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MEMORANDUM

TO: All Members of the World Commission on Environment and Development

FROM: Kazu Kato

DATE: 12 February, 1987

RE: Chapter 8

Herewith a final draft of Chapter 8, which has been revised on the basis of the discussions held last month at the Special Working Session in Berlin. As agreed, the major changes from the previous draft are summarized below:

- In part I: "Industrial Growth and Its Impact", the section on "Environmental Impacts of Industry" (paras 12 to 21) is re-introduced from the Moscow draft with minor changes, and inserted before the section on "Response to Pollution and Resource Degradation".

- In part II, three new paragraphs describing the kind of qualitative changes and regional differentiation required in future industrial development have been added (paras 33, 35 and 36).

- Previously two separate discussions of the "use of economic instruments" (paras 45-50 and 57-60 of the Berlin draft) have now been merged into one and redrafted (paras 64-69 of the present draft).

- Two preambular paragraphs have been added to part III section 4 "Increase Capacity to Deal with Industrial Hazards" in order to emphasize the gravity of risks posed by toxic chemicals and industrial accidents (paras 74 and 75).

- In part III section 5: "Strengthen International Efforts to Help Developing Countries", some paragraphs with recommendations overlapping with other chapters have been dropped, while a recommendation is re-introduced (para 102) from the Moscow draft calling for the creation of an independent international assessment body.

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CHAPTER 8

INDUSTRY: PRODUCING MORE WITH LESS

Tables

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1. Industry is central to the economies of modern societies and an indispensable motor of growth.[1/] It is essential to developing countries, to widen their development base and meet growing needs. And though industrialized countries are said to be moving into a post-industrial, information-based era, this shift must be powered by a continuing flow of wealth from industry.[2/]

2. Many essential human needs can be met only through goods and services provided by industry. The production of food requires increasing amounts of agrochemicals and machinery. Beyond this, the products of industry form the material basis of contemporary standards of living. Thus all nations require and rightly aspire to efficient industrial bases to meet changing needs.

3. Industry extracts materials from the natural resource base and inserts both products and pollution into the human environment. It has the power to enhance or degrade the environment; it inevitably does both.

4. Industrial development can be described as generally sustainable when what it takes from the environmental resource base remains within that base's capabilities to provide adequate resources for both the present and the future, and when it widens rather than limits future possibilities for human progress. But industry also consumes non-renewable resources. Thus its 'sustainability' will always be a relative, changing concept, based on its ability to continually improve the efficiency with which it uses resources and energy. In essence, it must always strive to produce more with less.

I. INDUSTRIAL GROWTH AND ITS IMPACT

5. As recently as 1950, the world manufactured only one-seventh of the goods it does today, and produced only one-third of the minerals. Industrial production grew fastest between 1950 and 1973, with a 7 per cent annual growth in manufacturing and a 5 per cent growth in mining. Since then growth rates have slowed, to about 3 per cent yearly between 1973 and 1985 in manufacturing and virtually no growth in mining.[3/]

6. That earlier, rapid growth in production was reflected in the rising importance of manufacturing in the economies of virtually all countries. By 1982, the relative share of value added to gross domestic product (GDP) by manufacturing (the 'manufacturing value added', or MVA) ranged from 19 per cent in developing countries as a whole to 27 per cent in industrialized market economies and to 51 per cent of net material product in centrally planned economies. (See Table 8-1.) If the extractive industries are taken into account, the share is even higher.

Table 8-1

Share of Manufacturing Value Added in GDP, by Economic Grouping and Income Group

Group of Countries	1960	1970	1980	1982
		(percentage)		
Developing countries	14.2	16.6	19.0	19.0
Low income	11.2	13.8	15.0	15.0
Lower-middle income	11.0	13.5	16.4	16.6
Intermediate income	10.6	14.4	17.1	17.6
Upper-middle income	19.4	21.6	24.1	23.3
High income	17.2	16.2	17.2	17.9
Developed market economies	25.6	28.3	27.9	27.1
Centrally planned economies*	32.0	42.4	50.5	50.8

* Figures refer to the share of manufacturing value added (estimated) in net material product. Data are at constant (1975) prices.

Source: UNIDO, World Industry: A Statistical Review 1985 (Vienna: 1986).

1. The Changing Structure of World Industry

7. In recent years, the trend of the 1950s and 1960s has been reversed: Manufacturing has declined in importance relative to other sectors of the economy. In many countries, this decline has been in progress since 1973. It is most noticeable in the case of industrial market economies, but the share of MVA in GDP has also declined in nearly half the 95 developing countries surveyed by UNIDO.[4/] This may reflect the growing interaction between industry and all fields of science and technology and the increasing integration of industry and services, as well as industry's ability to produce more using fewer resources.

8. The relative importance of industry as an employer has been declining for some time in developed countries. But the shift in jobs towards the service sector has accelerated sharply over the past 15 years with the increasing adoption of new processes and technologies. Economists continue to argue over whether the advent of an information-based economy will further depress employment in industry or will expand job opportunities overall.[5/] But one important consequence of industry's growing reliance on new, efficient, labour-saving technologies is that developing countries can no longer count as much on their cheaper labour to lure foreign investment to their industries.

9. Most developing countries started at independence with virtually no modern industry. Then during the 1960s and 1970s their industrial production, employment, and trade consistently grew faster than these sectors in developed market economies. By 1984, developing countries accounted for 11.6 per cent of world MVA (still well short of the 'Lima target' of 25 per cent adopted by UNIDO in 1975). The centrally planned economies of Eastern Europe had raised their share of world MVA from 15.2 per cent in 1963 to 24.9 per cent in 1984.[6/]

10. The international trade in manufactured goods, which has consistently grown faster than has world manufacturing output, is one of the factors underlying the changing geography of industrialization. Many developing nations, particularly newly industrialized countries (NICs), have shared in this growth and made spectacular progress in industrialization. Taking the Third World as a whole, exports of manufactured goods have grown steadily relative to primary exports, rising from 13.3 per cent of their total non-oil exports in 1960 to 54.7 per cent in 1982. (See Table 8-2.)

TABLE 8-2

Composition of the Merchandise Trade of Developing Countries

Item	Exports 1960	1970	1980	1982	Imports 1960	1970	1980	1982
			(billions of dollars)					
Primary commodities	25	45	452	369	11	17	166	166
Non-oil	17	27	107	93	8	12	79	73
Petroleum	8	18	345	277	3	5	87	92
Manufactures	3	9	101	112	17	39	288	296
Total	27	55	553	481	28	56	454	462
Total non-oil	20	36	208	204	25	51	367	370
			(per cent)					
Primary commodities including oil	90.4	82.6	81.8	76.8	38.8	30.1	36.6	35.9
Non-oil	62.3	49.2	19.4	19.2	28.4	21.7	17.5	15.9
Petroleum	28.1	33.4	62.4	57.5	10.4	8.4	19.1	20.0
Manufactures	9.6	17.4	18.1	23.2	61.2	69.9	63.4	64.1
	Share in Non-oil Exports				Share in Non-oil Imports			
Primary commodities (non-oil)	86.7	73.9	51.6	45.3	32.7	23.7	21.6	19.8
Manufactures	13.3	26.1	48.4	54.7	68.3	76.3	78.4	80.2

Source: UNIDO, Industry in a Changing World (New York: 1983). For 1982, WCED estimates based on UN, 1983 International Trade Statistics Yearbook, Vol. 1 (New York: 1985).

