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ECONOMIC GLOBALISATION,
COMPETITIVENESS AND ENVIRONMENT

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0. General Introduction

This report is a contribution to the OECD study of globalisation and the environment. It addresses the second topic within the study, "Globalisation, Competitiveness and Environment". In our paper, we try to develop a clear view of the problems related to *competitiveness* and environment controls, using for illustration a wide range of available information for small, mid-sized and large firms in European countries and elsewhere. In this way, we provide a conceptual framework that we hope will be useful for assessing risks and prospects for environmental quality associated with firms' actions within the ongoing economic globalisation process.

0.1. Competitiveness and Globalisation

We define *economic globalisation* as the manifestation, on a world scale, of the social values and requirements of business competition. This takes place, increasingly, through « open » local and international markets, and is epitomised in the incessant (largely electronic) movement of capital and of information, as well as the growing volume of international trade. Much of this economic activity can be understood as the expression, at the world level, of priorities and prerequisites of business competition. In that sense, there is a direct link between competitiveness and economic globalisation.

Ecological globalisation, by contrast, manifests itself in environmental problems referred to in connection with WTO (World Trade Organisation) free-market issues, international agreements on air pollution (ozone, acid rain, greenhouse gases), ownership claims to the products of bioengineering, or the transportation and disposal of toxic waste. The emergence of agreements hides the fact that, for one thing, industrial activity has world-wide ecological repercussions (Faucheux, Noël, 1990), and, for another, that local environmental issues, such as the disposal of toxic waste, air pollution, the availability of drinking water, noise, etc. are closely related to capital movements and world trade. Links between local economies and international trade mean that important international connections exist even with respect to ensuring the quality of the environment and having access to resources at the local level. It is within this context that the notion of sustainable development has become a global concern, and that a world-wide market for environment-friendly goods and services has emerged.

In this context, we characterise *competitiveness* (or, in the French version, *competitività*) as a dynamic process involving learning, adaptation and innovation. Firms of all sizes, together with governing bodies and other social groups, have to adapt to changing conditions, and also bring about change themselves. For example the expanded scale of industrial activity brings new sorts of environmental threats such as toxic chemical emissions, climate change, possible mistakes with biotechnology, or aquifer salination.

It is easy to identify instances of competitive activity that have adverse impacts on the environment. We can also, however, identify ways that competitive economic activity can evolve in ways respectful of environmental quality, and in some instances to provide a positive solution to environmental quality and sustainability issues. This leads us to the following general questions. First, what are the social and technological preconditions necessary for the identification of *win-win strategies for firms*, that is (as defined by Porter and van der Linde 1995a, 1995b), business strategies that secure a healthy competitiveness while also achieving a desired level of environmental protection? Second, under what circumstances can competitive free-market business activity work in the directions of a *sustainable development*, that is, a form of economic activity that respects long-run concerns for the maintenance of ecological life-support systems and economic welfare prospects for future generations? These are quite large questions. In particular we will consider:

- *The fundamental role played by technological innovations in providing all types of firms (small businesses, multinationals, government-owned companies) with a certain amount of freedom to implement their own strategies.*
- *The important roles of governance (at the local, national and international levels) required in the search for firm win-win strategies combining business competitiveness and improved environmental performance, and also for promoting the larger social goal of sustainable development.*

As we will conclude, the achievement in OECD countries, as elsewhere, of the social cohesiveness and environmental quality objectives normally associated with the objective of sustainable development, will hinge on developing a new equilibrium involving several action principles, i.e. competitive motivation and the will of business on the one hand, and notions of general welfare and of collective responsibility for environmental quality on the other.

0.2. Sustainable development as social partnership between business, government & citizens

Competitive market processes produce losers as well as winners. While this is generally accepted as a normal part of business life, there are nonetheless concerns about some social consequences of these ups and downs -- such as unemployment and regional stagnation. But there are also concerns about categories of loss or damage that can be associated with business success, such as the negative health and ecological impacts of industrial production, mobility and consumption. There is concern about the fairness of these « external environmental costs » along several dimensions: health damage and habitat degradation suffered disproportionately by the poor in many regions, burdens on taxpayers and citizens to pay for health care and environmental improvements, and the irreversibility of natural resource exhaustion and many pollution caused damages that may impose heavy penalties on future generations of society.

We can see here an example of a general political problem, how to assure an acceptable distribution of economic opportunities and of sacrifices when goals of fairness are pursued. *Sustainable development* seeks to reconcile the attainment of goals traditionally linked to economic growth (such as increased material wealth) with ecological constraints on economic activity. This may require major changes in business strategies in the private sector and in regulatory measures by the public sector. In the early 1970s, at the time of the energy crisis and of a wide range of local environmental-quality issues being raised, regulations were traditionally set by the public sector. Then, in the 1980s, the political objective of sustainable development has represented an attempt to reduce the apparent dichotomy between economic growth and environmental protection. Today, sustainable development is often presented as a reconciliation between free-market economics, with its perceived benefits (productivity incentives, technological innovations, representing the basis for increased material wealth and consumer satisfaction), and the protection of environmental quality as a prerequisite for sustainable economic activity and direct source of general welfare. This view has implications for, and is reflected in changes of attitude by all the economic partners:

- In the private sector, firms have shifted (to varying extents) from a position of simple hostility towards environmental regulations -- perceived as obstacles and as the source of additional expenses -- to a more positive consideration of the environment as a strategic opportunity. The recent coining of the term "natural capital" to describe environmental resources with a potential commercial value (such as water, forests, fisheries, and even the atmosphere as a carbon sink) offers another indication that many environmental problems are turning into a concern of business management. This commercialisation of the environment -- or of environmental concern -- is often perceived as a win-win opportunity for a firm or industry, which may seek to increase or protect its competitiveness while at the same time responding positively to environmental issues.

- Government agencies and scientists involved in environmental regulations have recently started giving more attention to the manner in which environmental objectives can be incorporated into standard business practices.
- Increasing numbers of "green consumers" or individuals concerned by the environment, express their support for environmental quality goals and for the principles of cross-generation equity, and for commercial practices and policies respectful of these ideals.

0.3. Competitiveness and the environment: Porter's win-win concept

These inter-related developments lend some prima facie support to Porter's suggestion (1985, 1990; Porter and van der Linde 1995a, 1995b), that the growth of environmental controls (laws, policies, standards and public expectations) is not incompatible with continued economic competitiveness. However, it cannot simply be assumed that these simultaneous changes in public attitudes, business policies and government regulations are going to guarantee the conditions for long-term ecological and economic sustainable development (Palmer, Oates and Portney, 1995). The risk remains that changes are made merely in response to certain environmental problems, while other and perhaps more serious environmental impacts are being overlooked. So we must look with an open mind at the prospects for reconciling economic competitiveness with the priority of environmental protection.

0.4 Competitiveness and competition at the micro- and macro-economic levels

During the past ten years, competitiveness has become the catchword in a great number of debates, even though it is difficult to define the term accurately. The dangers of this overuse have been pointed out by certain economists (e.g., Krugman 1994), who see too much being claimed in the name of competitiveness and its derivatives. The idea remains nonetheless at the forefront of debates on economic policy. For example, in Europe, the Commission's 1994 *Livre Blanc* (White Book) refers to competitiveness as a key issue in a chapter entitled "Towards global competitiveness". Likewise, in the United States, the Competitiveness Policy Council reports annually to the President and to Congress.

In this paper we consider competitiveness and competition as two aspects of a dynamic process which requires proactive and reactive adjustments by business and governance institutions (Porter 1985, 1990).

- *Competitiveness* refers to the ability of an economic player to manufacture, distribute and expand over time, using its own resources and capabilities within a system of alliances and oppositions.
- The degree of *competition* reflects the amount of antagonism that exists among players at a given time. It is the rivalry among economic players (individuals, corporations or countries) which arises whenever two or more players fight for something which only one can obtain.

Economic globalisation resulting from expansion of world-wide trade and monetary circuits represents one of the more obvious changes to the manner in which *competition* operates. Globalisation also affects, sometimes profoundly, the *competitiveness* of individual firms or entire sectors, depending on their insertion and vulnerability in this global trading scene.

In this regard, we emphasise that competitiveness takes on a significantly different meaning depending on whether one places oneself at the level of a firm, an industry, or of a government (see also the paper on environmental policy and competitiveness by Jan Adams in this study). From a business

point of view, major competitiveness factors are still those described by the traditional variables of competition -- that is, profitability, keeping costs down, the setting of prices -- even though these variables are strongly influenced by how a company adapts to and positions itself on a market. Firms will focus particularly on their own input and output markets. On the other hand, states are strongly concerned with international competitiveness for sectors as a whole, such as measured by aggregate trade flows, etc. There can be complicated interplays between firm and state. In its home country a firm or an industry may consider an environmental pressure as a constraint and thus oppose the application of controls. Yet, after regulations have been adopted, industry may co-operate with the government to ensure that other countries enact rules that are at least as strict. Hence, the same regulation can represent a constraint for an industrial company at the domestic level, while it constitutes an opportunity on the international marketplace if the country manages to impose it internationally in such a way that it works to its advantage.

0.5. Structure of the report

Within the context of economic globalisation (deregulated free markets), *competitiveness* refers to the ability to hold on to a market share and to innovate under constantly changing business and regulatory conditions. It is in this context of continued adaptation and transformation that we have to assess the extent to which the environment can be a significant factor in the competitiveness of firms and, inversely, how attempts at achieving competitiveness can work to the benefit of environmental objectives and sustained growth. This leads us to focus our analysis on:

- *Technological change*, and the fundamental role which technological innovation can play in procuring greater freedom for firms to opt for strategies at all levels.
- *Public policy*, that is, the capacity of governments to bring about changes in market conditions, in part through the creation or expansion of regulatory institutions.
- *Evolutionary dynamics*, meaning the ways that individual strategies that are employed by firms to remain competitive in the short and medium run can -- over time and because of their compound impact -- lead to new difficulties that require quite new strategies.

As mentioned, economic globalisation constitutes one of the clearest trends of change in the conditions governing both competition and competitiveness. Everywhere in the world we can observe the increased impact on household and manufacturing entities of transnational financial movements, advertising and trade in retail products and services (e.g. Coca cola and CDs), and the wide spectrum of raw materials trading. The rise of concern about environmental degradation around the world (e.g. air pollution, traffic congestion, deforestation) and the emergence of increasingly wide-ranging environmental controls, can be considered an "unintentional repercussion" of competitive economic activity that, now, places pressure on firms to find new responses.

In these new circumstances, different people make widely different responses. Some, seeing great risks of ecological destruction and social misery, want to inhibit the globalisation tendencies. Others, more optimistic about the benefits from competition, nonetheless propose to channel the search for sustained competitiveness in socially and environmentally benign ways. So, can improved environmental performance be considered a significant factor in the growth or renewal of competitiveness? What are the conditions required for a true win-win strategy, not just at firm level (company and sectoral competitiveness) but also for whole national units and world-wide (concerns for sustainability domestically and internationally)? What is the connection between environmental strategies that are or might be adopted, and environmental policies and social legitimacy? These are some of questions addressed (though not always fully answered) in this report.

