Competitiveness, Sustainability, and the North American System of Innovation

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1. Introduction

In Canada as well as in other countries, many of the concerns about the appropriateness of the technological basis of economic production are being expressed in terms of problems of competitiveness, sustainability, and innovation. Science and technology policies and innovation management practices, in particular, are addressing the competitiveness and sustainability agendas from an innovation perspective.[1]

Specialists have spilt much ink debating the meanings and implications of the notions of competitiveness and sustainability. Each notion often works as a metalanguage with its own set of assumptions, problems, and agenda of prescribed actions. The competitiveness and sustainability agendas share a sometimes apocalyptic language to describe the consequences of failure to attain competitiveness or sustainability. Both are frequently held up as imperatives which challenge systems of innovation at the deepest levels.

The competitiveness and sustainability agendas do not frequently refer to each other, and in many respects they talk past or contradict each other. There are few overlaps or linkages between the sustainability and competitiveness' policy networks and interest groups. However, the two agendas

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1 In this text I use the terms "science policy," "science and technology policy," and "innovation policy" interchangeably.

are each increasingly sensitive to problems of technological innovation, and each hints at the necessity or the inevitability of a new "techno-economic paradigm" upon which the next century's peace and prosperity can be based. In one formulation that is strongly advocated by some technology policy advisory agencies, a strategic course of technological innovation provides the only way to reconcile the two conflicting goals of reducing levels of pollution and resource deterioration while achieving major, sustainable increases in economic activity. In other words, a particular course of action regarding technological innovation may provide an intersection between the competitiveness and sustainability agendas.

This paper is meant to stimulate discussion about a social science research agenda on innovation, sustainability, and competitiveness in the North American region. I will try to be explicit about the paper's assumptions. First, I use the term "competitiveness" to refer to the ability to successfully offer products or services in an open trading system, in exchange for income, despite others who offer similar products or services, thus maintaining or expanding access to the life chances that income can purchase. Competitiveness is a frequently cited rationale and objective of innovation policy measures in Canada. I use the term "sustainability" to refer to development that does not pass on undue or irreversible environmental costs to succeeding generations.1 The term "innovation" usually refers to the first commercial application of a product or process by a user.2 This definition of innovation is close to what is commonly understood as "technological progress" and it focuses attention on increases in efficiency and productivity. About one-third of U.S. economic growth between 1929 and 1982 can be attributed to innovation of this sort (Denison, 1985).

A broader definition of innovation to address issues raised by the competitiveness and sustainability agendas is required because the larger the increment of technological change, the more likely organizational or social innovations are involved. Understanding innovation at the managerial, organizational, social, or cultural levels requires, at the very least, that a host of conceptual and measurement problems be addressed.

Second, I claim that two of the most consistent (and increasingly explicit) policy agendas of our

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1 The issue of social sustainability cannot be so simply specified. Insofar as poverty breeds environmental degradation and environmental degradation breeds poverty, linkages between environmental and social sustainability are evident. However, high consumption - as currently practiced, at least - also breeds environmental degradation. In some cases of "traditional" societies with extensive knowledge of the natural environment, social and environmental sustainability are closely linked.

2 In contrast, "invention" refers to the creation of originality or novelty.

times, the competitiveness and sustainability agendas, are committed to stimulating, guiding, or directing science and technology to achieve their ends. Each agenda attempts to influence technological and industrial innovation in the narrow sense and each ponders the broader issues of institutional and social innovation, raising a host of questions about ends and means.
Third, innovation takes place in "systems" of public and private institutions and the rules and routines of their behavior. Innovation research uses notions such as "system of innovation" (Niosi et al. 1993; Nelson 1993) to describe the social institutions of innovation.

