finally by industrial acceptance of a distant time horizon, followed by some industry members rapidly developing, using and marketing alternative materials, and last by general industry acceptance and compliance. The critical skill of the businessman is to survive - by continually adapting to those pressures.

B. Selected examples of government and public institution initiatives

As the following examples illustrate, the industry-government nexus in the promotion of ESID is both complex and multi-faceted:

1. The India National Steel Company adopted ESID/CP policies for all of its plants and plans to become a "role model" for ESID/CP, meeting international standards. Thus the Government is demonstrating ESID/CP to show that its policies should be taken seriously. 1/
2. Government and Industry cooperate in the UK, to provide a whole range of training publications, videos, data banks, newsletters and information services on various aspects of ESID/CP for use by enterprises. 40/
3. The EEC created in early 1989 the Network for Environmental Technology Transfer (NETT) which centralizes legal and technical environmental information in a database. NETT now offers a wider range of services including personalized help, conference organization etc. 41/
4. Government and Industry in the EEC cooperate in negotiating reduction of volatile organic compounds which affect the oil, car, manufacturing, printing and metal product sectors, and in present and future eco-labeling systems studies that deal with the problems of setting criteria for eco-label awards. 42/
5. The ILO worked in Indonesia to help APINDO (the Employers' Association) provide an environmental information service with training and audit capacity and maybe create a BAUM-type association. The project is currently deferred while awaiting further funding. 22/

6. The Spanish Postal Service has opened its network of over 13,000 branches for the collection of small (non-automotive) consumer batteries. These will then be recycled by private companies to recover the cadmium and mercury. 17/

C. Opportunities for building a special cleaner production capacity

Government can demonstrate ESID/CP in the nationalised public industries and public services, to provide the "role model" to motivate private industry to follow and make ESID/CP an accepted part of its strategic planning. Similarly, Government failure to set an example de-motivates private industry.

As Government cooperates with industry, for the design of "Polluter Pays Principle" legislation for taxation and provides grants for ESID/CP, this will effect a net transfer of funds from polluting to non-polluting enterprises and thus make ESID/CP investment economically more viable for the enterprise.

Some governments are moving towards annual external environmental audits with published results, as a useful tool for both government and industry to motivate ESID/CP.

To encourage enterprises to use annual external environmental audits, it is important that public reporting of the auditing should follow the procedures of financial audit reporting, i.e. a professional certificate that standards are met "in all material respects" but not a massive disclosure of confidential production, cost and profit data.

IX. ROLE OF NATIONAL INDUSTRIAL FEDERATIONS, CHAMBERS OF COMMERCE, TRADE UNIONS AND NGOs

A. General comments

The role of these organizations is critical as a channel of industry cooperation with the government on creating the "industrial motivators" for ESID/CP. Such organizations which are often defensive on environmental issues, can slowly be influenced by the volume of new research and data on ESID/CP which is demonstrating its feasibility and viability throughout the world. This has encouraged some industrial associations to set up data banks on ESID/CP potential for the use of members.

In some countries, trade unions have a strong motivational and creative role to play in cleaner production. Just as their influence in health and safety has contributed to a revolution in the workplace, so they have begun to recognize the role of the environment for health and safety in the community, and begin to encourage ESID/CP. It needs to be pointed out that ESID will probably be a net creator of jobs as many ESID goals may require techniques (such as disassembling for reuse) which are more labour intensive than capital intensive.

Case: The Paper and Forestry Workers' Federation (Québec, Canada) welcomed the recent decision by the Québec government to replace previous chemical-intensive deforestation methods (spraying by plane requires little personnel) by mechanical methods which would create many new jobs (chain saw operators) and be less damaging to the forest as a whole. 14/

Many trade unions recognize the need to inform the work force about the longer-term values of ESID/CP. However, in many developing countries, the unions are increasingly marginalised, so that ESID and CP are often low priorities. Trade unions are slowly beginning to recognize the "third man concept" i.e., negotiations for wages involve management, labour and environment. The costs of the "third man" (environment) require some sacrifices by the other two parties for the common good. This is the cost of enterprise survival and continuity of worker employment.

Environmental NGOs have a usefully provocative role to play in ESID/CP. Some NGOs currently have professional environmental staff and a high technical research capacity, which can challenge industrial scientific data; perhaps this is another justification for annual external environmental audit whereby an NGO can be member of the audit team.