- In part 1, we suggest a typology of business approaches to the environment -- what we can call firms' *environmental strategies* -- emerging from our reviewing of empirical studies covering various economic sectors.
- In part 2, we describe the instruments and variables used by firms in order to implement a genuine win-win environment strategy.
- In part 3, we explain, using examples, the crucial role that environmental technological innovation can at times play in the search for a competitive edge and for an improvement in environmental performance.
- In part 4, we raise the question of how to modify the organisational structure of firms in order to operationalise the implementation of technological innovations aimed at linking competitiveness with sustainability.
- In part 5, we seek to give an answer to the following question: what would be required in social and institutional terms in order to bring about a win-win relationship between healthy competition and the protection of the environment? We show that allowing competition among manufacturers to become the only factor determining strategies in response to environmental considerations could lead to "locked" technological and social options being chosen which do not contribute to overall goals of ecological and economic sustainability. That is why we introduce, as complements to competitiveness, other notions such as the public interest and collective responsibility for the future.

1. A typology of business strategies on the environment

The proliferation of national, regional and international regulations resulting from growing popular pressure has placed additional environmental constraints on nation-states and on business. Environmental regulations are expected to play an increasingly important role in the shaping and development of future markets. They have the potential of providing or denying comparative advantages and affecting the conditions of competitiveness.

Firms producing all kinds of goods and services (e.g. transportation) are required to respond to controls that reflect increased concerns over health, safety, the quality of the environment and the preservation of natural resources. Environmental policies can be looked upon as simply causing additional expenses, as barriers to flexibility and, hence, as going against the grain of competitiveness. Nevertheless, the need for local, national and international environmental policies is an accepted fact. Moreover, and to an increasing extent, the private sector is actively involved in the negotiation and implementation of environmental policies. This does not just amount to a passive adjustment to imposed constraints, but can be part of either highly proactive or defensive environmental strategies. Existing analyses suggest that strategies implemented by firms with respect to the environment fall along a line between two extremes:

- (1) Firms pursuing a defensive strategy with respect to environmental issues. These are firms which view environmental restrictions as extra costs that must be kept to a minimum, or even reduced to zero whenever possible.
- (2) Firms opting for proactive or integrated environmental strategies. These firms anticipate new regulatory requirements and, on that basis, add environmentally-positive technological innovations to processes and products. They turn to their own advantage business opportunities provided by new research required to solve environmental problems.

Between these two extremes there is a wide spectrum of positions, such as the "follower" firms which adjust to new environmental regulations without participating in their drafting.

1.1. Defensive environmental strategies

Traditionally, firms have regarded environmental performance requirements defensively, that is, as an additional constraint to be side-stepped if possible. This defensive attitude was dominant in many industries up to the eighties. According to a recent major study by the European Commission's DG III (1995), firms most likely to engage in defensive strategies in Europe are major companies that are leaders in their field at home, but not multinationals, and, to a lesser extent, small and medium-sized firms. The sectors where this typically occurs are the machine, textile, food-processing, wood and paper, automobile and metallurgical industries. Within the EU, the tendency was particularly pronounced for some of the Mediterranean countries. (The study "Attitude and Strategy of Business Regarding Protection of the Environment" is based on a survey of 1,400 small and medium-sized firms and 60 large companies (multinational or not) in Europe, in all industries.)

In traditional economic analysis, the damages done to the environment through production and consumption activity are « negative externalities » which mean there is a socially inefficient allocation of economic resources. The policy objective then is to « internalise » this negative impact by, for example, a tax on pollution or a requirement to introduce more expensive « cleaner » technology. Viewed statically, those mechanisms amount to an increase in the costs that polluting firms would have to meet. Such additional costs may reduce the firm's ability to gain export-market shares or limiting its potential domestic-market penetration. Take, for example, the cement industry where

competitiveness is based on the securing of margins, because the product is fungible and there is little possibility of brand differentiation, and also the technology changes slowly and is easily accessible to competitors, so that there can be little differentiation among products. Cement production involves substantial atmospheric pollutant emissions. Yet only very stringent controls on emissions would be sufficient to create an incentive for cement firms to look for a new manufacturing method for cement, or for a substitute product, by which means they could turn the strict environmental performance requirements to their competitive advantage (Faucheux, O'Connor 1997).

To see how environmental performance can be a factor in competitiveness, it is useful to give some examples of different kinds of defensive strategies. First of all, firms may refrain from reporting their pollution-causing activities or from cutting back on the pollution they cause, simply in order to avoid the costs of such measures. Or they may make reluctant adjustment to environmental regulations after the fact.

For example, in the case of concern with sulphur and nitrogen oxide emissions causing acid rain, the reaction of automobile manufacturers has varied significantly from one country to the next. German manufacturers anticipated the arrival of controls requiring the use of catalytic converters, and indeed in some cases were pushing for such regulations (BMW announced that all of its cars would have catalytic converters starting with the 1989 models). By contrast, the French automobile industry was hostile to those measures. The German manufacturers had gained expertise in the technology. Not only were their cars ready to add converters (at low costs to owners), but also Bosch had a monopoly on some of the components of catalytic converters. The French automobile industry (in particular PSA) then declared that the proposed catalysers solution was a bad one, and offered instead to develop a clean engine. But rapid progress in regulations and the estimated 5-billion franc cost of the suggested research programme dissuaded the French from fighting for their point of view. They subsequently had to accept European regulations imposing catalysers and to meet the extra costs of adjustments in their car design and manufacturing processes (Faucheux, Noël 1990).

A more aggressive strategy is either to bypass or to block regulations. This is not limited to lobbying action within a country or within a trading community (such as the EU). Firms may engage in transfers of production or in dumping practices to export markets where the safety or environmental regulations are non-existent or not enforced. For example, Atochem, France's only manufacturer of CFCs, after opposing regulations on CFC gases, tried to find ways, following the adoption of the Montreal Protocol, to use the regulations to its advantage. The moratorium given to developing countries and Eastern Europe opened the way to the construction of new manufacturing facilities for CFC 11 and 12 in Tunisia. Another recent example involves some Western cement corporations, which have started operating subsidiaries in countries where regulations were virtually non-existent (Latin America) or where controls existed but were lightly enforced (Turkey, Poland, Hungary). For instance, French and German cement manufacturers have been competing hard to expand operations in Turkey, where environmental costs are low and demand is growing (Gramond, Setbon 1995).

Historically, the adoption of environmental controls in industrialised countries is correlated with the phenomenon of hazardous waste being exported to developing countries and in the expansion of operations of highly polluting industries, such as leather, metallurgy or asbestos in these countries. However, according to several studies (Jacobs 1994, Sprenger 1995), if environmental considerations are sometimes a factor in decisions to relocate a firm, they are seldom the only one and seem to have, at least until now, always played a secondary role as compared to other factors such as labour costs, the availability of raw materials, barriers to trade, access to markets, etc. Environmental costs do not seem to have a sufficient impact, on their own, to justify a decision to relocate. It should also be noted that defensive strategies, while sometimes profitable in the short run, can expose firms to high adjustment costs if changes in standards or market conditions should catch up with them. They can also be the cause of serious disruptions in the event of an accident. In 1984, prior to the Bhopal accident which caused the death of several thousand persons, Union Carbide was the world's tenth largest chemical firm. By 1994, it had fallen to 44th place (Cairncross 1995).

1.2. Proactive and integrating strategies of firms towards the environment

Some highly publicised accidents such as the Seveso toxic cloud release in Italy and the Bophal disaster in India, have changed public and regulatory opinion so that firms are now obliged to take a more proactive position. A growing number of polluting firms have begun to consider environmental protection as not just a constraint but as providing a potential competitive edge, owing to their competitive situation and falling margins as well as to the increase in consumer awareness of the ecology. For these firms, environmental strategy means conscious and systematic effort to incorporate environmental considerations into their full range of strategic business considerations.

Since the 1980s, the world has witnessed the development of what Porter (1990) refers to as the new competitiveness paradigm based on a dynamic vision. According to this view, competitiveness at the industry level may well be achieved through higher productivity or lower prices, but also by the ability to provide different and better-quality products priced higher than others. This seems particularly important for understanding competitiveness in international trade, since a growing share of international trade is in differentiated products for which competition is not just based on prices, as in the case of staple goods, but on other features (quality, servicing, innovativeness of products, etc.). Empirical studies point to the fact that consumer preferences cannot be accounted for exclusively by price considerations, which, in some instances, are secondary to value-for-money or quality criteria. For example, this is what is revealed by a survey on the "image of French products" conducted periodically in France on importers, by the Economic Monitoring Centre (*Centre d'Observation Economique*) of the Paris Chamber of Commerce and Industry in various countries.

Armed with this new concept of competitiveness, many firms take the view that, rather than maximising profits within a fixed set of environmental constraints, it is better to modify those constraints in order to gain a competitive advantage. In that perspective, environmental considerations may cause a firm to cease distributing an old product or to bring out a new one. They may also lead to the discovery and use of outlets for certain goods resulting from the manufacturing process. Under this technical arrangement, materials which used to be considered waste become by-products that can be sold. The environment hence introduces a new criterion for differentiating among products, including on the basis of the development of environmental standards or labels (ISO 14000 at the international level), as will be discussed below, or else causes changes in the properties of products, such as their useful life or their price-to-weight ratio. Leading European automobile manufacturers, for example, have been looking for a way to compute a recyclability index that could be used for business purposes. Concerns about the disposal of old vehicles have also given rise to discussions concerning the useful life of cars. In addition, the approach is causing changes to take place in the technical specifications of products (composition, weight, etc.).

Commercial success then depends on a combination of technical expertise (innovative processes and products, life-cycle analysis), the attitude of consumers (demand for "green" products) and public relations. The firm, by developing a proactive strategy, does not limit its business exclusively to already existing market segments but also seeks to influence changes in consumer perceptions and demand (product differentiation, acceptance, changes in behaviour, etc.). Lastly, a proactive environmental strategy contributes to the firm gaining a more positive image. Firms today often refer to their responsibilities with regards to energy efficiency, the scarcity of resources, chemical waste, the disposal of polluting substances, waste management, recycling and nature conservation.

This kind of proactive strategy is evident among many large multinational corporations in the industries, especially those that see themselves threatened by environmental controls -- namely electrical utilities, chemical firms, oil refineries and water-treatment plants (survey by DG III, 1995). The strategy requires a considerable expenditure of time and financial resources by firms, including the hiring and employing of experts in various fields (political analysts, legal advisers, consultants on

technical feasibility, market researchers, lobbyists, etc.). This high cost means that the practice is principally limited to large companies as well as to industry associations in which firms have a shared interest, in particular with respect to control measures. (Small or medium-sized firms are, statistically, less likely to contemplate such strategies, given the fact that they can hold on to an "environmental edge" only for a limited time, any barrier to entry disappearing after a short while.)