11. In general, developing-country industrial production is diversifying and moving into more capital-intensive areas such as metal products, chemicals, machinery, and equipment. And heavy industries, traditionally the most polluting, have been growing in relation to light industries. At the same time, the share of industries involved in food products, and to a lesser extent in textiles and clothing, has fallen significantly.

2. Environmental Impacts of Industry

12. Industry has a major impact on the natural resource base of civilization, through the entire cycle of raw materials exploration and extraction, transformation into products, energy consumption, waste generation, and the use and disposal of products by consumers. All of this gives rise to both process and product pollution. The negative environmental impacts of industry take many forms, all these being but different aspects of the same problem - degradation of the resource base of development. When air and water quality deteriorates due to pollution, these resources may become scarce in a given area, with serious consequences for agriculture, industry, and for the people who depend on them.

13. The environmental impacts of industrial activity were at first perceived typically as localized problems of air, water, and land pollution. In the post-World War II years, industrial expansion took place at first without much regard for the environment and brought with it many of the worst pollution crises the world has known, such as Pittsburgh and Los Angeles smogs in the United States; threats to the Great Lakes ecosystems in North America; the progressive pollution of major rivers like the Meuse, Elbe, and Rhine in Europe; and the mercury poisoning in Minamata, Japan. The enormous expansion of maritime transport and off-shore oil drilling led to frequent mishaps on the sea, raising concerns about marine pollution by hydrocarbons, toxic chemicals, and radioactive materials.

14. Despite enormous efforts, expenditures, and considerable progress in pollution control, many industrialized countries still suffer 'traditional' air, water, and land pollution. The problems of nitrogen oxides (NO_x), suspended particulates, and hydrocarbons remain and in some cases have increased. As emissions from factories and plants begin to be regulated, mobile sources such as automobiles are growing significantly in many cities.

15. There have been major successes in water pollution control, such as the return of salmon to the Thames River and the restoration of Lake Erie. But the water quality of the world's major rivers has not markedly improved over the years. In many smaller rivers, it is worsening. Fertilizer run-off and sewage discharges into rivers, lakes, and coastal waters have accelerated in many waters, with resulting impacts on fishing, drinking water supply, navigation, and scenic beauty.

16. These problems have also surfaced in many parts of the Third World as industrial growth, urbanization, and the use of automobiles have spread. Air and water quality in many countries, particularly in or near urban centres, are sometimes far worse than in the polluted cities of industrial nations.[7/]

17. As the more direct and rampant forms of industrial pollution have begun to be controlled, it is becoming increasingly clear that the sources and causes of pollution are far more diffuse, complex, and interrelated - and the effects of pollution more widespread, cumulative, and chronic - than hitherto believed. Contamination of soils, groundwater, and people by agrochemicals is pervasive, and chemical pollution has spread to every corner of the planet. Major accidents involving toxic chemicals have taken place. New cases of

pollution and health hazards that have come to light include the possibility of release of minute amounts of the toxic chemical dioxin and heavy metal compounds from municipal waste incinerators. Discoveries of hazardous waste disposal sites - at Love Canal in the United States, for example, and at Lekkerkek in the Netherlands, Vac in Hungary, and Georgswerder in the Federal Republic of Germany - have attracted worldwide attention in recent years.

18. Industry is a developer and consumer of natural resources, both renewable and non-renewable. Non-renewable resources are by definition exhaustible, and the possibility that the process of industrial growth would run into material resource constraints has been an important theme in the environmental debate of the past 25 years. Although at the global level few minerals appear likely to be exhausted in the near future, it is now widely acknowledged that at the present rate of consumption, certain fossil fuels will approach the economic as well as technical limits of extraction early next century. (See Chapter 7.)

19. As for renewable industrial resources, such as agricultural commodities, forest products, fisheries, and other living resources, the threat of declining supply and eventual extinction is more imminent. Without due care to maintain their regenerative capacity, the industrial use of these commodities can greatly overtax the existing stock of resources.

20. Industrial policies and activities affect the availability and the quality of the finite resource of land through siting decisions, extraction of minerals, pollution, and the potential for accidents and accumulation of toxic substances in the soil. Damages

inflicted on land by pollutants or hazardous wastes not only decrease its present value but also severely restrict its future use.

21. Many of these environmental pollution problems have taken on a new dimension as they spill over borders. Air pollutants are now carried great distances, largely due to pollution control policies that encouraged industry to limit local damage by building higher smokestacks. Once-localized air pollution has now acquired a much larger regional dimension in the form of acid deposition. The stratospheric ozone layer that shields the Earth from harmful ultraviolet rays is apparently being depleted in large part though the increased release of certain industrial chemicals. The global warming induced by carbon dioxide and other greenhouse gases may permanently alter the Earth's climate regime, with untold consequences for world agricultural production. (See Chapter 7.)

3. Response to Pollution and Resource Degradation

22. The industrialized world began to take serious steps to limit industrial pollution in the late 1960s. Many developing countries also recognized the need to tackle the problem before it got out of hand. Governments established environmental protection policies and programmes, as well as agencies to administer them. They initially focused on regulatory measures aimed at reducing emissions. Later they considered a range of economic instruments - such things as taxation, pollution charges, and subsidies for pollution control equipment - but only a few countries introduced them.

Environmental policies must aim towards thrift in the exploitation of national resources. The driving force for the solution of the environmental problem caused by technological development may have to come primarily from new or reoriented policies promoting cleaner technologies at the expense of more polluting technologies.

It is a common although somewhat simplistic assumption that lower waste technology will necessarily result in higher manufacturing cost. Yet when all the costs of environmental damage are substracted, the balance is usually very much in favour of low-waste technology. Sound economic policies and progressive environmental policies are, therefore, not contradictory.

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WCED Public Hearing
Oslo, 24-25 June 1985

23. Industry also responded to public and government concern. Expenditures on pollution control measures began to rise rapidly in some of the highly polluting industries; corporations began to set up their own environmental policy and control units. Guidelines and codes of conduct were published covering safety of products and plant operations, trade practices, technology transfer, and international cooperation.[8/] National and international industry associations have also developed guidelines and voluntary codes of practice.[9/]

24. Both governments and industry were initially deeply worried about the costs of proposed environmental measures. Many predicted that they would depress investment, growth, jobs, competitiveness, and trade, while driving up inflation. In many cases, such fears proved misplaced. A survey of OECD countries indicates that the benefits generated by environmental measures over the past two decades, including health, property, and ecosystem damages avoided, have been significant.

More important, these benefits have generally exceeded costs.[10/]

25. One methodology to estimate the cost of pollution abatement in industry compares expenditures on new plants and equipment that have pollution control facilities to hypothetical expenditures on new plants without such features. Studies using this comparison in the United States found that pollution abatement expenditures for new plant and equipment for all manufacturing industries in that country in 1984 amounted to $4.53 billion, or 3.3 per cent of total new expenditures. The chemical industry spent $580 million (3.8 per cent) on such equipment.[11/] Similar studies in the Japanese steel industry found that new investment in pollution control equipment reached as high as 21.3 per cent of total investment in 1976 and even today remains around 5 per cent.[12/]

26. Costs and benefits have naturally varied among industries. Firms involved in food processing, iron and steel, non-ferrous metals, automobiles, pulp and paper, chemicals, and electric power generation - all major polluters - have borne a high proportion of the total pollution control investment by industry. Faced with such costs, many of these industries developed a broad range of new processes and cleaner and more efficient products and technologies.

27. And many benefited financially from this effort. Some firms that a decade ago established teams to research and develop technologies to meet new environmental standards are today among the most competitive in their fields.