Chambers of Commerce are often the closest to SMEs and local industry; thus they can be active in CP and ESID training programmes in ways that have specific local significance and impact. Chambers of Commerce in Germany (over 70 per cent have environmental programmes e.g., in Nürnberg, Hamburg etc.), Holland (Gelderland) and France (Avignon and Colmar) are pioneers in this area.

Numerous other organizations are active in promoting various aspects of ESID/CP including: INEM, ICC, ISO, BCSD, British Quality Association etc. The UN system (UNEP, UNIDO, UNESCO, ILO, WHO/IPCS) is very active, directly or indirectly, in ESID/CP with projects, newsletters, publications, industrial working groups, training programmes, congresses, data banks etc.

B. Selected examples of initiatives of these organizations

1. The Canadian Chemical Manufacturers' Association started its "Responsible Care Programme" for its members and large chemical associations worldwide (USA, Europe, Japan) have since adopted versions of Responsible Care. The programme sets out an environmentally responsible code of required conduct, with supporting information, training activities and reporting requirements. 43/
2. ILO devoted its entire 1990 Annual Report to environmental issues, with clear support for ESID/CP. 22/
3. An NGO in Ecuador reported on new heavy pollution impacts by industrial companies with their own TV camera news team. The report appeared that same night on national TV and was a strong motivator for remedial action and policies of ESID/CP. 44/
4. Industrial enterprises are beginning to collaborate with Greenpeace to resolve their pollution problems; Greenpeace has its own professional technical capacity and is thus fully qualified to help. 45/
5. In the United Kingdom, the Institute of Waste Management in cooperation with the Department of Trade and Industry, has developed "quality standards" for waste transport, disposal and dump management which are being slowly adopted by members of the industry. 46/

6. The International Chamber of Commerce developed Environmental Guidelines for World Industry and recently completed them with more specific Guidelines for Solid Wastes as well as Environmental Auditing. They recommend that the Guidelines for Environmental Auditing be used as an internal management tool, leaving to individual companies the choice of publicizing results or not. 47/

7. The UK Chemical Industries Association (CIA) encouraged its members to take a more open and consistent view to disclosure of information to Friends of the Earth. Dow and Monsanto are for full disclosure, but ICI, Shell, Du Pont and Albright Wilson are undecided. 48/

8. The Association of European Automobile Constructors is proposing a European network of licensed car centers, to improve existing arrangements for vehicle dismantling and recycling. 31/

9. Some Chambers of Commerce have introduced a simple system for annual external environmental audit which awards each enterprise positively rated with an environmentally responsible company certificate, and can give local community recognition for enterprise ESID/CP achievements. This is designed to encourage local SMEs to conform to local standards of measured progress towards ESID/CP.

10. The Canadian federal and provincial Round Tables for the Environment and the Economy bring together representatives of industry, government and NGOs to find common solutions to environmental problems. They then make recommendations to government at a regional and national level. 49/

11. The Industry Consortium for Ozone Layer Protection is a group of leading US, European and Japanese corporations dedicated to spreading cleaner production methods, mainly CFC-free processes, within the electronics and other industries. 50/

12. The International Standard Organisation (ISO) in Geneva to which more than 90 countries belong, has recently approved the establishment of the Strategic Advisory Group on the Environment which will deal with issues of environmental auditing, eco-labelling systems etc. Among its first priorities will be the international standardization of environmental symbols and terms (i.e. recyclable/recycled/biodegradable and corresponding graphic symbols etc.). 14/

C. Opportunities for building a special cleaner production capacity

ESID/CP requires cooperation and the sharing of data locally, nationally and internationally which can best be done by national and international trade/industry associations in workshops, congresses, newsletters, projects, publications, training packages etc.

Such organizations can have a profound effect on managers of industrial enterprises by creating a standard of "environmental business management" from workers to top management in each enterprise, by resolving practical problems with regular working groups and by producing credible role models for other enterprises.

Chambers of Commerce can encourage cleaner production for the benefit of their own communities with localized activities and ever with local annual external environmental audit systems which recognize and encourage enterprises that meet local environmental standards.