The famous example of Du Pont can be cited. Anticipating that regulations on CFCs were unavoidable, the company, one of the world's leading chemical firms and the largest manufacturer of CFC, had been conducting research into CFC substitutes since 1975 in order to obtain a decisive advantage in the distribution and manufacturing of those substitutes when the moment was right.

Likewise, in the debate over phosphates in laundry detergents, held to be responsible for the eutrophication of streams, Henkel, one of the four largest detergent manufacturers in the world, built up its production capacity for a substitute and then used existing institutions, German government agencies, consumer associations and advertising in order to gain a significant market share for laundry detergents containing the substitute, forcing other firms to follow suit (Benhaim, Schembri 1995).

Another example is that of Arco, the world's eighth-ranking oil company. Having developed a major research and development program starting in 1988, it put out a clean automobile fuel at the end of 1990. Arco had sales in 1990 of 19.9 billion dollars, or four times its total for 1986. Similar results were reported for 1992 and 1993. The company owes its success to a proactive environmental strategy which led it to bring out a new product that ended up influencing and anticipating environmental regulations (including some 1990 amendments to the Clean Air Act) in order to obtain a competitive edge in the highly competitive oil industry (Piasecki 1995).

1.3. The follower strategy regarding the environment

This strategy lies midway between the two extremes mentioned above. It is probably the most widespread tendency in the private sector at the present time. A follower is a firm that does not make the running with new innovations or lobbying for regulatory change, but adjusts purposefully to the new ground rules. Such behaviour can be motivated for a variety of reasons -- as on grounds of legitimacy, in order to avoid future accusations, or to secure future markets, or else simply to avoid being a loser in tomorrow's competitive race. For example, as mentioned above in connection with catalysers, it is the type of strategy which seems to have been adopted in the 1990s by the French automobile industry. Similarly, in the field of waste disposal, manufacturers are now preparing for new guidelines being progressively introduced at the European Union level (1991 Amendment to the 1975 general directive, and 1991 Directive on hazardous waste), without seeking to change those directives. They are also making ready to respond to provisions concerning packaging and priority waste as defined by the European Commission, which includes automobile carcasses (Directive 85/339 of June 27, 1985, on liquid foodstuff packaging and draft directive on packaging and packaging waste, which led to the adoption of Directive 94/62/CE at the end of 1994; see Seret 1996). The case of European cement manufacturers can also be cited. Despite a generally defensive approach to regulations concerning their main business, they have grasped at one significant advantage which could be gained from environmental controls. This is to develop their very minor side-business of waste disposal for industrial liquids and solids with a high and low energy content, such as hydrocarbon sludge, tar, pitch, solvents, varnishes, distillation residues, spent oils, tyres, residue from automobile-body crushing (see Faucheux, O'Connor 1997).

The "follower" strategy seems to have been adopted by a majority of firms. According to the 1995 DG III survey of firms, more than half the firms surveyed implemented measures in response to environmental regulations, from simple registration to the installation of capital-intensive pollution fighting equipment. But most of these (55 percent of the firms in the study), regardless of their industry, deal with environmental problems only to the extent required by regulations, and no more.

The smaller the firm, the more pronounced that attitude becomes. The main reason for this seems to be that environmental performance is usually perceived by small companies as a problem of compliance associated with non-productive expenditures.

These conclusions are corroborated by a 1994 survey of 175 firms (medium-sized and large) in the chemical and pharmaceutical industries and in services (financial services, information) located in the south of England (Garrod & Chadwick 1996). One of the conclusions of this survey (which had a 15-percent response rate) was that the primary motivation for pursuing environmental strategies is to obtain cost reductions (by way of recycling, for instance) and to comply with the law. Very few firms declared having radically changed their approach to the environment by adopting a proactive strategy. Most sought instead to incorporate the issue into their existing policies. This situation seems comparable to what has been observed in the United (cf. Frosh 1995).

As for France, it has been noted there that (1) only a minority of firms have become aware of the opportunities that are afforded by the consideration of environmental issues in management areas; (2) most measures, when implemented, are taken by large corporations; (3) the majority of small and medium-sized firms do not take any action with respect to the environment unless forced to do so, on the grounds of cost, personnel or diversification considerations (Chailloux 1996).

2. What instruments for environmental strategy?

The examples and empirical data discussed above show how important the consideration of environment performance can be as part of business strategies. So it is useful to look at the range of techniques that firms can use to identify, evaluate and also to publicise their choices of environmental strategy. Identifying these instruments can help to reveal the ways that firms' competitiveness and internal management practices may be influenced by changing external conditions, especially globalisation.

During the 1980s and 1990s, a large number of analytical tools and techniques for environmental management were created by firms with a proactive -- or in some cases "follower" -- strategy. Among those instruments are (1) the environmental review; (2) the environmental audit and report; (3) the environmental technology assessment, which includes cost-benefit analyses (CBA) and life-cycle analyses (LCA). The increasing use of such tools is an indicator of the extent to which the conditions of competition have changed from a situation where the quality of the environment was neglected to a context where firms are required to consider "all reasonable measures" aimed at protecting the quality of the environment -- such as eco-reporting, the introduction of best available technology, ISO 14000 certification, and so on (cf. Martin and Garcia 1997).

2.1. The environmental review

Environmental reviews are conducted when firms create a data base on the environment for the purpose of assessing their current environmental performance and subsequently perhaps perform audits and carry out monitoring on an ongoing basis. An environmental review is thus a first step in the direction of a comprehensive environmental management strategy.

According to the recent survey of firms in the south of England (Garrod and Chadwick 1996), environmental reviews have recently become a great deal more frequent, as 48 percent of the firms responding stated that they had performed an environmental review and 53 percent of those reporting that the practice started after 1993. However, the survey indicates, as does that conducted by the DG III (1995), that a substantial number of the firms surveyed had not yet undertaken an environmental review. Two reasons were given for this, namely that the firms either lacked the necessary resources or considered that such a procedure was not a priority.

2.2. The environmental audit and report

Environmental audits and reports were initially developed in the United States, to ensure that corporations there were in compliance with a complex anti-pollution legislation. A technique was developed in the 1980s by chemical and petrochemical companies to inspect and examine manufacturing facilities and processes (e.g., the legal requirement to report on toxic emissions into the air, following the 1986 creation of the Toxic Release Inventory, or TRI). In Europe during the 1980s, legislation on the liability of firms in terms of environmental protection was less stringent. However, European firms were encouraged to make use of environmental audit procedures by consumer groups towards the end of the eighties. In 1990 environmental audits for European companies represented between 30 and 40 percent of the environmental management business of Arthur D. Little, a company specialising in environmental audits, whereas in 1988 its only clients were European subsidiaries of US corporations.

The *environmental audit* is probably the best known and most widely used of all environmental management tools. Typically an audit involves:

- (1) an evaluation of the data needed for environmental reporting purposes;
- (2) an assessment of the environmental management system yielding information and setting objectives for improvement;
- (3) a verification of methods employed so as to take into account all of the collected data.

Some surveys (KPMG 1993, Welford 1994) have pointed to a rising trend to use this management technique. From 1992 to 1993, the number of British firms publishing the results of audits increased twofold, to 36 from 18. However, this trend concerns primarily multinationals, as opposed to small and medium-sized firms. The Welford (1993) report indicates that only one small or medium-sized firm issued an environmental audit in 1993. However this may be changing in at least some countries. For example, in Sweden since 1989 companies are required to publish the results of environmental protection measures in terms of applicable government regulations, which makes some sort of audit almost inevitable.

Apart from external reporting requirements, one of the primary purposes of collecting data on the environment is to improve the quality of a firm's management. Companies can operate in two ways. First, they can use the data for the purpose of training part of their personnel, which can then familiarise the rest of the employees with it. For example, British Petroleum uses its own staff to conduct audits, by setting up working teams from different corporate departments and various parts of the world. Or else, they can establish a working party responsible for monitoring issues brought to light by an initial audit or problem. Union Carbide became an after-the-fact specialist in this type of environmental audit procedure following the 1984 accident at Bophal. As discussed by Cairncross (1995), monitoring makes it possible to ensure that shortcomings noted in the informational audit result in real corrective action. British Gas, for instance, ranks the results of environmental audit on a scale ranging from essential events (matters that run counter to company policy or to the law) all the way to desirable events (matters that require a more hands-on approach).

Environmental reports are documents published by firms, usually as a by-product of a more complete environmental audit. One of the first company environmental reports of this sort was that issued by Norsk Hydro, a European fertiliser manufacturer. Published in 1990, it provided detailed statistics on manufacturing emissions and waste. Most emissions had as their source the fossil fuels used, a non-renewable natural resource (the fertiliser industry accounts for some 2 to 3 percent of world consumption). Fossil fuels causes emissions of effluents, which were measured whenever the fuels were used to produce heat. Norsk Hydro (1990) thus submitted reports on the various compounds discharged:

Waste compounds	Quantity
Ammonia	0 to 10 kilos of nitrogen per ton of nitrogen produced
Nitrogen oxides	0.3 to 4 kilos of nitrogen per ton of nitrogen produced
Nitrous oxide	0 to 10 kilos of nitrogen per ton of nitrogen produced
Fluorine	0 to 12 kilos of nitrogen per ton of nitrogen produced

Source: Borde and Douguet 1995

Since that time, other reports have been issued by hundreds of firms around the world. For example, the Swiss pharmaceutical company Ciba-Geigy compiles a report on the environment as a part of its regular complete audit on safety, energy and environmental protection. British Gas lists in its environmental report all aspects of its business having to do with environmental management, including soil contamination and energy savings, based on both qualitative and quantitative data.

Usually such reports do not specifically respond to external obligations, and for this reason (among others) the reporting conventions vary. One style that is common amongst British and American companies, is to document the polluting substances released by firms into the air, the water and the soil, and report on the rise or drop in polluting levels over time. Another approach, which originated in Germany, is to organise the information in terms of differences between what a firm uses up and what it puts out. This "ecobalance" principle takes into account inputs such as air, electricity and water required for production, and compares them to what the firm produces in terms of useable goods, pollutants and waste. However, the collecting of statistical data is not carried out using a sufficiently dependable technique (as to the sampling method, the consistency of assessment methods, the periodicity of measurements, etc.), thereby limiting the use that can be made of the reports.