28. Waste recycling and reuse have become accepted practices in many industrial sectors. In some industrialized countries technologies to scrub sulphur

and nitrogen compounds from smokestack gases made remarkable advances in a relatively short time. New combustion techniques now being developed both raise combustion efficiency and reduce pollutant emissions. Low-NO_x burners, fluidized bed combustion, and many other novel technologies hold great promise for the future.[13/]

29. In fact, pollution control has become a thriving branch of industry in its own right in several industrialized countries. High-pollution industries such as iron and steel, other metals, chemicals, and energy production have often led in expanding into the fields of pollution control equipment, de-toxification and waste disposal technology, measurement instruments, and monitoring systems. Many have found new opportunities for investment, sales, and exports. Looking to the future, a growing market for pollution control systems, equipment, and services is expected in practically all industrialized countries, including NICs.

30. 'Prevention is better than cure' is now a widely accepted motto among the world's leading industries.[14/] The belief that pollution prevention pays is becoming an essential element of strategic planning for industrial policies and projects in both government and industry. It requires integrating environmental considerations, fully and at the earliest stages of development, into the processes of industrial planning and management.[15/]

31. Gaps, of course, can be found in this progress. In many countries, particularly in the developing world, emission standards, their enforcement, and environmental monitoring are inadequate. Few countries use economic instruments effectively to prevent pollution before it arises. The frequency of accidents releasing toxic substances is a growing global concern. The accumulation

of hazardous wastes threatens present and future generations, as does the introduction of inadequately tested chemicals and technologies. Much remains to be done.

II. SUSTAINABLE INDUSTRIAL DEVELOPMENT IN A GLOBAL CONTEXT

32. If industrial development is to be sustainable over the long term, it will have to change radically in terms of the quality of that development, particularly in industrialized countries. But this is not to suggest that industrialization has reached a quantity plateau, particularly in developing countries. Even today, according to UNIDO, world industrial output would have to be increased by a factor of 2.6 if consumption of manufactured goods in developing countries were to be raised to current industrial country levels.[16/] Given expected population growth, a five- to tenfold increase in world industrial output can be anticipated by the time world population stabilizes sometime in the next century. Such growth has serious implications for the future of the world's ecosystems and its natural resource base.

33. In general, industries and industrial operations should be encouraged that are more efficient in terms of resource use, that generate less pollution and waste, that are based on the use of renewable rather than non-renewable resources, and that minimize irreversible adverse impacts on human health and the environment.

1. Industrialization in the Third World

34. Growing populations and high proportions of young people in Third World countries bring large increases in the labour force. Agriculture will not be able to absorb such numbers. Industry must provide these expanding societies not only with employment but with products and services. They will need massive increases in basic consumer goods and a concomitant build-up of industrial infrastructure - iron and steel, paper, chemicals, building materials, and transportation. All this implies increases in energy and raw material use, industrial hazards and wastes, accidents, and resource depletion.

35. The problems and prospects for industrial development vary among the countries of the Third World. From and environmental point of view the factors of greatest relevance are the relative importance of basic material processing industries, the degree of geographical concentration in industrial development and the role of the small-scale sector.

36. There are some large countries with abundant natural resources and a substantial domestic market that provide a base for wide-ranging industrial development. Smaller resource-rich countries are trying to build up an export-oriented processing industry. Several developing countries have based much of their industrial development on highly competetive export industries in textiles, electronics, and engineering. In many countries, industrial development is restricted to a few consumer goods industries that cater to relatively small domestic markets.

37. The developing countries' share in world production of iron and steel rose from 3.6 per cent in 1955 to 17.3 per cent in 1984, when four countries - China, Brazil,

South Korea, and India - produced more than 10 million tons of steel each, as much as in many medium-sized industrialized countries.[17/] At the same time that this industry is contracting in many developed countries, it is expected to expand by 38 million tons between 1982 and 1990 in the developing world. Latin America is projected to account for 41 per cent of this rise, Southeast Asia for 36 per cent, the Middle East for 20 per cent, and Africa for 1.3 per cent.[18/]

38. Many developing countries still depend heavily on their exports of minerals and other commodities, mostly in unprocessed or only intermediately processed forms. In the case of several major minerals such as aluminium and nickel, a few transnational corporations control the whole industry, from mining through final processing.[19/] Some countries have been moderately successful in increasing the share of refined products in their exports. Yet most of these 'manufactured' goods are processed further in the industrial country that imports them. Thus in 1980, only 39 per cent of all Third World exports of manufactured goods were ready for final use, while 43 per cent of its total exports were unprocessed.[20/] This ratio should improve as developing nations move into the further stages of processing.

39. Paper is a basic manufactured consumer good based on a renewable natural resource. Between 1950 and 1980, developing countries increased their production and consumption of paper and paperboards by about twenty- and tenfold, respectively. But they continued to import paper, as demand always exceeded domestic production. However, the ratio of production to consumption has consistently improved, with total developing-country production reaching 22.5 million tons (about 13 per cent of world total) in 1980.[21/] Developing-country demand

for pulp and paper will continue to grow rapidly with increasing population, education, literacy, and incomes. This demand will also increase pressures on forests.

40. The expected growth in basic industries foreshadows rapid increases in pollution and resource degradation unless developing countries take great care to control pollution and waste, to increase recycling and reuse, and to minimize hazardous wastes. These countries do not have the resources to industrialize now and repair the damage later; nor will they have the time, given the rapid pace of technological progress. They can profit from the improvements in resource and environmental management being achieved in industrialized countries, and so avoid the need for expensive clean-ups. Such technologies can also help them reduce costs and stretch scarce resources.

41. Industrial structure in developed countries is expected to change radically with the increasing use of new technologies and with the relocation of some basic, traditional industries like paper, metals, and chemicals to the Third World. Developing countries can use elements of this revolution for their own advancement. They could industrialize by skipping some of the more damaging steps in the gradual development of industry in developed countries and mitigate some of the negative impacts of this process on society and on the environment.

42. Economies of scale are no longer always the primary consideration. New technologies in communications, information, and process control allow the establishment of small-scale, decentralized, widely dispersed industries, thus reducing levels of pollution and other impacts on the local environment. Such dispersed industries could relieve big cities of some of their population and pollution pressures. They could provide

> It is absolutely clear now that the present scale and rate of development of the productive forces require a different approach to the questions connected with environmental protection and rational utilization of natural resources. This is a task of immense economic and social significance. For actually it is a question of people's health and a caring approach to the national wealth of each country. Moreover, it is also a question of the future. And on the solution depends the conditions in which the coming generations will live.
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> A. P. Semyonov
> Central Council of Trade Unions
> WCED Public Hearing
> Moscow, 8 Dec 1986

non-farming jobs in the countryside, produce consumer goods that cater to local markets, and help spread environmentally sound technologies.

2. Declining Role of Energy and Raw Materials

43. Industrial growth is widely seen as inevitably accompanied by corresponding increases in energy and raw material consumption. In the past two decades, however, this pattern appears to have fundamentally changed. As growth has continued in the developed market economies, the demand for many basic materials, including energy and water, has levelled off; in some cases, it has actually declined in absolute terms.