In 1991 the German Environmental Management Association (BAUM), which has been working since 1985 at a grass roots level with all size companies, helped to form a federation of similar organizations in other countries called INEM - the International Network for Environmental Management - which has member and partner organisations in: Germany, Austria, Sweden, the United Kingdom, Denmark, South Africa, Israel, Switzerland and the United States of America and is planning for members in France, Brazil, Hong Kong, Japan and other countries.

INEM plans to concentrate on environmental management with a range of international cooperative activities including: seminars, workshops, research and education, congresses, publications etc. and a global network of member associations. INEM seeks to reconcile business and environmental objectives by encouraging enterprises to deal with environmental problems in an acceptable order: first, compliance with the law; then changes which are profitable to the enterprise; then changes for which the cost/benefit to the enterprise is neutral, and finally changes that require new cost or investment.

X. INDUSTRIAL EXPERIENCE OF R&D, MANAGEMENT AND TRAINING METHODS

A. Research and development hardware: technology

As stated in the beginning of this paper, sustainable development for industry must reflect sustainable development in nature: a highly efficient closed loop in which each element of the loop passes on its end-products to the next link. Our present practices reflect a linear mentality which assumes nature is a bottomless well of resources and a bottomless pit for our end-products. R&D must focus on the complete process from design to eventual recycling or reuse of the constituent materials (e.g., design for disassembly to cars, appliances etc., that is design them so that they can be easily reprocessed at the end of their useful first life).

ESID means using more "circular" processes and technologies, ideally using materials which fulfill their functions inherently with minimum external input of energy and information. The following case gives an example of a material which fulfills its functions by virtue of its inherent molecular properties:

Case: CloudGel - this normally transparent substance which can be incorporated in windows becomes cloudy when the sun hits it directly and heats it beyond a certain point, decreasing the amount of heat coming in and thus reducing cooling costs.

Such efficient automatic feedback systems are the hallmark of the future materials and technologies which will make ESID attainable. These requirements clearly set out the target for ESID/CP Research and Development. Various companies have put ESID/CP into their R&D priorities, to try to identify "unacceptable materials, products and processes" because they recognize the need to start now, to research for alternatives which may take several years to develop.

The problem with many R&D programmes is a focus on current technology, rather than the "optimal processes" and "optimal products" required by ESID/CP. Similarly such R&D may often seek to merely comply with existing legal standards, rather than anticipating more stringent future environmental standards.

Many technological developments presently considered "impossible" may be confidently expected. Bio-technology, genetic engineering, material technology and advances in computer and communication systems (to diminish the highly adverse environmental effects of mass travel and great concentration of people in one work or leisure place) may well provide unexpected benefits for ESID/CP in the future.

Industrial R&D has already developed a wide range of synthetic chemicals and it is here that biotechnology has much to offer as specially manipulated organisms can be tailor-made with the required capacity to tackle novel forms of environmental contaminants. Bacterial recycling of pollution and waste is just beginning and will require cooperative collection and management of waste disposal. Special controls on bio-technology and genetic-engineering may help to prevent severe environmental accidents, due to unforeseen outcomes. As usual, the management problems will continue to be more difficult to resolve than technical problems.

As computer-aided design, computer-aided and integrated manufacturing, robotics, and other manifestations of the micro-electronic revolution continue to enter the factory, we can expect simultaneous improvements in industrial productivity, product quality and flexibility and environmental performance.

B. Selected examples of R&D hardware initiatives

1. Bio-technology - A bacterial strain digests cellulose and phenol-formaldehyde components of scrapped East German Trabant cars without producing the dioxins of incineration. 51/
2. Cooling/food conservation - A French SME has developed a series of processes and mobile devices enabling inexpensive high quality conservation of plants and foodstuffs for long periods; including recently a relatively inexpensive CFC-free cooling system scalable from car air-conditioning units to large cargo ship size, already in use in the refrigerated trucks of the largest French retailing group. 14/
3. Leather technology - UNIDO projects in the tanning industry of various developing countries (Indonesia, Kenya, Costa Rica, Viet Nam etc.) all include special assistance to leather R&D establishments for the development and testing of new cleaner production applications, to achieve both economic and ecological benefits.
4. Pulp/paper technology - With UNIDO assistance, Turkey is establishing a large-scale desilication plant at the Afyon pulp and paper mill. In collaboration with the Central Pulp and Paper Research Institute of India, joint semi-pilot scale trials have achieved an 80 per cent reduction in the silica content of black liquor, which can now be recycled and cause less pollution. This cooperative project should achieve both economic and environmental benefits; and furthermore it should demonstrate the efficiency and effectiveness of cleaner production cooperation between developing countries.
5. Bio-technology - India has a major biotechnology research programme for industry covering: anaerobic and aerobic treatment systems, degradation of aromatic and aliphatic hydrocarbons, bioconversion of solid organic wastes, microbial degradation of chemical pollutants. 52/