Publishing an environmental report can, directly or indirectly, relate to the identification of business opportunities. On the one hand, significant sources of waste can be identified, and possibilities of recycling or better use can be considered. On the other hand, reports as communication exercises can raise the confidence of shareholders and consumers in the products offered for sale. A positive image can be translated into a business asset by way of an expansion of the market niche and an increase in brand loyalty, among others, as well as providing an advantage in the negotiating of regulatory agreements with government agencies. In these ways, the issuance of environmental reports stating that a firm produces "cleanly", without adverse effects on the environment, can become a strategic tool for internal and external use. Firms may also contract with outside companies having recognised expertise in the environment field, to perform an environmental audit. The detergent producer Ecover, for instance, asked Greenpeace to audit its manufacturing process and to draft and issue an environmental audit report. Being "approved" by Greenpeace constitutes an important strategic asset in the eyes of consumers (Cairncross 1995).

2.3. Life cycle analysis as a method of technology assessment

The origin of the Life-Cycle Analysis (LCA) goes back to the 1970s and the impact of the oil crisis on energy and material analyses (Faucheux and Pillet 1994, Faucheux and O'Connor 1997). The Life-Cycle Analysis approach responds to various needs for the quantification and management of natural resource inputs as well as categories of wastes. The method consists of two stages. First, an inventory provides an assessment of the environmental impact of a system, by examining the primary flows of raw-material removals and the ultimate discharge of waste, throughout the production process. Second, measures are made of the part played by each identified factor in terms of various categories of environmental impact.

It is a "comprehensive" approach, meaning that a measure implemented at a given point in the production process may generate, indirectly and elsewhere, other uncontrolled polluting emissions. In addition, the notion of "life-cycle" suggests that consideration should be given to the fact that a significant part of the pollution may be caused not just at the production stage but also at those of distribution and use of products. Lastly, the environmental impact must be considered from an overall point of view, as measures aimed at reducing one kind of pollution could cause an increase in another.

Life-Cycle Analysis is a tool making it possible for managers to orient their decisions towards choices of products and processes that are more acceptable from the standpoint of their environmental impact, either before production (choices affecting the extraction of raw materials) or after (in the manner in which products are used and disposed of). This approach to environmental management from the "cradle to the grave" of production is thus a nature support for proactive environmental strategy. As such, it is being used increasingly in decision-making and negotiations. In France, for example, a common methodology has been set forth for the food-processing sector. Europe's chemical companies have adopted a joint approach, exemplified by the APME programme for the development of data bases on the inventory of the life-cycle of plastics in Europe. Industries in Sweden and the

Netherlands have also developed this tool in connection with assisted product-design processes. Decisions concerning EU packaging waste regulations are being influenced by studies based on the LCA method. Several government agencies are creating ecological certification procedures for industrial products based on an LCA approach (e.g., so-called "ecolabels"). The scope of LCA has now gone well beyond industrial production to the design of industrial strategies.

For example, in 1994 and 1995, the Ford automobile company and BP Chemicals investigated the impact of a major industrial decision. In order to comply with regulations on the reduction of emissions of volatile organic compounds (VOC) from the painting of cars at manufacturing plants, they asked whether it would be more profitable to reduce pollution at the source (by investing in new processes for applying water-soluble paints) or to improve existing processes (by investing in an on-site air-cleaning unit).

Another example, in the household-appliance sector, is Electrolux which has been participating since 1994 in a Swedish industrial research project for developing an LCA assessment method known as Environmental Priority Strategies. In order to reduce the overall environmental impact of its operations, Electrolux has been investing in manufacturing, packaging and shipping, as well as in the use of products and their recycling. In its own manufacturing, Electrolux is reducing the volume of chemical emissions and solvents discharged by its facilities. With energy consumption considered as having a major environmental impact, expenditure has been made to lower the unit need for energy, water and chemicals in the manufacturing process. In order to improve reclamation and recycling, Electrolux has expanded its business, with the corporation's AB Gotthard Nilsson subsidiary recycling reclaimed steel, non-ferrous metals and paper, while its Gränges subsidiary has been developing new applications for recycled aluminium (Persson, Luttrupp, Ritzen and Abermark 1995).

3. Environmental technology innovation

The use of the analytical support and reporting tools for firms' environmental management tools described above, is one indicator of the growing significance of environmental performance in firms' strategic considerations. These analysis tools and information management methods are particularly important in the context of technological innovation, as they help orient the ways that environmental performance may be considered as a criterion in innovation choices. In this section of the report we discuss how environmental technology innovation can work as a dimension of strategy for competitiveness. This shows how technological innovation has the potential to open up « win-win » opportunities where both competitiveness and environmental performance are enhanced simultaneously.

3.1. Technological innovation : A key variable in win-win strategies

A close connection exists between technological change, industrial competitiveness and sustainable growth (Skea 1994, Faucheux 1997). This section reviews those links, focusing mainly on long-term changes in environmental technology. *Environmental technology* as we use the term, refers to all techniques, processes and products playing an important role in reducing pressures on scarce natural resources, in reducing pollution flows, and in the prevention and reduction of environmental hazards.

New forms of competitiveness are dynamic and increasingly international in nature. By dynamic, we mean that a competitive advantage is not dependent only on existing cost and price considerations (or, more generally, on the ability to perform within a given set of restrictions), but rather on the ability to innovate and bring about technological change so as to shift or even eliminate existing constraints. A dynamic competitiveness process is thus characterised by changes in technological as well as marketing opportunities. Inherent in this are elements of unpredictability, incomplete information and organisational inertia. But, while specific innovations and decisions may be unpredictable, maintaining competitiveness may depend on organisational features that enhance creativity and responsiveness to newly perceived opportunities.

The importance of this cannot be stressed too much. According to studies made by the Japanese government (MITI), some 40 percent of the world's production of goods and services over the first half of the twenty-first century may be from environment- or energy-linked products and technologies. This forecast explains why, for almost 20 years, Japan has been making the development of these technologies a priority, followed at some distance by Germany, The Netherlands, Sweden and Denmark (see MITI 1988; Miller and Moore 1994; Krupp 1992; Erkman 1996). More particularly, technological change is not, in this context, considered an exogenous variable of an unknown nature. On the contrary, innovation potential is seen as closely related to political choices, social conditions and economic institutions. Sustainable development depends on trajectories of sustained innovation and associated institutional changes that yield continually improved environmental performance as well as new market opportunities.

Many debates about prospects for sustainable development hinge on views about the extent to which technological change is thought to have the potential to reduce pollutant emissions and improve efficiency of natural resource, land and water use. Recent studies by the Wuppertal Institute in Germany can be given as an example. They develop the notion of MIPS (Material Inputs Per Service unit) as an indicator of improved environmental performance in economic production and product utilisation. If products, manufacturing processes and services are to be made significantly less intensive from an environmental viewpoint over the coming ten years, it is obvious that technological

progress must play a fundamental role, even though changes in consumption patterns should also be taken into account.

The links between environmental technology innovation and competitiveness prospects can be explored by identifying the different sorts of objectives or improvements that the innovations may attain (cf. Coenen, Klein-Vielhauer, Meyer 1996). For example, performance improvements may be achieved in regard to pollution control, or problems associated with the end of the life-cycle of products, or repairing ecological damage and rehabilitating ecosystems, or the monitoring and controlling the quality of the environment, reducing technological and ecological hazards, improved efficiency in use of natural resources, and so on (Valenduc, Vendramin 1996). The significance of innovation for competitiveness depends not only on the significance of the environmental performance, but also on the way that the innovation is incorporated within the production or service provision system. In this regard it is useful to make two distinctions:

- (1) between added technologies and integrated technologies;
- (2) between an incremental innovation and a radical innovation, which introduces the issue of the dynamics of technology (acceptance, penetration, saturation, etc.) over an extended period.

3.2. Add-on (end-of-pipe) technologies versus Integrated technologies

Much of the new environmental technology can be considered to be of the "natural capital augmenting" type. That is, it either seeks to improve the productivity of natural resources or else make it possible to reduce the adverse effects of pollution and waste corresponding to a given level of production of goods and services. In this connection, it is useful to distinguish between the following:

- (1) *Add-on, or end-of-process technology*, is any modification made *ex post* to a production or machine use process that alters its environmental performance. It frequently consists of incremental changes to existing technology, such as the addition of dust filters in smokestacks, or steps taken to collect and dispose of sewage and industrial waste materials rather than letting them go in uncontrolled fashion into rivers or lakes. This is the type of technological innovation that has served as a basis for the development, starting in the 1970s, of the so-called environmental industries. It is the « cleaning up » sector. The technologies include processes and products for waste separation, storage and disposal, such as incinerating techniques for industrial waste or systems for cleaning up contaminated soil. The techniques do not prevent the creation of polluting substances, rather they are employed for reducing the impact of the toxic substances through controlling the final destination and form of the emissions. One problem is that such measures frequently shift the environmental problem from one place to another (e.g. toxic solid wastes rather than toxic smoke) instead of eliminating it.

During the past 20 years, many firms have incorporated this sort of end-of-pipe technology, either to help their own business comply with regulations (if they cause pollution), or in order to provide a service (acting as a part of the cleanup sector) ensuring that others may comply *ex-post* with regulations. According to the DG III study (1995) of European firms having resorted to technological measures in response to environmental controls, 46 percent had installed equipment of the add-on technology type, with the figure rising to 49 percent when only small and medium-sized firms are considered. The data vary significantly from one country to the next, with 88 percent in Italy as against 18 percent in Germany.

- (2) *Integrated technologies, also referred to as clean technologies* (see Duchin, Lange and Kell 1995; Frosh 1995) are new production or service methods whose whole conception is to reduce environmental harm. Rather than, for example, capturing polluting substances after they have been produced (as with the end-of-process technologies), the ideal is not to produce the harmful substance at all, or to produce less of it, or a less harmful one.

(4) The generalised labelling of plastic parts, for easier disassembly and sorting (Chailloux 1996, Serret 1996).

The technical aspects of the manufacturing process can also be affected, leading to an alteration of existing techniques (addition of technology, equipment alterations) or to the development of new processes. This can give rise, for example, to a re-examination of technical aspects having to do with the assembly stage, in light of the new notion of "disassembly". Xerox, for example, has become a leader in component products which can be disassembled. Canon has innovated by inventing recyclable and reusable cartridges. In the European automobile industry, consideration of the end of the products' useful life has also led to a simplification of assembly systems (systems suitable for rapid stripping, with a reduced number of fastenings and greater uniformity and accessibility) and to the development of disassembly techniques at newly-created pilot facilities. BMW has taken the lead with the first fully recyclable car (Cairncross 1995).

Table 1. Comparison of add-on and integrated technologies

	Add-on technologies	Integrated technologies
Overall productivity	Productivity drop	Potential for productivity increase
Cost of production	Higher	Potential for cost reductions
Investment expenditure	Low	High
Fixed-cost increase	Not in general	Possibly
Information and access cost	Low	High
Adaptation or conversion cost	Low	High
Compatibility within firm	High	Low
Financial risk	Low	High
Position on market for		
environmental technologies	Very good	Potentially very good
International competitiveness	Tendency to be lower	Future competitive advantages

(Source: Coenen, Klein-Vielhauer, Meyer 1966, p.37)

Some integrated technologies are of the "eco-restructuring" type, associated with the notion that new technologies will make it possible to "dematerialise" manufacturing, as mentioned above, and to "decarbonise" energy production, by changing over to natural gas and later to hydrogen (Ayes 1991, 1995). The United Nations University of Tokyo has created an eco-restructuring research program, as has the Wuppertal Institute in Germany. Industries making use of new technologies selected on the basis of improved environmental performance are sometimes referred to as "ecology industries".