44. Energy consumption per unit of GDP in OECD countries has been dropping at a rate of 1-3 per cent every year since the late 1960s. Between 1973 and 1983, these nations improved energy efficiency by 1.7 per cent annually.[22/] Industrial water consumption per unit of production has also declined. Older pulp and paper mills typically used about 180 cubic metres of water per ton of pulp; those built during the 1970s, however, used only 70. With advanced techniques that keep water circulating within a closed system, and with proper staff training,

use rates could be lowered to 20-30 cubic metres per ton of pulp.[23/]

45. An integrated steel mill uses about 80-200 tons of water for every ton of crude steel. However, since only about 3 tons of water per ton of crude steel are lost, mostly by evaporation, recycling can greatly reduce consumption.[24/] Closed water circulation systems are not unique to the steel industry or to developed market economies. Between 1975 and 1980, the USSR chemical industry output increased by 76 per cent, but the total consumption of fresh water remained at the 1975 level.[25/] And between 1981 and 1986, Soviet industrial output increased by 25 per cent but industrial water consumption remained constant.[26 /]

46. Declines in consumption of other raw materials began much earlier. In fact, the amount of raw materials needed for a given unit of economic output has been dropping over this entire century, except in wartime, for practically all non-agricultural commodities.[27/] A recent study of consumption trends of seven basic materials in the United States bears this out,[28/] as do studies in Japan. Japan used only 60 per cent as much raw materials for every unit of industrial production in 1984 as it used in 1973.[29/] These efficiency trends do not result from a decline in manufacturing in favour of service industries, for over these periods the output of the manufacturing sector continued to grow. The productivity and efficiency of resource use are constantly improving, and industrial production is steadily switching away from heavily material-intensive products and processes.

47. The two oil price hikes of the 1970s shocked many countries into saving money by promoting conservation measures, switching to other fuels, and raising overall energy efficiency. All of this also reduced pollution

and helped firms maximize profits. These events demonstrated the importance of energy pricing policies that reflect a more realistic cost of resources, taking into account their current stock, depletion rates, availability of substitutes, and any unavoidable environmental damage associated with their extraction or processing. (See Chapter 7.) They also indicated the potential of similar pricing policies for other raw materials.

48. Some have referred to these processes as the increasing 'de-materialization' of society and the world economy. Yet even the most industrially advanced economies still depend on a continued supply of basic manufactured goods. Whether made domestically or imported, their production will continue to require large amounts of raw materials and energy, even if developing countries progress rapidly in the adoption of resource-efficient technologies. To sustain production momentum on a global level, therefore, policies that inject resource efficiency considerations into economic, trade, and other related policy domains are urgently needed, particular in industrial countries, along with strict observance of environmental norms, regulations, and standards.

3. Promises and Risks of New Technologies

49. Along with opportunities for raising productivity and living standards, for improving health, and for conserving the natural resource base, new technologies also bring new hazards, threaten environmental degradation, and could induce subtle but irreversible changes in the social, cultural, and economic fabric of nations or even of the world community. Skillful environmental planning can forecast some of these new hazards and mitigate their effects.

50. Information technology based chiefly on advancements in micro-electronics and computer science is of particular importance. Coupled with rapidly advancing means of communication, it can help to improve the productivity, energy and resource efficiency, and organizational structure of industry. Information technology is already affecting international trade and investment patterns.

51. New materials such as fine ceramics, rare metals and metal alloys, high-performance plastics, and new composites allow more flexible approaches to production. They also contribute to energy and resource conservation, as in general they require less energy to manufacture and, being lighter, contain less matter than conventional materials.

52. Biotechnology will have major implications for the environment. The products of genetic engineering could dramatically improve human and animal health. Researchers are finding new drugs, new therapies, and new ways of controlling disease vectors. Energy derived from plants could increasingly substitute for non-renewable fossil fuels. New high-yield crop strains and those resistant to weather and pests could revolutionize agriculture. Biological methods of pest control will become more common. Biotechnology could also yield cleaner and more efficient alternatives to many wasteful processes and polluting products. New techniques to treat solid and liquid wastes could help solve the pressing problem of hazardous waste disposal.[30/]

53. Advances in space technology, now the almost exclusive domain of industrial countries, also hold promise for the Third World, even for agriculture-based economies. Weather forecasting services provided through a satellite and communications network can help farmers

in deciding when to plant, water, fertilize, and harvest crops. Remote sensing and satellite imagery could permit optimal use of the Earth's resources, facilitating the monitoring and assessment of long-term trends in climatic change, marine pollution, soil erosion rates, and plant cover. (See Chapter 10.)

54. These new technologies and the Green Revolution blur the traditional distinctions between agriculture, industry, and services. And they make it possible for developments in one sector to more radically affect those in another. Agriculture has become virtually an 'industry' in developed countries. Agriculture-related services - especially for regional weather forecasting, storage, and transport - are becoming ever more important. New techniques of tissue culture and genetic engineering could soon generate plant strains able to fix nitrogen from the air, a development that would drastically affect the fertilizer industry, but that would also reduce the threat of pollution by agrochemicals.

55. The chemical and energy industries are moving increasingly into the seeds business, providing new seeds that meet specific local conditions and requirements - but that may also need specific fertilizers and pesticides. Here research and development, production, and marketing need to be carefully guided so as not to make the world even more dependent on a few crop varieties - or on the products of a few large transnationals.

56. Yet new technologies are not all intrinsically benign, nor will they have only positive impacts on the environment. The large-scale production and widespread use of new materials, for example, may create hitherto unknown health hazards (such as the use of gallium

arsenate in the microchip industry.)[31/] Riskier research might be carried out and products manufactured where safeguards are weak or where people are unaware of the dangers. The need for caution in introducing a new technology is reinforced by the experience of the Green Revolution, which, despite formidable achievements, raises concerns over dependence on relatively few crop strains and large doses of agrochemicals. New life forms produced by genetic engineering should be carefully tested and assessed for their potential impact on health and on the maintenance of genetic diversity and ecological balance before they are introduced to the market, and thus to the environment.[32/]

III. STRATEGIES FOR SUSTAINABLE INDUSTRIAL DEVELOPMENT

57. Resource and environmental considerations must be integrated into the industrial planning and decision-making processes of government and industry. This will allow a steady reduction in the energy and resource content of future growth by increasing the efficiency of resource use, reducing waste, and encouraging resource recovery and recycling. It will guide industry in its adaptation of new technologies. It will also help industry to play its proper role in improving human resources while improving existing work patterns. In general, including such considerations will permit government and industry to shift to more cost-effective 'anticipate-and-prevent' approaches - though curative measures will still be needed to cope with the backlog of environmental damages already inflicted.

58. An integrated approach to industrial development planning and management will require an emphasis on:

* the incorporation, at the most effective and least costly stage, of measures to prevent adverse effects on health and the environment;

* improved resource management, particularly in areas where the continuing or anticipated erosion of the natural resource base is critical, and in environmentally sensitive areas;

* pollution abatement and waste minimization in all branches of industry, globally, especially where rapid industrialization in or near major population centres poses critical public health and safety problems;

* improved environmental and risk assessment methods as well as risk management capabilities involving plant siting, design, and choice of products or technology;

* more international cooperation between governments and between government and industry to address transboundary, regional, and global environmental problems related to industry; and

* increased technical, financial, and institutional assistance to and among developing countries, aimed at improving their capacity to assess their natural resource base and the sustainability of industrial projects or technologies, as well as to deal with pollution, accidents, and other industrial hazards.

1. Establish Environmental Goals, Regulations, and Standards

59. In dealing with industrial pollution and resource degradation, it is essential that industry, government, and the public have clear benchmarks. National governments must therefore establish clear environmental goals and enforce environmental laws, regulations, and standards on all industrial enterprises, irrespective of ownership or size. In formulating such policies or regulations, they should give priority to public health problems associated with industrial pollution and hazardous wastes. And they must improve their environmental statistics and data base relating to industrial activities.