6. Motor technology - Chrysler and GM are doing research on electric cars to cut greenhouse gas and air pollution emissions, while Honda is researching lighter cars and Mercedes-Benz hydrogen powered vehicles. Meanwhile Volvo is developing a superior vehicle based upon flexible fuel, environmentally less-harmful refrigerants, three-way catalytic converters and plastic parts designed for recycling. 1/

7. Coal technology - New "clean-coal" technology has led to UNIDO pilot/demonstration plants in several countries including Poland and China (liquification of high sulfur coals), Korea and India (fluid bed combustion and gasification of high ash coals) and Bulgaria (pulverized fuel combustion of low rank ignite).

8. Bio-technology - The copper industry has used the same basic methods of ore smelting for six millenia with extensive pollution. During the 1980s, bio-technology was introduced in the form of "Thiobacillus ferrodoxins" which now accounts for 30 per cent of US copper production and is credited with saving the industry. 8/

9. New materials - Ceramic motors can withstand higher temperatures than metallic motors and therefore reduce the proportion of unburnt fuel in exhaust gases thereby reducing air pollution. 53/

C. R&D software: management and training methods

Similarly, various companies doing R&D by experimenting with new management and training systems, which seek to create organizational environments for ESID/CP developments, arise spontaneously at all levels.

Business schools and NGOs are beginning to research ESID/CP and publish appropriate material; they are trying to produce professional (Harvard Business School type) case studies but find companies still reluctant to release environmental data which is professionally researched rather than "success stories" for public relations. Few companies are willing to release hard data on environmental problems, because it may be misinterpreted or used in damage claims against them.

According to inventors, some of the main barriers to innovation, hindering the rapid introduction of ideas and inventions in the field of environmental protection, include established companies' cartel-like protection of markets against environmental innovations, as well as a multitude of restrictive standardisation, safety and administrative measures which have not kept up with technical developments. 19/

Research is needed into the reality of environmental management audit and annual external environmental audit of industrial enterprises. Will it be a public relation exercise or a continuing tool for motivating creative management? Perhaps when annual external environmental audits become as accepted as professional financial audits, they will be one of the major motivators for ESID/CP in many enterprises.

D. Selected research and development software initiatives

1. Bio-technology - UNIDO projects now include expert missions to Algeria, Indonesia, Mexico and Venezuela to advise on the application of bio-technology for environmental oil clean-up.
2. Cleaner production databases - Several cleaner production databases have been created recently. ICPIC, the International Cleaner Production Information Clearinghouse is a joint venture between the US EPA and by UNEP/IEO. It has two nodes (Paris and Washington, DC), is free of all charges and contains more than 400 case studies of cleaner production. 53/ The Deutsche Bank has a slightly different database which contains the name and contact information for companies specialized in solving particular cleaner production and environmental problems (e.g., bacterial decontamination). 54/
3. Genetic engineering control - UNIDO in collaboration with UNEP/WHO/FAO is formulating a draft Code of Conduct for the release of genetically modified organisms into the environment, for industrial and other applications; this will be presented to the UNCED Conference.
4. Paper Technology - UNIDO is working with Asian countries in a cooperative regional programme to set up a relationship between six pulp and paper research institutes for joint research projects, technology transfer, and a network for ongoing exchange of information and staff.
5. Waste management technology - UNIDO is planning a new project in Kenya to study the required infrastructure and management needs for local production of environmentally oriented industrial products including equipment for air/water treatment equipment, refuse collection, waste recycling and pollution control.
6. Management - The Federal German Government has asked six research organisations to research the state of ESID/CP in 600 industrial enterprises representative of the German economy. Preliminary results were published in 1990 and the study, the largest and most comprehensive of its kind to date, is expected to continue in the future. 55/
7. Oil Industry Technology - In Thailand, UNIDO is studying the potential for collaboration with oil industry transnational companies, to establish an oil waste recovery facility/system which would recover the waste and produce significant economic and environmental benefits.
8. Management - Price Waterhouse/AGL are researching environmental auditing practices to develop training packages for managers and environmental auditors. The packages will relate environmental auditing to the professional auditing skills already applied to financial audits, management audits, energy audits and social audits etc. 1/
9. Information - UNEP/IEO's quarterly newsletter "Clean Production" provides a summary of ESID/CP development and training activities in developed and developing countries. 28/