Investment in integrated environmental technology is part of a proactive environmental strategy which can, in the long run, turn out to be a win-win approach. The competitive advantage of the innovation gives access to, or creates, a specific market segment. Worth mentioning is the case of Warner Lambert, a very marginal US pharmaceutical company operating in an industry dominated by giant corporations, but which nevertheless created the first fully (100-percent) biodegradable polymer, Novon (a water-soluble plastic made from starch). This firm has suddenly become very active in the environmental field.

3.3. Incremental innovations / radical innovations

The question may be asked whether integrated technologies can generate a new impulse to innovation in favour of genuinely sustainable growth, which goes beyond mere environmental-protection imperatives. In order to answer the question, another distinction may usefully be introduced, between "incremental" and "radical" innovations (Freeman, Soete 1987). This distinction does not apply exclusively to environmental technology, but rather comes from evolutionary theory of technology change.

(1) *Incremental innovations* are improvements to products or manufacturing techniques occurring continuously throughout the history of the class of technology. They do not result in major transformations but are essential to secure productivity improvements, gain market share, or deal with fashion trends. For example, the successive versions of existing software programs represent incremental innovations.

(2) *Radical innovations* cause breaks in the continuity of evolving processes or products, leading to the transformation of methods of production or distribution. They serve as a starting point for the development of new technical systems or new technological trajectories. The convergence of several new technical systems, at a time of economic recession, causes a turnaround and makes it possible for a new business cycle to start. The personal computer and the CD-ROM are examples of radical innovations.

Most environmental technology innovations, whether add-on or integrated, belong to the category of incremental innovations. This is indicated by the frequent use of terms such as "improvement", "reduction", "substitution", etc. to describe them. Nevertheless, radical innovations also can occur in response to environmental objectives. Chlorine-free chemical processes, organic fuels and photovoltaic energy generation would fall into that category, because their introduction can have far-reaching consequences for economy-wide production and consumption and lifestyles.

This raises the important point that environmental technology innovations often result from radical innovations made in other technical fields, such as synthetic chemicals, new materials, biotechnology, electronic data processing, etc. In other words, radical break-throughs in environmental technology originate today with advances in other fields of technology. In part this may be because of relatively low investment in environmental research (Valenduc, Vendramin 1996), but it also shows the transversal character of discovery and innovation.

For these reasons, improvements in environmental performance can be expected as one product of a strong research/innovation culture, not just through the specification of environmental goals. This may be an important lesson for regulatory policy. Recently in several parts of the world there have been initiatives to use information on technology as a frame of reference for the implementation of regulatory policies. The most efficient technology, relative to a particular environmental criterion (such as primary energy needs or emissions of a major pollutant) has been termed the best available technology, or BAT. The notion thus may refer to the technology that, for a given product or service category, uses the least energy per unit output, or contaminates the least land, or minimises discharges of polluting waste. However, it could prove very costly to seek and achieve conditions that are largely pollution free. So the application of BAT standards in combination with a concern for the firm's survival has led to the notion of "best-available technology not entailing excessive cost" (BATNEEC). Following Pearce and Brisson (1992), the term refers to a pollution-control technology that is "reasonably obtainable" in the sense that the technological option for protecting the environment is perfectly practical and entails only reasonable costs.

The BATNEEC as a performance standard is introduced in a number of regulations, for example concerning air pollution and some toxic emissions under European commission directives. There are difficulties with application of BATNEEC. From a theoretical point of view, Forsund (1993) points out that if the cost (per unit of output) of installing systems using the agreed best-

available technology at several individual facilities varies significantly from one firm to the next, the same environmental quality overall could be achieved at a reduced cost to society through a more flexible policy designed for individual sources. Another problem is that the evaluation of environmental performance may depend on several criteria (e.g., different pollutants into air, water or land media, with differing toxicity properties), so a technology that is best from one point of view may be less-than-best from another. This becomes especially significant as firms shift to integrated technologies away from single-objective end-of-process techniques. There is a need to apply such standards in a flexible manner.

3.4. Advantages and shortcomings of environmental innovation

Environmental technology innovation provides many competitive advantages but is also held back by many obstacles. The advantages of environmental technology innovation include the following:

(1) *Opportunities for reducing costs.* Environmental technology provides opportunities for lowering production and distribution costs by making use of potential increases in ecological efficiency. Integrated technology can help reduce production costs and increase productivity, a great deal more so than add-on technology. Some examples can be cited. Texaco has greatly gained in profitability by cutting back on waste-water discharges (by 40 percent) and solid and toxic emissions (by 58 percent) (Cairncross 1995). Riker, a pharmaceutical subsidiary of 3M Corporation, has developed water-based capsules to replace those made with solvents. The change-over required an initial expenditure of 180,000 dollars for pollution-control equipment, but has resulted in annual savings of 15,000 dollars and prevented the emission of 24 tons of polluting substances into the air. More generally, 3M has earned an estimated 500 million dollars since 1975 through its policy of environmental technology innovation (Walley and Whitehead 1994).

(2) *Quality improvements.* Environmental technology innovation is easily made part of the "total quality management" approach. There are even references today to "total quality environmental management". The conventions now being established for an international standard for environmental audits (ISO 14000) will bring environmental management closer to "total quality" management (ISO 9000). The US-based multinational corporation 3M provides a perfect illustration of this trend, with its Pollution Prevention Pays (3P) program, whereby every project must fulfil four criteria: eliminate or reduce a polluting substance, contribute to the environment through energy savings or a more efficient use of manufacturing materials and resources, demonstrate an ability for technological innovation and save money by reducing cleanup costs (Shrivastava 1995). It may be noted that 3M uses life-cycle analysis to assess the value of all the technology it develops or seeks to develop, enabling it to prevent unforeseen adverse outcomes and reduce costs. Also worth mentioning in this context are Chevron, with its SMART (Save Money and Reduce Toxics) programme, Texaco with WOW (Wipe Out Waste) and Dow Chemical with WRAP (Waste Reduction Always Pays).

(3) *Competitive advantages.* As indicated earlier, environmental technology innovation may provide firms with an opportunity to pursue unique and exclusive strategies. A small or medium-sized business can gain a competitive edge and become a leader within a strategic market segment. Examples of this were cited earlier. The Body Shop is another. The company has created a genuinely "green" business within a cosmetics industry that used to be dominated by major multinational chemical corporations.

(4) *Social responsibility.* Environmental technology innovation makes savings possible in public health-care budgets and helps firms gain social acceptance and legitimacy in the marketplace.

(5) *The possibility of influencing legislation.* Firms developing or implementing environmental technology innovation have the possibility of influencing legislation to their benefit. This can in turn give them a competitive edge over others in the industry. For example, Germany's head start in

regulations applicable to the cement industry and their implementation has enabled German cement manufacturers to develop and make use of the latest end-of-process technology, while at the same time conducting research into integrated technology for recycling and reusing gaseous emissions, as well as for improving energy efficiency (OECD 1993). At the same time, the German cement industry, by pushing for European regulations, has secured a medium- and long-term competitive advantage in certain segments of the market. Other examples, more widely known, were referred to earlier, such as catalytic converters and the competitive advantage of German automobile manufacturers, and the strategy of Du Pont with its CFC substitutes, etc.

Japan is one country where the importance of the competitive advantage has been well appreciated. The general policy there has been to encourage industry through fiscal and research incentives to develop a wide environmental technology "portfolio", so as to ensure that there is flexibility of response in the face of unpredictable economic and environmental changes. It is further presumed that such a portfolio will enhance Japanese international competitiveness in the medium and long run (5 to 50 years ahead), during which period environmental technology innovation is expected to play a crucial role. Outside of Japan, many large corporations, including chemical companies such as Du Pont and Dow, have also seen the advantages of this flexibility and acquired considerable expertise in various fields of environmental technology (recycling, waste and water treatment, disposal of toxic waste, risk management, etc.).

With so many potential benefits at stake, why do not more firms invest sooner in environmental technology innovation? In fact, many obstacles stand in their way (Shrivastava 1995a, 1995b). Among those obstacles are the fact that environmental performance is only one axes of possible competitive advantage and an ambiguous one at that. Environmental policy is marked by complicated, vague and contradictory regulations (in particular for different jurisdictions, i.e. local, regional, European, etc.). Added to this is the inertia displayed by many firms. All this said, two particular hindrances are the following:

(1) *Lack of environmental expertise and information.* Technological solutions have not yet been found for certain environmental problems, and there is uncertainty as what the regulatory obligations may be. Under such circumstances, many firms have chosen to wait because they are not in a position to finance basic research nor to take too many investment risks if policy changes leave them in a cul-de-sac. In the European Commission DG III report (1995) referred to above, more than 75 percent of those polled (the percentage was significantly lower in Germany and The Netherlands) stated the desire for additional and clearer information about environmental regulations and available technological solutions.

(2) *Development costs.* Although technical solutions may be available, the cost of implementing them may still be high. When this happens, some firms -- especially small and medium-sized ones -- prefer to adopt a wait-and-see attitude. Capital investment for environmental technology takes longer to pay for itself than most investment outlays. This can act as a disincentive for firms that are ruled by requirements of short-term performance. Furthermore, given a firm's limited financial resources, different types of capital expenditures compete for funds. Choosing an environmental technology in a search for competitive advantage may well be risky, and at any rate less attractive for the firm than investing in another area.

For example, French cement makers do not always use the best available technology. The utilisation of bag filters by this sector would reduce dust-particle emissions by a significant 0.5 mg. per cubic meter. The technology is rarely used, however, owing to its higher cost, in particular in terms of maintenance (Faucheux and O'Connor 1997). Another example is the European pesticide industry. Data supplied by the agrochemical sector reveals that research and development expenditures have increased considerably over the past ten years and environmental testing accounts for a significant share of the costs. Environmental and toxicological tests reportedly combine to account for between 25 and 40 percent of R&D expenditures, estimated at some 150 million dollars

per molecule (Nadai 1996a, 1996b). Yet, in the case of agricultural chemicals, market conditions make it impossible to earn an adequate return on investment in environmental technology. The European Crop Protection Association reports that profit margins at agrochemical firms operating in the European Union over the past twenty years fell to 6.8 percent of sales in 1990, from 10.5 percent in 1981, and it is claimed that environmental regulations were the primary cause of the drop. The situation has led a growing number of firms to put pressure on governments to improve patenting and to extend the life of patents. This would, however, result in a trade-off between the profitability of innovations and their availability. The life of a patent determines how much a producer of speciality goods can expect to earn from holding a monopoly.