60. The regulations and standards should govern such matters as air and water pollution, waste management, occupational health and safety of workers, energy and resource efficiency of products or processes, and the manufacture, marketing, use, transport, and disposal of toxic substances. This should normally be done at the national level, with local governments being empowered to exceed, but not to lower, national norms. In preparing environmental regulations, it is important that flexible systems are adopted without specifying a particular process or technology.

61. Environmental regulations can seldom be comprehensive enough to take all factors or interests into account. Hence governments should require an environmental/resource sustainability assessment for all major investments as an integral part of licensing, funding, or other permit-granting procedure. The assessment should be made public to allow affected parties an opportunity to comment before a governmental decision is made, and followed up in the implementation

> Our ecological movement is not against industry, but we must think of the social function of industries and that pollution and progress are not the same thing. Pollution is not the synonym of progress and therefore time has come for new development concepts to come up. Pollution should not be a synonym of progress because we know that pollution is controlled and when you do not control pollution you are transferring this pollution to the community of the whole.
>
> Fabio Feldman
> Lawyer for Victims of Cubatao
> WCED Public Hearing
> Sao Paulo, 28-29 Oct 1985

phase and monitored throughout. (See Chapter 3 for a fuller discussion of this concept.)

62. Sustainability assessments need to be applied equally to cases of transboundary pollution, international trade, foreign investment, and technology transfers, including projects involving exploration and development of natural resources and of the global commons.

63. Regulations to control the impacts of industrial activity across national boundaries and on the international commons are also needed. Existing or future international conventions dealing with transfrontier pollution or management of shared natural resources should enshrine certain key principles:

* the responsibility of every state not to harm the health and environment of other nations,

* liability and compensation for any damage caused by transfrontier pollution, and

* equal right of access to remedial measures by all parties concerned.

2. Make More Effective Use of Economic Instruments

64. Pollution is a form of waste, and waste of resources in industrial production is a symptom of inefficiency. Industries that recognize pollution as such, and that account for it as a cost factor of production, are motivated to reduce the pollution and waste they generate. Thus to some extent efficient industries can be expected to regulate their production of pollution and waste if and when they see that their efforts increase profits or improve productivity.

65. However, the improvements that industrial enterprises can achieve through voluntary efforts are severely limited. Air and water have traditionally been regarded as 'free' goods, but the enormous costs to society of past and present pollution show that they are not free. Treating them as such transfers economic benefits from those who bear the damage costs of pollution to those who enjoy cost-free air, water, and other environmental resources. Today manufacturers are expected to take responsibility for a larger and larger proportion of these 'external costs'. This new cost equation is prompting many firms to review their approaches to pollution control.

66. In this regard, OECD in 1972 agreed upon a Polluter Pays Principle (PPP).[33/] Essentially an economic efficiency measure, PPP is designed to encourage industries to reflect environmental costs in the prices of products. This principle places the costs of pollution prevention or clean-up on the industry, and ultimately - through the price-setting mechanism of the marketplace - on consumers. It thus gives industry economic incentives to use production methods that are less polluting and gives consumers incentives for conservation. Since it means government intervention in

> We move towards attacking the sources and not the effects. But we also meet environmental questions in our markets, among our own employees and in our local environment. This definitely provides experiences that underline the need for a more complete and comprehensive thinking about the systems of which environment becomes an integral part. We also, as industry, meet the problems of international relations and environment, unfortunately very often in the way of hidden trade barriers or difficulties in cooperation between authorities.
>
> Rolf Marstrander
> Director,
> Environment Affairs,
> Norsk Hydro
> WCED Public Hearing
> Oslo, 24-25 June 1985

the functioning of the market, PPP can also be applied through government regulations and price controls in centrally planned economies.

67. Economic instruments such as user charges, fiscal levies, liability legislation and other measures to back up regulatory standards can all help in the implementation of the Polluter Pays Principle. Whether these costs are passed on to consumers or borne by the industry will depend on the market situation. But in general, the use of economic instruments combined with strict enforcement of enviromental norms and standards will allow individual industries to seek out least-cost options for reducing pollution and increasing recycling, thus internalizing the cost of pollution prevention and waste minimization. (See Chapter 3 for a broader application of PPP to international trade and investment.)

68. Incentives to reduce pollution can be enhanced by other measures. Energy and water pricing policies, for example, can push industries to consume less. Product redesign and technological innovations leading to safer products, more efficient processes, and recycling of raw materials can also be promoted by a more effective,

integrated use of economic incentives and disincentives, such as investment tax breaks, low-interest loans, depreciation allowances, pollution or waste charges, and non-compliance fees.

69. Sometimes the way in which other policy objectives are promoted unintentionally reduces the effectiveness of environmental programmes. For example, subsidies on raw materials or water supply or energy to promote the development of industry in remote areas may well dilute the pressure to conserve resources. Governments should examine whether existing economic policies, instruments, or subsidies provided to various industry-based programmes and projects contribute effectively to the promotion of environmentally sound and resource-efficient practices.

3. Ensure a Constructive Response from Industry

70. Industry's response to pollution and resource degradation should not be limited to compliance with regulations. It should accept a broad sense of social responsibility and ensure an awareness of environmental considerations at all levels. Towards this end, all industrial enterprises, trade associations, and labour unions should establish company-wide or industry-wide policies concerning resource and environmental management, including compliance with the laws and requirements of the country in which they operate.

71. International trade associations can play a major role in setting standards and disseminating information. They should establish and make widely available sectoral guidelines for assessing the sustainability and potential hazards of new facilities, for developing accident contingency plans, and for selecting pollution control or waste treatment technologies.

72. With limited resources at their disposal, small and medium-sized industries often find themselves unable to afford the changes necessary to meet environmental regulations and product controls. Small-scale businesses such as metal working, machine tools, printing, and tanning and dying are frequently among the worst offenders of environmental regulations in any country. New technologies, especially micro-electronics, already allow small industries inexpensive means to control an entire production process. Energy-saving biological systems may be well suited to the needs of small and medium-sized industries for pollution control or waste disposal.

73. Small and medium-scale enterprises, constituting the largest segment of industry in most nations, need information and may in some cases require financial and technical assistance from the public sector. Management and worker training can help them to incorporate cleaner technologies and environmental planning into work patterns. Governments should encourage cooperative efforts among smaller firms - in joint research and development on environmental issues, for example, or joint use of pollution control or waste treatment facilities.

4. Increase Capacity to Deal with Industrial Hazards

74. Chemical products have greatly improved health and life expectancies; increased agricultural production; raised comfort, convenience, and the general quality of life; and expanded economic opportunities. The chemical industry is also one of the most dynamic sectors in most countries, including many developing ones. Yet this industry, together with its products, can have a particularly severe impact on the environment. It has given rise to a host of new problems both of product and

process pollution. It continues to generate an increasingly wider range of products and wastes whose effects, especially long-term ones, on human health and the environment are not precisely known. Major accidents have taken place, and the safety record of the industry has been challenged in recent years.

75. In a world more and more dependent on chemical products and highly complex large-scale technologies, accidents with catastrophic consequences are likely to increase. Various hazardous products and processes are already built into current systems of production and the technological structure of contemporary society, and it will be a long time before these can be replaced with less dangerous, inherently safer technologies and systems. Some highly toxic chemicals that are known to cause cancer and birth defects and have long-term genetic effects are already in the environment in significant concentrations, and may take decades to be diffused.

4.1 Chemicals

76. Chemicals represent about 10 per cent of total world trade in terms of value.[34/] Some 70,000-80,000 chemicals are now on the market - and hence in the environment.[35/] The figure is only an informed estimate because no complete inventory has been done. Some 1,000-2,000 new chemicals enter the commercial market each year, many without adequate prior testing or evaluation of effects.