E. Opportunities to building a special ecologically sustainable industrial development and cleaner production capacity

Research and development can reach out towards the new concept of clean technology with "optimal products" and "optimal processes" with pollution prevention and resource conservation, and with new products that satisfy currently unmet needs. Processes will move towards "zero waste/pollution" and products will be managed in their life cycle from material extraction, manufacturing, use and disposal.

Research and development from the new biological, material and computer technologies will probably achieve presently "impossible" objectives. However the main difficulty with ESID/CP will not be technology "hardware" but the management "software". If management acts honestly to empower their employees and unleash their creativity, technology and processes will follow. Management problems may lie in the lack of political will or institutional capacity, or the unwillingness to devote adequate financial resources to environmental objectives, or in the conflicts within Industry/Government and associated institutions. Thus R&D on management and the means to obtain top executive commitment for ESID/CP is a key priority, especially in developing countries.

Authorities should promote institutions providing free and unbureaucratic advice to inventors of CP/ESID materials or processes. Forums should also be created where innovators have a chance to present their ideas and discuss them with representatives of public authorities, chambers of trade, industrialists and the press. Finally, environmental R&D should be fiscally encouraged.

TNCs should not hinder SMEs' efforts to introduce new environmentally beneficial processes even if their own immobilized capital prevents them from doing the same. Better to cooperate with the SME in introducing the new technology on a larger (global) scale and gradually write off the outdated equipment.

In a nutshell, new management systems and training methods are the critical challenge if ESID/CP is to become the "normal" rather than the "exceptional" course of action in the industrial development of the future.

XI. CONCLUSIONS

1. The key problems of ESID and CP are probably not technical, but more political, economic and social. This may well be due to the conflicts, divisions, diversity and disparity within industry and government and associated institutions, which prevent them from reaching a consensus on what to do.
2. CP, which seeks "low/zero-waste" and "low/zero-pollution", can become viable and even "optimal" for new industries and products of the future. Old industry must be content with relatively cleaner production until it becomes technologically obsolete. Thus cleaner production is harder and will need special support to motivate action. This is particularly acute in the case of developing countries.
3. Cleaner production needs "performance standards" which provide flexibility and motivate innovation; it does not need "technology standards" which lock attitudes into the current technology.

4. Cleaner production in industry is mainly motivated by business objectives for market advantage, profit and risk reduction; thus environmental benefits are a by-product not a key objective. The best motivators for an enterprise to be open to cleaner production are that full environmental costs have been internalized, and that competitors are doing cleaner production profitably, thereby offering acceptable "role models" for action.
5. Government can create the rules for ESID and CP through environmental standards, enforcement, taxes and grants, whereby pollution control and resource economy become relevant costs and benefits of the enterprise and therefore motivators for cleaner production.
6. Cooperative effort between enterprises, transnationals, governments and trade associations can set up associations and role models for environment-conscious business management in each country.
7. Cooperative effort between industrial and trade union organizations and government can develop the positive environmental legislation that motivates cleaner production development as part of an integrated system of environment-conscious business management.
8. Special R&D aid to industry in both developed and developing countries can make cleaner production technology transfer viable and self-sustaining, provided it is associated with new technology and development of human resources with appropriate annual external environmental audit.
9. Much work must be done to establish a relationship of mutual trust between developed and developing countries when discussing ESID and CP. It must be demonstrated to the developing countries that international cooperation in cleaner production must be an inseparable component of any programme to attain sustainable, socio-economic development.
10. There is a generation gap on the practical value of ESID and CP between the older and younger industrial managers; in some countries developing the new younger managers may be easier than trying too hard to change the older ones.