These many examples show that the commercial advantages that can be gained from a proactive environmental strategy depend a great deal on the type of technological innovation concerned, as well as the regulatory and market conditions. Nothing automatically assures a « win-win » prospect for a firm. In fact, environmental performance obligations can seriously complicate the life of firms, because of the way that external (public image, social responsibility) and internal (cost, technical mastery, personnel training and management) considerations are wrapped up together.

4. Changing organisational structures for win-win strategies

Pursuit of competitiveness under changing national and world conditions is also reflected in organisational change of firms and sectors (Chandler 1962, 1977). In a firm, the process of environmental technology innovation can require changes in working relationships and result in the need for new research and monitoring. Consideration of environmental issues can occur at several levels. It can involve the creation of a specialised field with its own structures, the addition of an extra variable to an organisational chart or the implementation of environment-specific concepts throughout management. In-house discussions can result in the creation of new departments (environment division, recycling division, etc.) and cause the inclusion of an additional parameter at existing ones. The environment can also cause the business of the firm to evolve or be a catalyst for new activities. Major innovations can also result in external organisational changes, such as in the case of the establishment of new connections for obtaining raw materials and semi-finished inputs, as well as new marketing strategies (in particular in the case of product innovations) and measures aimed at recycling and processing waste. Many changes can then be introduced by means of vertical and/or horizontal integration, through the setting up of new co-operation alliances among firms and within sectors, and even, as will be discussed in part 5 below, through new types of agreements between firms and governments (Martin and Garcia 1997).

4.1. Changing the internal organisation of firms

A simple way to discuss organisational change of firms is in terms of the structure of the market (S), the behaviour of firms (B) and performance (P), as proposed by Bain (1951). These three elements can be seen as interactive over time. For example, a firm's profitability, market share or environmental performance has an impact on its subsequent strategies (or behaviour), which can contribute to modifying market structures. The Du Pont Corporation, for example, adopted early on a particular research strategy (behaviour) when it elected to emphasise research into CFC substitutes. Subsequently, a strong negotiating activity (in support of regulations on the reduction of CFC emissions) enabled Du Pont to improve its performance by securing a competitive edge in the new market conditions and structures that changed to its advantage.

Changes in the market structure generally go hand-in-hand with changes in a firm's internal organisation. It can easily be observed, in many large corporations, how the introduction of environmental factors in business and management strategies leads to a transformation of internal structures. The trend is particularly visible in the chemical industry. Rhône-Poulenc, ICI, Bayer, Union Carbide and Ciba, for instance, have added special "environment" divisions and, at the same time, created incentives (e.g. the Proforis employee-motivation programme, or PRISE) to ensure that activities are horizontally co-ordinated (Chailloux 1996). Recognition of the environment as a competitiveness-determining variable has also resulted in the introduction by Rhône-Poulenc of a certain degree of horizontality within its predominantly vertical structure.

The trend is also in evidence in the automobile industry. For example, Renault has focused on the disposal of used vehicles and created new structures as a result (recycling programmes). Also, while Renault's policies were until recently based on four considerations, i.e., quality, cost, time and weight, recycling has now been added. In addition, the French automotive manufacturer, which used to operate according to a matrix-like business structure, has now included recycling as part of its projects as well as operations.

Consideration of environmental issues can cause a firm's business to change dramatically, and/or result in its expanding into new fields. The cement industry can be taken as an example for its

growing secondary business of toxic-waste incineration (Faucheux and O'Connor 1997). Another case is that of Ricoh, an electronics company, which single-handedly developed a substitute for a polystyrene that is easier to recycle, to be used in packaging. The company has developed a cardboard-based packaging with the same properties as packaging made of polystyrene. Ricoh has improved its cardboard packaging so that its electronic components will cause less environmental pollution (Persson, Luttrupp, Ritzen and Abermark 1995).

4.2. Changing the external organisation in response to the environment

Environmental technology innovation can, equally, provoke external organisational changes, such as new co-operation among firms or between firms and the government. The environment here becomes a factor in the evolution of relationships between firms and others they do business with, either vertically (as in the case of industries and business contacts upstream or downstream from production), or else horizontally (companies in the same sector), or even with respect to links with other entities (government, consumers, etc.)

For example, influenced in part by questions of liability in relation to environmental impacts and accidental damages, insurance companies and other financial institutions are revising their relations with business firms. For insurance companies, environmental hazards belong to a special category of risks (Schmidheiny 1992), not just because accidental damages can be very severe but also because of the uncertainties associated with gradual pollution, occurring over a long period of time. This can lead to increased attention by companies to their environmental management, because of the possible exclusion of accidental pollution risk from coverage under general policies. Likewise, banks have been expanding the scope of their management audits to include environmental aspects, in particular in the case of mergers and acquisitions or in connection with the creation of environmental funds.

Other changes in relations among participants at the various stages of an industrial process can be identified (see the the European Commission report on the topic of "Structures and trends in the environmentalisation of industrial relations in EEC countries," 1993). Changes in relations with "upstream" participants in the system (subcontractors and suppliers) provide a vivid example of this, bringing about stronger links and demands for evidence of the environmental quality of goods. Many factors are contributing to this, including the certification procedures required of suppliers in certain instances. In the automobile industry, for example, the fact that manufacturers are taking into consideration the disposal of scrapped vehicles has had repercussions for all firms operating upstream, whether they are parts suppliers or processors and chemical companies supplying raw materials. Business links are developing between manufacturers and suppliers, in connection with the development of recycling systems or of designs that take into account disposal problems, as well as between the various suppliers of automobile manufacturers (as in the case of the invention of Valcor in 1991). Giving consideration to the environment and in particular to the disposal of used products has also resulted in the development of a new set of interconnections between firms operating downstream from manufacturers. It can lead to the joint creation of business entities. In the case of the automotive sector, it has resulted in joint operations being set up by manufacturers and downstream companies to develop recycling systems. For example, a joint project by PSA, Compagnie Française des Ferrailles (CFF) and the Vicat cement company resulted in the creation of a facility for pre-industrial applications at Saint-Pierre de Chandieu. There have been other agreements of the same type (such as between Renault and CFF at Athis Mons in 1992). In addition, the organisation of the sector has tended to put more emphasis on quality (merger of two trade associations of scrap yard companies in 1995) (Chailloux 1996, Serret 1996). Finally, the growth of certain environmental-policy instruments such as voluntary agreements also illustrates this trend. The French master agreement of March 1993 on the processing of scrapped cars was signed jointly by representatives of the automobile industry and the government.

In the case of horizontal relations among firms in the same line of business, mergers can be encouraged in order to achieve greater concentration and economies of scale. Given the unpredictability of environmental developments and the importance of capital outlays for environmental protection, co-operation is particularly attractive for firms pursuing a proactive environmental strategy. Many categories of agreements call for a sharing of environmental risks and costs. Alliance strategies range from simple co-operation agreements to mergers and acquisitions. Their typology can be derived from examples taken from various industries and countries.

(1) *Co-operation agreements for the development of new processes.* France's Rhône-Poulenc and Sweden's Kenura set up a jointly-owned subsidiary in 1990 to look for more efficient and cheaper ways of fighting water pollution. In September 1992, SITA (a subsidiary of Lyonnaise des Eaux) and Rhône-Poulenc jointly created TERIS to develop their know-how in the treatment of industrial waste. The principal manufacturers of CFC have formed a strategic alliance known as ICOLP (for Industry Co-operative for Ozone Layer Protection) to develop substitutes. Fertiliser firms are seeking to develop electrolysis-based processes in order to replace gases which are now needed to manufacture fertilisers. Still, the development of new processes depends on trends in the relative price of natural gas, regardless of the successful outcome of research into cheaper electrolytic processing. France's EDF estimates that the development of electrolysis for manufacturing could not be profitably employed in the fertiliser industry before 2010. As can be observed, the success of a win-win strategy does not depend merely on co-operation conditions but also on how the market is regulated. There are also co-operation agreements between European cement makers and parts manufacturers, for the development of new processes and to conduct basic research into combustion and flame control. One of the objectives of the research is to measure the influence of the type of burner and fuel used on the production of NOx, in order to develop burners with lower emissions of NOx. Likewise, co-operation agreements on research into alternative manufacturing processes for cement exist as part of the research and development programmes of the European Cement Association (Cembureau), in part due to fear of a tax on CO2 and energy (Gramond, Setbon 1995).

(2) *Co-operation agreements for the development of new products.* Siemens and Bayer have developed catalytic converters for the denitrification of flue gases in order to lower nitrogen oxide emissions. Elbo, the public authority operating the Athens bus system, and Rhône-Poulenc have designed a catalytic converter for diesel engines which cuts back on exhaust fumes.

(3) *Co-operation agreements for the recycling of packaging and products.* Eco-emballages is a company founded in 1992 in France by a group of packaging firms and manufacturers and distributors of packaging materials. In the automobile industry, the issue of scrapping vehicles has been the object of several agreements involving either just manufacturers or other industry firms as well. Agreements on the development of a recycling network have been signed, such as the 1994 pact between Renault, BMW and Fiat, which Rover later joined. Research agreements have in addition been signed by French manufacturers and some of their competitors (the 1995 agreement between Renault and Mercedes-Benz). In the automobile sector, it is estimated that 75 percent of a car's weight can be reused or recycled, while 25 percent is disposed of as waste, with 50 percent of that waste being represented by plastics. Given the fact that the average car weighs one ton, 250 kilos of non-recyclable waste is generated for each car that is put on the scrap heap. Public pressure, legislation and the growing cost of waste have caused the automobile industry to develop a new recycling strategy. Projects have been started for salvaging various materials such as metals, plastics, rubber, etc. BMW has a recycling division. Its strategy consists of selecting components and materials which can be used again for manufacturing new cars. Recyclable products are supposed to be used by the company itself. Plastics for bumpers are reclaimed and used again to make new bumpers. BMW is developing its own know-how and constantly improving it in order to gain a competitive advantage. At the same time, the German firm is involved in a joint project with Fiat and Renault. The three companies are mutually responsible for salvaging vehicles covered by this co-operative agreement on their respective domestic markets. One of the reasons for the success of the agreement is the shortage of original raw materials and their rising prices. In addition, BMW wishes to protect its image and

wants to be able to meet the growing demand for "green" consumer goods. Co-operation can also involve firms from other sectors. In 1990, PSA, the maker of Peugeot automobiles, launched various recycling programs and vehicles designed to be disassembled and recycled. In 1991 it built a pilot plant jointly with the salvaging firm Compagnie Française des Ferrailles and Vicat, a cement maker. The plant has three units. Ecoval is a facility for disassembling and separating polluting materials, Purment salvages metals and Valerco processes residues and reclaims tyres and plastics. Plastics are also recycled jointly with suppliers. At the same time, PSA has been participating in the RECAP (for Recycling of Automobile Plastics) programme since 1991, along with Enichem, ICI and Fiat Auto. The aim here is to reuse and recycle all residues from polymers from the manufacturing stage of vehicles through their final scrapping. Since 1988 Renault has been experimenting with Rhône-Poulenc on ways to handle wheel axles. Renault also recycles bumpers jointly with Aparyl, etc.