77. According to a U.S. National Research Council sample of 65,725 chemicals in common use, data required for complete health hazard evaluations were available for only 10 per cent of pesticides and 18 per cent of drugs. No toxicity data existed for nearly 80 per cent of the chemicals used in commercial products and

processes inventoried under the Toxic Substances Control Act.[36/] This situation is now beginning to change as governments move gradually from a system of post-market testing to one of pre-market testing of all new chemicals.

78. By 1986, more than 500 chemicals and chemical products had been banned altogether or had their uses severely restricted in the country of origin.[37/] In industrial countries, an increasingly interdependent and effective system of chemical control agencies share test results and notify each other of new restrictions on chemicals. A ban in one country is thus often quickly followed by similar action in other industrial nations. But few, if any, effective restrictions exist on the export of banned chemicals and chemical products to other countries.

79. While most industrial countries are now tightening their regulatory systems, most in the Third World have no effective control over this trade. Many are simply unable to establish such systems because of institutional and financial limitations and a shortage of professional staff.

80. To correct this, all governments, particularly in the major chemical-producing countries, should:

* agree that no new chemicals will be placed on the market until the health and environmental impacts have been appropriately tested and assessed in accordance with internationally agreed guidelines, laboratory practices, and procedures;

* reinforce efforts to obtain international agreement on selection of existing chemicals for priority testing, on criteria and procedures for their assessment, and on a system for international sharing of the tasks and the resources required; and

The most explosive development in the establishment of chemical and pollutive industry has come in developing countries. This is an outright danger. The last accidents are but a few of those that may come. However, we recognize that considerable responsibility rests on the trade union movement in the individual countries in pressing for influence on authorities and managements to avoid both such accidents and investments from companies that do not follow acceptable standards.

Technology development has improved environment in the industrial parts of the world. The new production and information systems make it more difficult, then, for the developing countries to use cheap labour as a means to attract industry to their countries. The future for these countries does not look very bright, unless the international society takes it upon itself to affect a sharing of production technology and resources. This is politically difficult indeed.

Juul Bjerke
International Conferedation
of Free Trade Unions
WCED Public Hearing
Oslo, 24-25 June 1985

* strictly regulate the export of banned or severely restricted chemicals to other countries, in particular to the Third World, by requiring prior notification of the intent to export; the provision of all available information concerning health, environmental, and other effects of the chemicals, as well as methods for safe use and disposal; and the prior consent of the importing-country government.

81. Consumer awareness should be increased. Governments should encourage the establishment of information centres on chemical products used by consumers and strengthen the international networks of information exchange, assessment, and data banks that are now evolving in the UN and elsewhere.[38/] Another essential step is the adoption and enforcement of regulations on the packaging and labelling of chemicals whose use may be potentially harmful to ensure that clear directions are provided in common local languages.

Consumer unions and other non-governmental organizations should take the lead in collecting and distributing comparative risk information on ingredients in consumer products such as cleaning agents and pesticides.

82. The chemical producer and user industries, as the source of the risks associated with chemicals and as the greatest beneficiary of their use, should bear the responsibility for ensuring (and the liability for not ensuring) that their products meet the highest standards of safety, have the fewest adverse side-effects on health and the environment, and are handled with appropriate care by workers and users. This will require the fullest possible disclosure of information about the properties and production processes of chemical substances and on comparative risks, not only to the regulatory authorities but also to the workers, consumers, and residents of the community in which a chemical industry operates.

4.2 Hazardous Wastes

83. Industrialized countries generate about 90 per cent of the world's hazardous wastes. Although all estimates have a wide margin of error, given considerable differences in definition of 'hazardous waste', in 1984 some 325 million to 375 million tons were generated worldwide,[39/] around 5 million tons of which were in the newly industrialized and developing areas of the world.[40/]

84. In OECD member countries alone, thousands of waste disposal sites exist, many of which are likely to require some form of remedial action. Clean-up is expensive: Estimates include $10 billion for the Federal Republic of Germany, more than $1.5 billion for the Netherlands, $20-100 billion for the United States, and at least $60 million for Denmark (in 1986 dollars).[41/] A large number of potentially hazardous sites may also exist in

concentrated industrial-urban areas in centrally planned economies as well as in developing countries. Clean-up costs are so high that at present no insurance policies would adequately cover such operations. Some form of government intervention is required through regulatory action or financial support.

85. Waste management in developing countries suffers from a variety of problems. Frequent and heavy rains in the tropics, for instance, leach wastes into the soils under landfills or even cause them to overflow. With little or no pre-treatment of wastes, this could contaminate water supplies or cause local people to be directly exposed to the wastes. Land-filling generally occurs close to industrial estates that are surrounded by poor neighbourhoods or shanty towns.[42/] These dangers point up the need for land use planning in developing countries, and the more urgent need to actually implement and enforce such plans.

86. The overriding policy objective must be to reduce the amount of waste generated and to transform an increasing amount into resources for use and reuse. This will reduce the volume that otherwise must be treated or disposed of through incineration, land disposal, or dumping at sea. This is first and foremost a problem of industrialized countries. But it is also a problem in NICs and developing countries, where rapid industrialization is bringing the same severe problems of hazardous waste management.

87. The amount of wastes crossing national frontiers is increasing and is likely to continue to do so. Between 1982 and 1983, wastes transported in Western Europe for disposal in another country virtually doubled, reaching some 250,000-425,000 tons (1-2 per cent of the total hazardous wastes generated).[43/] This increase may be

attributed partly to the availability of relatively low-cost, legal, land-based disposal facilities in some countries. For example, about 4,000 shipments of hazardous wastes went from the Netherlands to the German Democratic Republic in 1984. And the Federal Republic of Germany sent about 20,000 shipments to the German Democratic Republic the preceding year. International transport of wastes meant for disposal at sea, either by incineration or dumping, amounted to about 1.8 million tons in 1983.[44/]

88. Some countries have recently proposed what amounts to a commodity trade in hazardous (including radioactive) wastes. Strengthened international cooperation in this area is vitally important, and several international bodies have taken up the matter.[45/] An international agreement currently being developed by OECD is to be based on three important principles: equally strict controls on shipments to non-member countries; prior notification to and consent from the country of final destination, whether member or non-member country; and a guarantee of existence of adequate disposal facilities in the recipient country. UNEP has drawn up extensive draft guidelines.[46/] Governments and international organizations should actively support these efforts to achieve an effective international regime to control the transfrontier movement of hazardous wastes.

4.3 Industrial Accidents

89. Accidents involving toxic chemicals and radioactive materials can occur in plants in any region. According to a survey carried out by the U.S. Environmental Protection Agency, 6,928 accidents of varying severity occurred at U.S. plants between 1980 and 1985 - an average of five a day.[47/]

> In industry, we feel it must now be made mandatory for any firm that is potentially polluting nature through liquid gas or particle emissions to enrol their staff in short but instructive courses of environmental education. Too often firms pollute not just through accident or design but through gross ignorance by the labour involved of the destructive effect on the environment.
>
> Donald Aubrey
> Society to Overcome
> Pollution
> WCED Public Hearing
> Ottawa, 26-27 May 1986

90. In 1984, liquid gas storage tanks exploded in Mexico City, killing 1,000 people and leaving thousands more homeless. Only months after the Bhopal tragedy in India, which killed over 2,000 people and injured 200,000 more, an accident at a plant in West Virginia in the United States operated by the parent company of the Bhopal facility resulted in emergency evacuation of the community residents and some health problems. The accidental release in 1976 of the highly toxic and mutagenic chemical dioxin at Seveso, Italy, and the ensuing saga of drums of contaminated soil being passed around Europe, also showed that in industrial countries regulations can be evaded and minimum safety standards breached.