XII. RECOMMENDED ACTION FOR UNIDO

1. Introduce ESID/CP into all current and future UNIDO projects with special training components/materials, which can be adapted for needs of each country, industry and enterprise. Train all UNIDO staff in the concepts of sustainable development, ESID and CP, and on how to translate these ideas into technical cooperation.
2. Set up a "UNIDO Low-Cost CP Programme" with research, manuals, publications, conferences, training packages and UNIDO certificates for enterprises that comply. Demonstrate that with simple "production engineering housekeeping", a high degree of cleaner production can be achieved with no new investment and at little or no cost. For example, use cost reduction through energy savings to open the doors. Make the programme realistic and practical for a CRITICAL MASS of enterprises in each developing country. Start with Indonesia (population 180 million) where APINDO, the employers' organization, is keen to work with UNIDO in ESID/CP for its 5,000 members.

3. Set up pilot schemes in developing countries for cleaner production technology transfer to manufacture new products to provide cleaner production role.
4. Create a series of UNIDO ESID/CP fellowships for younger managers in developing countries.
5. Develop UNIDO procedures and professional training for environmental management audits and annual external environmental audit. Encourage chambers of commerce to set up simple audit schemes for their members; encourage industrial associations to develop simple systems for their particular industries.
6. Design quantitative measures of ESID/CP whereby the current status and annual progress can be measured and publicized in the form of simple indices.
7. Expand, in cooperation with UNEP/IEO, the present, EEC-wide Better Environment Awards for Industry for other countries and regions.
8. Develop with UNEP/IEO group-based ESID/CP training packages, designed to be easily adaptable for the special conditions of enterprises and industries in different countries. Promote such training to a critical mass of industrial managers every year.
9. Develop and publish a directory of training resources for ESID and CP (or databases such as UNIDO's Industrial and Technological Information Bank (INTIB) and UNEP/IEO's International Cleaner Production Information Clearinghouse (ICPIC).
10. Work to establish a relationship of mutual trust between industrial enterprises and the industrial sector in general in developed and developing countries for ESID/CP through the organization of consultations and global, regional and sub-regional fora for the exchange of experience on ESID/CP.

XIII. NOTES

- 1/ INEM personal communication.
- 2/ United Nations, UNEP/IEO
Environmental Auditing (Technical Report Series No.2), Paris, France, 1990
- 3/ UNEP/IEO, Cleaner Production
No. 1 April 1991.
- 4/ ENDS Report 186, July 1990.
- 5/ United Nations, International Labour Office (ILO).
Dynamics of Accounting Development in Africa,
Geneva, Suisse, 1987. R.G.A. Boland and J.B. Wallace
- 6/ Heaton G.R. Jr., Regulation and Technological Change, Charting a New
Emphasis. Paper prepared for the World Resources Institute symposium
"Toward 2000: Environment, Technology and the New Century,".
Annapolis, Maryland, 13-15 June 1990.
- 7/ Sierra Club, Bankrolling Disasters
International Development Banks and the Global Environment
San Francisco, Cal. USA, 1986
- 8/ Heaton G., Repetto R. and Rodney Sobin
Transforming Technology: An Agenda for Environmentally Sustainable Growth
in the 21st Century, World Resources Institute, Washington DC, USA, 1991.
- 9/ Elkington J.
Cleaning Up: US Waste Management Technology and Third World Development
World Resources Institute, Washington DC, USA, 1989.
- 10/ World Resources 1991
WRI (World Resources Institute)/UNEP/UNDP
Washington DC, USA, 1991.
- 11/ Charter, Martin, The Green Employee, KPH Marketing, Alton, Hants, UK 1990
- 12/ UNDP/IEO 1991
Centre for Environmental Science and Engineering
Efficient Recovery and Re-use of Caustic Soda from Mercerizing Washwaters,
15/3/1991, Identification No. TEX-31
- 13/ Royal Society of Arts, Industry: Caring for the Environment
London, January 1987
- 14/ INEM, ESID worldwide survey, Hamburg, May 1991 (unpublished)
- 15/ EEC, 1991 - Commission of the European Communities
Better Environment Awards for Industry in Europe, 1990
- 16/ The Economist, 1991, The Economist, 18-24 May, 1991