(4) *Mergers and acquisitions.* This type of strategy can be justified by a desire on the part of firms to focus on their core business and to reduce risk exposure and the cost of implementing environmental technology innovation. Rhône-Poulenc and Sita have acquired, through their jointly-owned subsidiary TERIS, the business of SCORI, a company specialising in the disposal of waste with cement makers. Elf Atochem has taken over several small CFC manufacturers in Greece and the United States in order to increase its capacity to conduct research into substitutes.

All of these co-operation strategies are built along the principle of quasi-integration (Aoki 1986). They offer a number of benefits. Co-operation on environmental technology innovation is a long-term relationship. Each party is familiar with the products and processes of the other, thereby overcoming the problem caused by asymmetrical information. The situation tends to inhibit opportunistic behaviour, even though "cheating" behaviour may continue to exist.

This sort of co-operation may be a significant factor in commercial globalisation. The process of strategic alliances leads, typically, either to more concentration or to the creation of network entities or networks of firms. These alliances and mergers by firms alter the balance of power, and in the process of organisational changes it is easy to foresee the disappearance of certain market participants. In certain instances, this leads to a loss of local control (or of national economic sovereignty), and can lead to more concentration within a sector or domain of activity.

5. The Social and Institutional Aspects of a Win-Win Strategy

We have mentioned that firm's process and product innovations that simultaneously enhance environmental performance and maintain competitiveness, can contribute to wider objectives of ecological and economic sustainable development. Major business corporations and alliances are, indeed, in a position to influence the direction taken by environmental technological innovations and also to change various aspects of public policies. Environmental technological innovations are not isolated processes having to do exclusively with the strategy of firms. There is a complex and significant interplay between environmental technological innovations and political, social and economic developments (Smeets and Weterings, 1996).

But, it cannot simply be assumed that the simultaneous adjustment of business practices and of regulations are going to provide adequately for long-term sustainable development (see e.g., discussion by Duchin, Lange and Kell, 1995). Changed business practices and regulations may bring solutions to certain environmental protection problems while ignoring serious and potentially irreversible processes of resource depletion and the deterioration of ecosystems. Business strategies that may see win-win from a firm's point of view in relation to specific environmental targets, may in the longer term be judged, from wider social points of view, as wrong-wrong.

This is why, in the pursuit of sustainable development, a social partnership would seem necessary. For example it has become commonplace to speak of the Precautionary Principle as a guideline for public policy and commercial behaviour, meaning the obligation to refrain from actions that would impose serious risks on future generations. The growing popularity of concepts such as the extended responsibility of producers has helped solidify relations between business and the environment while at the same time making them more complex. (See for example the seminars organized in 1993 by the University of Lund on the topic of "Extended Producer Responsibility as a strategy to promote cleaner products".) Recent references to the precautionary principle, first in international statutes then in national legislation, cannot fail to contribute still further to this trend, by introducing a new notion of the nature of the "fault" where liability is based on fault. The official declaration of the Second International Conference on the protection of the North Sea in 1987 appears to be a watershed document in this regard. The principle has since been referred to again, including in the Rio Declaration on the Environment and Development in June 1992, and in the Treaty of the European Union.

These are examples of new social obligations that are being placed on firms reflecting environmental quality concerns. If this view is adopted, firms pursuing a win-win environmental strategy ought to reconcile business considerations with the requirements of social responsibility. That is,

1. On the one hand, business practices will reflect the need to earn a profit is reflected in costs, product prices and competitiveness considerations, as well as in market shares and positioning.
2. On the other hand, a problem of social legitimacy exists which has to do with a notion of public interest that ought to encompass current environmental problems along with the interest of future generations.

The European Commission, for example, frames this in its recent document *Towards Sustainable Development* (1993) as a three-way co-operation between the private sector, governance, and citizens. National and international political institutions, as well as the public at large, play roles complementary to that of business in choosing technological trajectories.

5.1. Social and environmental tensions within the new competitiveness

There is no particular reason to believe that approaches to meeting environmental performance obligations taken by private sector actors, based on their own ideas of what constitutes a competitive edge, will necessarily take into account these broader notions of public interest.

First, successful innovations may cause the economy to develop along locked-in technological trajectories that turn out to be sub-optimal environmentally. Worth citing here again is the example of the development of catalytic converters as the exclusive technological solution to the problem of acid rain attributable to pollution caused by automobile exhaust fumes. The « clean car » technology has been put back on the shelf. The case of phosphate-free detergents is also interesting. In this case, the technological lock-in did not originate with an institution or regulation, but was linked to increasing returns from the products' popularity. Henkel based its strategy on an hypothesis of increased return from the popularity of phosphate-free laundry detergents, which caused the market penetration theory to be confirmed by their growing acceptance (with all brands gradually bringing out their own phosphate-free detergents). All manufacturers came out with phosphate-free laundry detergents not because it had been ascertained that they were safer than traditional products, but because every time one company brought out a phosphate-free detergent, the probability rose that another company would do likewise. Phosphate-free detergents took the lead from the start of the process and the fact that manufacturers earned increasing returns from their popularity caused a lock-in. The manufacturer, Rhône-Poulenc, which found itself on the wrong technological track (as the world's leading producer of phosphates), tried to postpone the manufacturing of phosphate-free detergents for as long as possible by financing research into alternatives and by denouncing the unreliability of substitutes. The argument was that more time needed to be given for the "alternative" technology (in this case the traditional technology) to demonstrate its advantages (Moreau, 1994, 1996); this debate is still going on.

From these examples we can see the danger that successful innovations can cause the economy to take off in new directions which, while viable from a business point of view and satisfying for consumers in the short run, are in the longer run sub-optimal or even directly in conflict with objectives of a sustainable environment. There is also the problem of « green window-dressing ». There was a revealing case of Mobil Chemical Company. After the firm started marketing its biodegradable garbage bags, a company spokesman declared to the *Tallahassee Democrat* in 1991 (cited by Worldwatch and by *The New York Times*) that "degradability is just a marketing tool [...] We're talking out of both sides of our mouth because we want to sell bags. I don't think the average consumer knows what 'degradability' means. Customers don't care if it solves the solid waste problem. It makes them feel good." (cited in Piasecki, 1995). Mention here might be made of the well publicised replacement by McDonald's of a white polyethylene packaging sheet with polystyrene foam, which makes no significant difference from an environmental point of view -- it is a matter of air pollution versus water pollution (Duchin, Lange, Kell 1995).

Further, there are concerns that commercially driven environmental innovation can, in some cases, worsen social inequalities on an international level. The environmental-protection sector, which generated estimated revenues of 200 billion dollars in 1990 and is expected to grow by 50 percent during the coming ten years (OECD, 1992), operates primarily in OECD countries (90 percent of world production); the main exporting countries are Germany, the United States and Japan. Demand for products and services is expected to increase during the coming ten years in some developing countries, including the newly-industrialised countries of Southeast Asia, as well as in Eastern Europe. However, both the manufacturing and consumption of products and services will continue to take place chiefly in OECD countries.

The growth of the "ecology industry" could also have major repercussions on patterns of trade. If substantial raw material savings can be achieved, and substitutes are found for bulky raw materials, this will tend to lower demand for those goods and to increase that for recycled materials. Terms of

trade can hence be expected to worsen for a number of developing countries where raw materials are produced but whose prospects of benefiting from recycling are limited. The situation is exemplified by Western concerns with deforestation which have led to boycotts of wood products from some developing countries.

It should be added that proactive environmental strategies also contribute to financial globalisation. Since about 1987, firms have been presented with the possibility of issuing "green" financial instruments based on health and environmental protection. At this time, securities of this type have been issued by major corporations active in the environmental protection sector (for example, Générale des Eaux), chemical companies with a waste-disposal business (Rhône-Poulenc) and major pharmaceutical firms working on biotechnology that uses biodiversity (Merck). The financial instruments were created at the initiative of the World Bank and the WEF, on the grounds that countries were no longer in a position to finance expenditures needed for the protection of the environment (Chailloux, 1996). This sort of measure can, however, contribute to a loss of autonomy by the nation-states concerned. Likewise, if best available technology norms (BATNEEC) become manufacturing standards for international trade, the unequal distribution of know-how (including patents) could mean that developing countries lose autonomy and see a meagre portion of the benefits.

More generally, the fear is sometimes expressed that the movement in favour of deregulation within states and internationally, could mean that governments are playing a less clear part in environmental protection and handing the reins over to business. Indeed, a process by which industry seeks to self-regulate is emerging through an increase in so-called voluntary collective agreements. In some instances, the trend is supported by developments within the governments themselves. An example is the adoption, at the European level, of an "eco-audit" regulation designed to incite industry to implement environmental policies on a voluntary basis.

It is interesting, in this respect, to note that far from slowing down the setting of standards, deregulation has actually coincided with more and more technical standards being adopted by trade and industry bodies. At the international level, a new generation of ISO standards on environmental management is being drafted. These ISO 14000 standards (especially 14020, 21, 22, 23 and 24; some are still being developed.), which contain provisions relating to environmental labelling, in some respects resemble the ISO 9000 standards on quality. Furthermore, national standards are being adopted, as illustrated by the French X 30-200 and the British BS77-50 standards. Environmental standards are also being developed for specific sectors at the initiative of industries. This was the case, for example, with the standard on the environmental properties of electrotechnical products created by the International Electrotechnical Commission (IEC).

5.2. Proactive environmental strategies as accelerating economic globalisation

The evolutionary systems view of economic and ecological change that underpins our analysis of competitiveness is exemplified in the recent work of Krupp (1992), who writes:

"Technologically, this century is characterised by an unprecedented rate of innovation triggered by and triggering a fast competitive race of economic and political entities [...] All production and feedback has become polarised towards profit generation [...] Divergent lifestyles are integrated within this self-referencing as an innovative stimulus which is capitalised upon by appropriate products (blue jeans or sports cars, for example) and services (convenience food or night bars, for example) and propagated by advertising and mass entertainment."

"Today's numerous incremental decisions by politicians and businessmen on energy, made wittingly and willingly or not, will accumulate to form fundamental constraints and contingencies shaping the lives of future generations. They determine whether, with all their

growing wealth, they might have to cope with unfavourable climate changes, billions of tons of radioactive materials, millions of square kilometres of genetically-manipulated monoculture, including biomass for energy conversion, to name but a few examples, or, alternately, whether early resourceful self-restraint has avoided the related risks without impairment of the quality of future life on earth."