91. In early November 1986, a fire at a warehouse of a chemicals manufacturer in Basel, Switzerland, sent toxic fumes into France and the Federal Republic of Germany and released toxic chemicals into the Rhine, causing massive fish kills and affecting the vital water supply in countries downstream, all the way to the Netherlands. Scientists investigating the Rhine agreed that it could be years before the damaged riverine ecosystems would be to their former status.[48/]

92. Thus incidents at Mexico City, Bhopal, Chernobyl, and Basel - all occurring within the short lifetime of this Commission - raised public concern about industrial disasters. They also demonstrated the likelihood of significant increases in the frequency and magnitude of industrial accidents with catastrophic consequences.

93. These events point to the need to strengthen national capabilities and the framework for bilateral and regional cooperation. National and local governments should:

* survey hazardous industrial operations and adopt and enforce regulations or guidelines on the safe operation of industrial plants and on the transport, handling, and disposal of hazardous materials;

* adopt land use policies or regional development plans that would require or provide incentives to industries that have a high pollution or accident potential to locate away from population centres, and that would discourage people from moving close to plants and waste disposal sites;

* ensure that plant workers are provided with full information about the products and technologies they handle, and are given adequate training in safe operational procedures and emergency preparedness; and

* involve local governments and community residents in major siting decisions and emergency preparedness planning.

94. In many cases the consequences of accidents spill over national borders. Hence the governments of countries with hazardous industrial facilities should work with their neighbours or countries downstream from those facilities to:

* jointly prepare emergency preparedness plans for existing plants and sites;

* agree on criteria for selection of sites for such facilities, which would then be subject to pre-construction consultation, joint review, and emergency preparedness planning among the countries affected;

* start negotiations for an international treaty providing for prompt notification and mutual assistance in case of toxic chemical accidents; and

* agree on the minimum distance from an industrial site that would be subject to the risk management process.

95. Industrial accidents and their consequences are to a large extent unpredictable. In order to better identify risks, governments, international organizations, and industry itself should promote further development of technology/risk assessment methodologies, establish data banks on such assessments conducted, and make them easily available to all countries.

5. Strengthen International Efforts to Help Developing Countries

96. Pollution-intensive, resource-based industries are growing fastest in developing countries. These governments will thus have to substantially strengthen

> I think there must be a persistent push, a persistent effort towards establishing some kind of international code for areas of technologies having high environmental risks. At the moment not many in Indonesia would be considered as very knowledgeable industries. We need also this kind of thing in order to guarantee some kind of minimum safety for countries like ours to develop within the context of international economic relations.
>
> Speaker from the floor
> WCED Public Hearing
> Jakarta, 26 March 1985

their environmental and resource management capabilities. Even where policies, laws, and regulations on the environment exist, they may not be consistently enforced. Many developing nations have begun to build up their educational and scientific infrastructure, but their technical and institutional capacity for making the most of imported or new technologies remains small. Some countries thus continue to depend on outside technical and managerial skills for the maintenance of industrial operations. For lack of capital, they often find that a new industry can only be started with the support of foreign aid, commercial loans, a direct investment, or a joint venture with a transnational corporation.

97. Furthermore, the problems of developing-country governments are compounded by the vagaries of the international economic system, such as high debts, high interest rates, and declining terms of trade for commodities. These do not encourage hard-pressed governments to spend high proportions of their meagre resources on environmental protection and resource management. (See Chapter 3.)

98. The developing countries themselves will eventually have to bear the consequences of inappropriate industrialization, and the ultimate responsibility for ensuring the sustainability of their development rests with each government. They must define their own

environmental goals and development objectives, and establish clear priorities among competing demands on their scarce resources. They will also need to search for more self-reliant means of industrial and technological development. The choices are theirs, but they will need all the assistance - technical, financial and institutional - that the international community can muster to help them set an environmentally sound and sustainable course of development.

99. Large industrial enterprises, and transnational corporations in particular, have a special responsibility. They are repositories of scarce technical skills, and they should adopt the highest safety and health protection standards practicable and assume responsibility for safe plant and process design, and for staff training. The transnationals should also institute environmental and safety audits of their plants measured against standards at other subsidiaries, not just against those of other local companies, which may have less stringent requirements. These audits and their follow-up should be made available to governments and other interested parties.

100. Particular care is required in dealing with toxic chemicals and hazardous wastes, and in contingency planning for accidents. The views of non-governmental organizations and the local community should be sought in planning new industrial facilities. The relevant national and local authorities must be fully informed about the properties, potentially harmful effects, and any potential risks to the community of the technology, process, or product being introduced. The necessary information should be disclosed to the nearby residents in an easily understandable manner. The enterprises must cooperate with the local government and community in contingency planning and in devising clearly defined

mechanisms for relief and compensation to pollution or accident victims.

101. Many developing countries need information on the nature of industry-based resource and environmental problems, on risks associated with certain processes and products, and on standards and other measures to protect health and ensure environmental sustainability. They also need trained people to apply such information to local circumstances. International trade associations and labour unions should develop special environmental training programmes for developing countries and disseminate information on pollution control, waste minimization, and emergency preparedness plans through local chapters.

102. Many developing countries, particularly in Asia and Latin America, have adopted systems for environmental impact assessment. But the lack of institutional capacity and skilled personnel mean that these are often conducted by outside consultants, without quality checks. In some cases, government authorities would benefit from a second opinion on the environmental documentation they receive. Interested governments should create an independent international assessment body to help developing countries, upon request, evaluate the environmental impact and sustainability of planned development projects.

103. Regional organizations can, and should, promote research and development on environmentally sound technologies and their adaptation to local conditions, including environmental monitoring and assessment techniques, plant and process design, and policies governing the siting of industrial plants and projects. They should also encourage close working relationships between individual companies and regional institutions so as to provide training, technical assistance, and finance to local industries.

CHAPTER 8 - FOOTNOTES

1/ WCED wishes to thank John Elkington, Harris Gleckman, H. Jeffrey Leonard, Charles S. Pearson, and Dr. B. B. Sundaresan for their reviews of this chapter.

2/ As will be noted later in this chapter, the conventional classification of economic activities into three sectors - primary (agriculture and mining), secondary (manufacturing), and tertiary (commerce and other services) - has become increasingly ambiguous. Some economic activities cut across all three. Furthermore, the services sector has begun to occupy an important place of its own in industrialized economies. In this chapter, however, the term 'industry' will be used in the traditional sense to include mining and quarrying, manufacturing, construction, electricity, water, and gas.

3/ GATT, International Trade 1985-86 (Geneva: 1986).

4/ UNIDO, Industry in the 1980s: Structural Change and Interdependence (New York: 1985).

5/ See, for example, W.W. Leontief, The Impact of Automation (Oxford: Oxford University Press, 1986); F. Duchin, 'Automation and its Effects on Employment', in E. Collings and L. Tanner (eds.), Employment Implications of the Changing Industrial Base (New York: Ballinger Books, 1984); J. Rada, The Impact of Micro-electronics (Geneva: ILO, 1980); and D. Werneke, Microelectronics and Office Jobs (Geneva: ILO, 1983).

6/ UNIDO, Industry and Development: Global Report 1985 (New York: 1985).

7/ WHO, Urban Air Pollution 1973-1980 (Geneva: 1984); World Resources Institute/International Institute for Environment and Development, World Resources 1986 (New York: Basic Books, 1986).