The set of distinctions among minor and major forms of technological change employed by evolutionary economists helps to address the level-of-analysis problem that one encounters when searching for the boundaries of a system. Freeman (1992) distinguishes among innovation at the level of the firm, the production system, the technology system, and the technoeconomic paradigm. These distinctions identify progressively larger increments of change in current practices of production, and progressively broader groups of organizations and behaviors taken as reference points. Incremental innovations are minor cumulative changes continuously occurring in firms which can add up over time to significant improvements in productivity and efficiency. Radical innovations are discontinuities in the production system. Nylon and the oxygen steelmaking process are historical examples. More recently, radical innovations "are usually the result of deliberate research and development in enterprises and/or in university and government laboratories" (Freeman 1992). Changes of "technology system" are the result of clusters of radical innovations that create "far-reaching changes in technology, affecting several branches of the economy, as well as ultimately giving rise to entirely new sectors." Synthetic materials and the associated manufacturing techniques are examples. Technological revolutions, or change of "technoeconomic paradigm," are "new technology systems which have such pervasive effects on the economy as a whole that they change the style of production and management throughout the economy" (Freeman 1992). Technological innovation entails organizational, social, or cultural innovation.

Fourth, I inquire whether it might be useful to develop and apply a "systems of innovation" approach in the North American region. The existence of a North American system of innovation may be surmised on the basis of the considerable degree of economic integration that has taken place among the United States, Mexico, and Canada. However, the contours and dynamics of this system have not been well described.

Fifth, my discussion focuses primarily on problems of industrial innovation, and the section on sustainability is correspondingly limited. Issues of natural resource management, energy, transportation, sustainable cities, or sustainable agriculture need to be examined from an innovation perspective, but it has not been possible to do it here.

While neither competitiveness nor sustainability (however defined) is imaginable in the absence of innovation, the key issue, in my view, is the degree to which a production system can be both competitive and sustainable in a given context. As North American economic integration proceeds, science and technology policies and private management strategies will respond to the emerging conditions of innovation in the region. Subregional patterns of economic activity will change, and successful social mastery of new configurations of production will be an important skill to acquire. The greening of technology policies and management practices presents a new set of challenges in the context of trade regional liberalization, heightened intra- and inter-regional competition, and increased mobility in factors of production.

2. A North American System of Innovation

The notion of "system of innovation" can be operationalized in terms of financial flows, legal and policy links, and flows of information, science, technology, and people (Niosi et al. 1993). Among the legal and policy measures that are contributing to an integrated North American innovation system are the NAFTA rules governing investment, intellectual property, and technical standards. Among the financial and technology flows is the huge volume of bilateral trade between the United States and its two neighbors, especially intrafirm trade. Among the flows of science are the innumerable linkages between Canada and the U.S. on the one hand and the U.S. and Mexico on the other. The familiar "hub-and-spokes" pattern of North American economic interchange, in which the United States' neighbors entertain extensive interactions with it but very little with each other, is paralleled in patterns of scientific communication.[1]

A regional system integrator is an actor that aligns and integrates the economic and technological systems of regional members in interaction with them, including bilateral and multilateral trade, direct investment, official development assistance, non market technological collaboration (for example, military), political relationships, provision of services, establishment of trade rules, export of production technology, and export of the "software" of technological development such as

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1 For example, co-authored U.S.-Canada and U.S.-Mexico scientific publications accounted for about 12% of Canadian scientific output and about 16% of Mexican output in 1990. However, these publications only represent about 2% of American scientific output (Davis, Dufour and Halliwell 1993: 277). Bilateral Canada-Mexico scientific publications and trilateral Mexico-Canada-U.S. publications are negligible.

management beliefs, social science paradigms, administrative and technical curricula, information, publications, symbolic reward systems, etc. (Yamashita 1991). These linkages help spread a pattern of growth into related economies. In Asia, the Japanese role of regional integrator may represent "an enlargement of the parent-subcontract industrial relation" to include newly industrializing countries (Yamashita 1991, 4). In Europe the role of systems integrator is played by a supranational institution, the European Community, its multitude of programs and policies, and the networks of firms and institutions within the regional economic space. The United States, its large firms, and the regional trade rules are the principal innovation system integrators in North America.