The economic dynamism is expressed through technological innovation and the incessant release of new and "improved" products. The commodity economy and circuits of capital now become the main engines and beneficiaries of this dynamic of innovation, a positive-feedback loop driven by the quest for profits, and characterised by incessant liquidation and renewal. Yet, the intensification and extensification (through the growth of output and mass consumption levels) of this innovation process now threatens global resources and ecological conditions of life for hundreds of millions of people. Thus, as Krupp catalogues, fossil-fuel resources are being used up within a few generations in processes which endanger the earth with pollution and global warming; large quantities of radioactive materials are being destabilised into toxic fission products; tropical forests shrink perceptibly each year; soil erosion and desertification proceed at an increasing pace; incineration of solid waste transfers harmful substances into the air; pesticides cause problems of drinking-water pollution; and so on.

The social and environmental costs of this innovation process are unevenly distributed (Beckenbach 1994, who in turn draws on the cost-shifting notion of Kapp). Under pressures of commercial survival, firms seek to off-load environmental and social performance burdens onto other social partners -- e.g., onto the state and taxpayers, onto workers (in terms of bad working conditions, commuting costs, etc.) onto future generations and non-human nature. According to the polluter-pays principle, business and consumers ought to take full account of the burdens they impose upon communities and ecosystems. But this is a responsibility which, considered an additional cost, is clearly in conflict with the profit motive.

Recently, in the context of observations about globalisation, increased attention has been given to instances of international externalities, cases of alleged cost-shifting by economic players separated by very large distances. Many of these involve multinational firms, such as the mining companies RTZ-CRA and Freeport-McMoRan, under attack in the courts and in the boardrooms for the adverse social and ecological impact of their gold and copper mining operations in Irian Jaya (Indonesia) (see "The Fun of Being a Multinational" in *The Economist*, July 20, 1996). These and other sorts of experiences are giving rise to a growing literature on "unequal ecological exchange" between the North and South countries. For example, conflicts over the control of the commercial exploitation and profits generated by agriculture and "wild" biodiversity have led to accusations of "biopiracy" against multinational firms. Analyses are increasingly being conducted of the "ecological footprints" left by production and consumption in rich countries, in terms of land area, water and photosynthesis requirements, compared with the availability of these resources in the producing and consuming countries (Rees and Wackernagel 1994; Rees 1996; Wackernagel and Rees 1995). The opportunity costs of forests and fisheries depletion are being discussed in terms of inter-society and intertemporal injustice (McEvoy 1986, McGarth 1993, O'Connor 1995). Likewise, now that the limits to the "sink" capacity of the planet for carbon dioxide emissions have become the object of an international debate, it has been argued that the already-industrialised countries have appropriated the environmental "services" in an historically inequitable way, in this sense imposing a cost on future generations (Azar and Holmberg 1995, Azar and Sterner 1996).

Many commentators have raised concern about uneven social distribution of the benefits of economic globalisation (e.g., Gedicks, 1993; Balvin Diaz, 1995; Anderson, May and Balick, 1991). For example, the destruction of the communal fabric of economic infrastructures by large-scale dam and irrigation projects in India and China is well documented (Goldman, 1993), and much controversy surrounds the use of cost-benefit analyses to identify net social benefit in such circumstances.

Relatively more aluminium is imported into Japan today from countries such as Canada where hydroelectricity is very cheap than in the 1970s. Similarly, Japan is "developing hydroelectric power in countries such as Brazil and Indonesia" (Mukaibo, cited in Krupp 1992). For reasons such as these, as well as for reasons of technological innovations referred to in Part 3, within Japan itself "pollution will not seriously worsen" (ibid. p.17). A large part of the pollution and ecological damage associated with Japan's economic dynamism is currently being shifted offshore. Again, the fairness of distribution of the benefits of economic globalisation is being questioned.

Today market economies depend for their viability on the efficient and increasingly wide-ranging exploitation of the physical habitat through the appropriation of raw materials and the disposal of waste, as well as of publicly provided infrastructures (Krupp 1992; Altvater 1993; O'Connor 1994). Through international trade and the circuits of capital, this process of shifting costs over to natural systems and future generations can readily cross national borders, or even move from one side of the planet to the other. As Krupp puts it (1992), in history up until now, industrial society has not so much tried to fit itself into the eco-niche of the earth, as to aggressively reshape it. As things stand at present, this pattern seems likely to continue and indeed to become more pronounced. Increasingly, "civilisation will define what nature has to be" through genetic engineering, large-scale attempt at greening of deserts and climate modification, and intensive energy technology development. The meaning of this will be "to turn our earth into an ecological laboratory" whose long-term ecological, genetic, and geophysical and climatic outcomes are impossible to predict (ibid.).

This sort of vision emphasises the fact that "improved environmental performance", as measured for an individual firm or production process, has to be set against the backdrop of non-sustainable high levels of fish and forest harvesting, intensive agricultural and animal husbandry practices that are degrading the soil and water quality, in some cases irreversibly (e.g. aquifer and soil salinisation and soil structure breakdown).

A proposal for the North's response is provided by a recent study on the future of Japan, entitled "MITI's Centennial Vision of Global Environment and Technology and the Response to Global Warming: Concerning New Earth 21" (Okamatstu, in Krupp 1992). The report envisages, inter alia, the greening of deserts and space-based energy sources as solutions to global greenhouse problems. For the South, a parallel image might well be that of the urban or rural poor being obliged to walk long distances in order to obtain minimally drinkable water piped at considerable expense from distant sources, because of the contamination or exhaustion of local water supplies.

5.3. Conclusions: From win-win firm strategies to sustainable development?

These considerations, both empirical examples and speculations, show the risks that environmental innovation may, in some cases, be like taking steps up an escalator (improved environmental performance) while the escalator itself (overall environmental quality) is sliding rapidly down. Business practices and regulatory standards evolve jointly. But it cannot simply be assumed that concurrent adjustments of business practices and political measures can meet the needs of a win-win environment-competitiveness strategy. In fact, worsening resource exhaustion and environmental problems can provide stimulus for innovation, and hence renewed competitiveness for some firms and sectors, while the overall situation worsens.

Our conclusion is that, in order to ensure that a win-win type of environmental strategy for whole nations and for the community of nations -- a vision of ecologically and economic sustainable development -- it seems indispensable to take into consideration other factors besides competitiveness alone.

These additional factors include the notion of "public interest" extended to future generations (and, more arguably, to ecosystems and other species as non-human living communities). It is, or

would be, the task of governance to put out clear prescriptive signals and to direct all participants (including those in governance itself) towards the desired trajectory.

This task would obviously be made easier if participants choose to move voluntarily. This means that the social partners would participate from their own initiative in the improvement of environmental performances. To what extent will this be something that firms, government leaders and consumers want to make an investment in?

The outlook for a social partnership on win-win environmental strategies, and, more generally, on sustainable development strategies, can be examined in various manners, with social legitimacy being considered and challenged by various categories of participants from the environmental field. For example, in the context of current climate policy negotiations (leading up to the late 1997 Kyoto conference), the environmental views of firms as well as their strategies in this respect need to be appraised with reference to CO₂ emission objectives and to available responses.

Many firms fear loss of competitiveness if they are forced to make major improvements to their environmental performance. This may often be true if end-of-pipe measures are having to be employed. In such situations, the marginal and total costs of abatement for any given pollutant can rise quite sharply as the abatement target is made more severe. Firms are also concerned about getting locked-in to expensive environmental protection measures that become obsolete if regulations or market conditions change. This is a problem of uncertainty. However, for several reasons, business outlooks may not be as bad.

- First, there are often significant gains in (for example) energy and raw materials use by improved efficiency practices within the production and transportation processes, at relatively low (or even negative) costs.
- Second, if a dynamic view of competitiveness is taken, then investments may be targeted on new generations of products and process technologies, through which substantial improvements in environmental performance may be obtained in the longer-run without prohibitive extra costs. (This is sometimes referred to as the « cost-hump » that has to be got over in the short-term to achieve lasting improvements in environmental performance. The diagnosis may be valid at firm as well as sectoral and national economy levels.)
- Third, if clear signals are provided through public policy, including international conventions, that improved environmental performance is a basic « rule of the game », then firms can be reassured that all players are obliged to respond to the same standards.

These last two points represent possible starting points for building alliances between the public, private and communal sectors. Some empirical evidence exists to suggest that this is already partly taking place. Experiments conducted with large companies indicate that they are under two types of pressure to improve environmental performance, clearly indicative of the diversity of participants concerned whenever win-win environmental strategies are to be initiated:

1. vertical pressure (from outside of business) from public opinion and regulations imposed by governments and their agencies;
2. lateral pressure (from within the business) linked to the demands of principals, banks, insurance companies and shareholders; that pressure takes longer to bring about but it is also more productive as it is directly reflected on the order books of companies.

There is no general consensus as to the collective approach that should be used in order to resolve the problem of "imbalances in the relationship between the economy and the environment." Many agree that sustainable development is an ethically attractive social goal, and from this point of view it is attractive to point to prospects for firms' to grasp win-win opportunities. This does not

necessarily mean undermining competitiveness. Rather, it means that changes are taking place in the background against which competitiveness is pursued. These are changes in social values and preoccupations, that show up also as changes in the aspirations and expectations of market participants. In a way, it is the collective dynamics of those aspirations which, through their translation into measures taken by organisations and institutions, is going to determine future economic activity.

It is not necessary to convince business executives of the need to treat the environment in a strategic manner in order for them to agree to do so. It will suffice if they find it likely that their competitors, government institutions and consumers grant the environment such a status. At times when there are hesitations about future understandings, a key factor for economic co-ordination becomes the development of collective alliances of government (national and international institutions) the private sector (trade and industry associations) and the people (consumer associations, NGOs of all types) to promote a common understanding and vision of the world along with new standards of conduct giving legitimacy to a given orientation. It is interesting to note, for example, that almost 20 percent of all adults in the United States and Canada belong to consumer groups supporting the environment, such as True Blue or Greenback (Gallup International, 1992; Stisser, 1994). The commercial demand for environment-friendly products is estimated to be worth 120 million dollars and expected to reach 200 million dollars by the end of the century.

Under those circumstances, the negotiation of voluntary agreements can be given a new dimension in the crystallisation of common concepts. From a sociological viewpoint, the public interest is defined on the basis of a wide variety of ethical positions and of definitions of communities of reference. Those various definitions and reference points are not necessarily in harmony. For example, environmental principles based on the heritage from the past (such as canal or river systems), or the identification of a community within a small administrative area, may come into conflict with the "harmonisation" as understood by the WTO and European Directives. Protecting ecosystems and national biodiversity may conflict with economic trends (including mobility). These compromises must all be negotiated. Here, as the chairman of AKZO, a chemical corporation, recently commented (Schot 1996):

History shows that no firm has ever outlived a permanent conflict with society. Dialogue, adjustments and co-operation are therefore not luxuries but rather necessities.