8/ The UN Commission on Transnational Corporations has been working on a comprehensive code since 1977 but the sections on environmental and consumer protection have been virtually agreed. For other examples, see FAO, 'Code of Conduct on the Distribution and Use of Pesticides', Rome, 1985; UNEP, 'Guidelines on Risk Management and Accident Prevention in the Chemical Industry', adopted in 1982; and OECD, 'Declaration of OECD Member Countries on International Investment and Multinational Enterprise', 1976 and 'Clarification of the Environmental Concerns Expressed in Paragraph 2 of the General Policies Chapter of the OECD Guidelines for Multinational Enterprises', Paris, 1985.

9/ See, for example, International Chamber of Commerce, 'Environmental Guidelines for World Industry', Paris, 1976 (revised in 1981 and 1986); Hellenic Marine Environment Protection Association, 'To Save the Seas, Declaration of a Voluntary Commitment' and 'Guidelines for the Officers of HELMEPA Member Vessels', Athens, 1982; and U.S. National Agricultural Chemicals Association, 'Guidelines on Labelling Practices for Pesticide Products in Developing Areas of the World', Washington, DC, 1985.

10/ OECD, 'The Impact of Environmental Measures on the Rate of Economic Growth, Rate of Inflation, Productivity and International Trade', Background Papers Prepared for the International Conference on Environment and Economics, Vol. 1 (Paris: 1984).

11/ U.S. Department of Commerce, 'Plant and Equipment Expenditures by Business for Pollution Abatement', Survey of Current Business, February 1986.

12/ Japanese Ministry of International Trade and Industry, data compiled annually for the Industrial Structural Council, Tokyo, 1970-86.

13/ The UN Economic Commission for Europe compiles and publishes a 'compendium of low- and non-waste technologies'. A special department in the French Ministry of Environment collects and disseminates information on clean processes and technologies ('les techniques propres').

14/ See, for example, M. G. Royston, Pollution Prevention Pays (Oxford: Pergamon Press, 1979), and D. Huisingh et al., Proven Profits from Pollution Prevention (Washington, DC: Institute for Local Self-Reliance, 1985).

15/ Thus, more than 500 representatives of government, industry, and labour from developed and developing countries gathered at the World Industry Conference on Environmental Management in 1984 declared: 'Environmental management should be an integral part of economic development. Environmental issues should be addressed in the earliest stages of the economic planning and development process.' See 'Declaration of the World Industry Conference on Environmental Management', Versailles, 14-16 November 1984. As a result of this meeting, the International Environmental Bureau was established in 1986 as a specialized branch of the ICC to promote information exchange on vital environmental concerns among governments, industry, and other groups.

16/ UNIDO, Industry in the 1980s, op. cit.

17/ N. Namiki, The Japan Research Center, 'International Redeployment of Pollution-Intensive Industries and the Role of Multinational Corporations', paper prepared for WCED, 1986.

18/ OECD, Developments in Steel Making Capacity in Non-OECD Market Economy Countries (Paris: 1985).

19/ Namiki, op. cit.

20/ UNIDO, Industry in a Changing World (New York: 1983).

21/ FAO, Yearbook of Forest Products (Rome: 1985); UNIDO, Global Report 1985, op. cit.

22/ OECD, The State of the Environment 1985 (Paris: 1985).

23/ 'Industry Experience with Environmental Problem Solving', background paper prepared for the World Industry Conference on Environmental Management, organized by the International Chamber of Commerce and the UN Environmental Programme, Versailles, 14-16 November 1984.

24/ Ibid.

25/ UNEP, The World Environment 1972-1982 (Nairobi: 1982).

26/ V. Anikeev, Director of the Department on Environment and Rational Use of Natural Resources, GOSPLAN, during a visit by WCED to the GOSPLAN headquarters, Moscow, 12 December 1986.

27/ P. F. Drucker, 'The Changed World Economy', Foreign Affairs, Spring 1986.

28/ E. D. Larson et al, 'Beyond the Era of Materials', Scientific American, June 1986.

29/ Drucker, op. cit.

30/ For a discussion of various possibilities for industrial application of biotechnology, see J. Elkington, Double Dividends? U.S. Biotechnology and Third World Development, WRI Papers, No. 2 (Washington, DC: World Resources Institute, 1986).

31/ The 1986 annual report of the Japanese Environment Agency to the Parliament dealt extensively with this topic of the potential environmental impacts and risks posed by the new technologies. Quality of the Environment in Japan 1986 (Tokyo: 1987).

32/ The U.S. Government recently announced a comprehensive regulatory policy for ensuring the safety of biotechnology research and products. See 'Coordinated Framework for Regulation of Biotechnology', Federal Register, 26 June 1986.

33/ See OECD, 'Guiding Principles Concerning International Economic Aspects of Environmental Policies', Council Recommendation C(72)128, Paris, 26 May 1972.

34/ OECD, Economic Aspects of International Chemicals Control (Paris: 1983).

35/ The Conservation Foundation, 'Chemicals Policy in the Global Environment', paper prepared for WCED, 1986.

36/ National Research Council, Toxicity Testing (Washington, DC: National Academy Press, 1984).

37/ See 'Consolidated List of Products Whose Consumption and/or Sale Have Been Banned, Withdrawn, Severely Restricted or Not Approved by Governments', compiled by the United Nations, 1st revised edition, DIESA/WP/1, 1986.

38/ Notable examples include the International Programme on Chemical Safety (UNEP/WHO/ILO), International Register of Potentially Toxic Chemicals (UNEP), International Agency for Research on Cancer (WHO), and the UN's 'Consolidated List', op. cit.

39/ H. Yakowitz, 'Global Aspects of Hazardous Waste Management', prepared for WCED, 1985; U.S. Congress, Office of Technology Assessment, Superfund Strategy (Washington DC: U.S. Government Printing Office, 1985). U.S. estimates include wastewater in very dilute form. The result is a much larger estimate of total hazardous wastes for the United States than for other countries.

40/ Some other sources quote figures as high as 34 million tons for Brazil alone, and 22 million and 13.6 million tons for Mexico and India, respectively. See H. J. Leonard, 'Hazardous Wastes: The Crisis Spreads', National Development, April 1986.

41/ Estimates quoted in an OECD Secretariat paper, Paris, 1986.

42/ UNEP, 'Transfrontier Movements of Hazardous Wastes With Regard to Developing Countries', prepared for the Working Group of Experts on Environmentally Sound Management of Hazardous Wastes, Munich, 1984.

43/ Yakowitz, op. cit.

44/ OECD, Background Papers for 'Conference on International Co-operation Concerning Transfrontier Movements of Hazardous Wastes', Basel, Switzerland, 26-27 March 1985.

45/ See EEC, 'Supervision and Control of Transfrontier Shipments of Hazardous Waste', Council Directive, Brussels, December 1984; OECD, Resolution of the Council C(85)100, Paris, June 1985.

46/ UNEP, 'Transfrontier Movements', op. cit. See also M. J. Suess and J. W. Huismans (eds.), Management of Hazardous Waste: Policy Guidelines and Code of Practice (Copenhagen: WHO Regional Office for Europe, 1983).

47/ Preliminary findings of a study conducted for U.S. Environmental Protection Agency, 'Acute Hazardous Data Base', Washington, D.C., 1985, quoted in Yakowitz, op. cit.

48/ See, for example, La Suisse, 3-9 November; Die Welt, 10 November; Die Zeit, 14 November; Der Spiegel, 17 November; International Herald Tribune, 14-16 November 1986.