In contrast to trends in Asia and Europe, science, technology, and innovation have not been prominent considerations in the discussions about the North American region's future. Before the present decade, neither Canada, nor the United States, nor Mexico tended to see itself as a member of a North American "community" or "system." Most attention focused instead on the extensive bilateral relationships between Canada and the United States on the one hand, and between Mexico and the U.S. on the other. It was implausible to suggest that North America might evolve into a region possessing a specific, shared identity and continental-scale institutions.

Regional economic integration is reshaping the North American economic landscape. The North American Free Trade Agreement (NAFTA) establishes a framework for a trade regime encompassing one of the largest (about 360 million people) and richest (about $6 trillion) regional markets in the world. NAFTA sets trade rules for a regional economy that has already undergone substantial integration. Canada and the United States have the world's largest bilateral trade relationship, and the United States is Mexico's largest trading partner.

NAFTA includes provisions for the reduction and eventual elimination of most tariffs affecting commerce among Canada, the United States, and Mexico in commodities, manufactured goods, and services. However, NAFTA goes beyond tariff elimination to establish rules governing trade and investment. The three countries agree not to discriminate against each others' goods and services, and to eliminate most tariffs over a decade. Customs procedures and temporary entry for business travellers are simplified. Mexican import licensing procedures are immediately eliminated.
The chapter on rules of origin sets out formulae by which Mexican, American, or Canadian products incorporating third-party materials or components can qualify for preferential access to each other's markets. Under the net cost formula, most products qualify for preferential treatment with 50% North American content. In the case of light vehicles, the figure is 62.5%. This provision is designed to discourage new transplants from using Mexico to supply the U.S. automotive market. The rules for determining North American content can be complex in practice, and their primary implication for

manufacturing is in sourcing practices.

NAFTA extends national treatment to member countries' suppliers of goods and services to public markets. NAFTA signatories agree not to impose offsets or performance requirements in public procurement. Improved tendering and dispute resolution procedures are specified. The rules governing public procurement are broader than those in the GATT procurement code, and NAFTA, in its extension of procurement rules to subnational governments (states, provinces, and municipalities), goes well beyond the Canada-U.S. Free Trade Agreement. The net result is to liberalize a North American public market of about $70 billion.

NAFTA sets rules regarding control over foreign investments. It establishes the principle of national treatment for all three parties regarding investments, establishment of new businesses, acquisition and sale of businesses, and the conduct and operation of businesses. No minimum levels of equity may be imposed on purchases or ownership. No performance requirements (for import substitution, local sourcing, export targets, foreign exchange generation, production sharing, product mandates, hiring of nationals in management positions, or technology transfer) may be imposed on investments from any of the three countries or on any investments from any third country (Article 1106). However, governments may offer "advantages" to firms in exchange for commitments regarding R&D, training, expansion, or location of production facilities. Canada retains the investment screening regime established under CUFTA (the right to review direct acquisition of Canadian controlled firms valued at more than C$ 150 million). No restrictions may be placed on the patriation of profits and transfer payments. Mexico retains a range of investment prohibition privileges in the energy and communication sectors.

Unlike CUFTA, NAFTA contains a chapter setting out rules for intellectual property. Chapter 17 applies standards regarding sound recordings, literary and artistic works, software, data, designs, copyright, trademarks, and patents. It makes provisions for enforcing intellectual property rights, and it restrains the parties' latitude to permit compulsory licensing of patents.

NAFTA also contains provisions governing energy, natural resources, agriculture, financial services, technical standards, telecommunications, cultural industries, and transportation services. Like the Agreement's provisions discussed above, the general thrust is to deregulate and liberalize trade in these industries within North America, and to specify special cases in which governments retain rights to discriminate. Two "side agreements" cover labor and environmental issues. However, the disciplines envisaged by these two agreements in case of noncompliance are weak (Shrybman, 1993; Martin 1992).