- 17/ WARMER 1991 - WARMER, No. 28, January 1991
- 18/ CNOF, "De l'analyse de la valeur économique à l'analyse de la valeur écologique: l'exemple de l'automobile," in Management France, No. 75, Puteaux, France, April 1991.
- 19/ Winter, G., Ewers, H.J., Gege, M.
Business and the Environment, a handbook of industrial ecology with 22 checklists for practical use,
McGraw Hill, New York, London, 1988.
- 20/ Greengauge, No. 5, November 1989, Verdant Publications, London.
- 21/ World Bank Annual Report FY91, The World Bank and the Environment, unpublished draft, June 16, 1991.
- 22/ United Nations, International Labour Office (ILO).
Annual Report of the Director General,
Geneva, Suisse, 1990.
- 23/ SRI 1991 - Robert Shelton, Stanford Research Institute
private communication, 1991.
- 24/ Programme Prévoir, Banque Populaire du Haut Rhin, Mulhouse, 1990.
- 25/ Financial Times, London, June 26, 1991.
- 26/ WARMER 1991 - WARMER, No. 29, May 1991.
- 27/ Dr. Dieter Riesterer, Dr. Andreas Troge in:
Mittelständische Unternehmen und Umweltschutz, Verein Deutscher Ingenieure
VDI Berichte 746, Düsseldorf, 1989.
- 28/ UNEP/IEO, Industry and Environment, Vol. 13, No. 1, Jan.-March 1990.
- 29/ INEM, Bulletin No. 1, March-April 1991.
- 30/ ENDS Report 195, April 1991.
- 31/ ENDS Report 192, January 1991.
- 32/ Declared by Richard J. Mahoney, Chair and Chief Executive Officer,
Monsanto Services International, Breaking the Circile of the Short-Term
Fix: We must earn the right to operate, EPA Region III Environmental
Conference, Philadelphia, USA, Nov. 16, 1989.
- 33/ ENDS Report 193, February 1991.
- 34/ ENDS Report 181, February 1990.
- 35/ AUGÉ, Projekte 1988 bis 1990, hamburg, 1990.
- 36/ Norsk Hydro UK Environmental Report, London, October 1990.
- 37/ Dr. R.G.A. Boland, ed., Environmental Management, ILO/UNEP, Geneva
1986, (in 5 volumes).

- 38/ Standing Conference of Rectors, Presidents and Vice-Chancellors of the European Universities, Project Copernicus, Münster, May 1990.
- 39/ Deutsch-Deutscher Umweltschutz Markt, Referate zum Kongress, 27-28/9/91.
- 40/ DTI Cutting Your Losses: A Business Guide to Waste Minimisation, 1989
- 41/ UNEP/IEO, Final Report: Seminar on the Promotion of Cleaner Production, Canterbury, U.K., 17-20 September 1990.
- 42/ ENDS Report 196, May 1991.
- 43/ Chemicalweek International, July 17, 1991
- 44/ Dr. R.G.A. Boland, ILO mission to Ecuador unpublished, 1986.
- 45/ ENDS Report 185, June 1990.
- 46/ Institute of Waste Management, Report of the Working Party of the IWM Technical Committee, U.K., 1990.
- 47/ ICC, Environmental Guidelines for World Industries, Paris, 1986;
ICC, Environmental Auditing, Paris, 1989.
- 48/ ENDS Report 194, March 1991.
- 49/ National Round Table on the Environment and the Economy
A Report to Canadians, June 1989-1990.
- 50/ Industry Cooperative for Ozone Layer Protection, information packet,
Washington D.C., 1990.
- 51/ Cutter Information Corp.
Business and the Environment, Vol 2, No. 9, 10/5/1991.
- 52/ UNEP/IEO 1990, Industry and Environment, Vol. 10, No. 4, Oct.-Dec. 1987.
- 53/ M. Taguchi, S. Kimura, T. Hamawaka.
Automobile and Ceramic Censors - Ceramics Data Book.
New York Gordon and Bridge, 1987.
- 54/ UNEP/IEO, Final Report: Seminar on the Promotion of Cleaner Production,
Canterbury, U.K., 17-20 September 1990.
- 55/ BAUM, BAUM Arbeitsbericht 1990/1991, Hamburg, 13 February 1991.