Continental market liberalization necessarily modifies the options available to policymakers to structure national or subnational economic development, and reduces the range of policy instruments available. Because NAFTA establishes new rules of the game for regional trade, it has been called an "economic constitution for North America." What are the implications of NAFTA for innovation policy and management?

In the first place, NAFTA clearly restrains governments from imposing performance requirements on foreign investors, North American or other, and considerably reduces governments' latitude to screen foreign direct investment (FDI).[1] Also, under NAFTA governments cannot impose performance requirements but may negotiate some kinds of innovation-related performances with firms in exchange for incentives.

In the second place, like CUFTA, NAFTA contains no rules governing subsidies, one of the most difficult issues on the trade policy agenda. Many kinds of government assistance have been labelled subsidies in U.S.-Canada trade disputes, including grants, tax credits, low-interest loans, and unemployment insurance. The subsidy issue was not resolvable during CUFTA negotiations. In the case of NAFTA, the subsidy issue was referred to the GATT, where the recently signed Dunkel text contains rules governing publicly-supported R&D and other kinds of subsidies. Since NAFTA does not cover subsidies, the "rules of the game" are unclear regarding direct or indirect public involvement in initiatives that help create advantage in the private sector. Given the uncertainty about subsidies, policymakers in Canada and Mexico will probably pay close attention to innovation policy practices in the United States in the belief that American practices will set a de facto standard in the region. The Clinton administration has adopted a more vigorous approach to promotion of industrial innovation than the two preceding administrations.

In the third place, NAFTA is clearly intended to cover the activities of subnational governments, insofar as the respective Federal governments are empowered to commit subnational governments through international agreements. This will have the same effects on state and provincial innovation policies as on national policies in North America. Many states and provinces have developed quite extensive programs and institutions in support of innovation. Similarly, many American cities offer substantial industrial incentives. Tax and subsidy competition among localities is widespread in North America.

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1 The issue is not whether unencumbered inward and outward FDI confers important benefits. The issue is whether selective intervention to affect the terms of investments and takeovers in specific cases of strategic importance is warranted (Lipsey 1991).

European and North American regional trade arrangements shield regional economies from offshore competition. However, the two regional arrangements are based on quite divergent philosophies. Europe has adopted a "Keynesian" approach to regional economic integration, creating a wide range of institutional arrangements to address economic and social issues. European economic integration involves "an attempt to build an administrative framework that takes into account the economic efficiency and collective security needs of the community, by means of the creation of a genuinely mixed economy at the regional level, when it seemed no longer viable on a national level" (Deblock and Rioux 1993: 32).

In contrast, NAFTA, like the Canada-U.S. Free Trade Agreement it superseded, largely concentrates on removing barriers to the movement of goods and capital. NAFTA is a "negative" approach to regional economic integration. It is concerned largely with removing tariff and nontariff barriers to movements of goods, services, and capital. It has no mechanisms to promote positive adjustment to economic integration. Problems of adjustment are largely left to the national governments to resolve. A regional trade agreement provides preferences among member countries, and fosters intraregional trade at the expense of interregional trade. Continental trade liberalization is precipitating wide discussion in North America about jobs, the environment, and national sovereignty. What are the implications of economic continentalization for science and technology strategies in the region, considering the increasingly integrated continental production system into which the two smaller countries have opted, and considering also the constraints placed by NAFTA on use of a wide range of traditional instruments of industrial and economic policy?

The rationale for trade liberalization is well known. Manufacturing firms require economies of scale to compete in global markets, and production efficiencies are determined by relative size of market. Under tariff protection, inefficient, subcritical plants produce short runs of excessively diverse product lines. Access to a large market and increased competition should lead to rationalization and accelerated R&D investments (Daly and MacCharles 1986). Trade liberalization should induce manufacturers in Canada to rationalize within the North American market, decreasing unit costs and reducing the productivity gap with the United States (ECC, 1988). One expects increased competition to improve the technical and allocative efficiency of firms (Globerman 1990). Thus economic gains from trade liberalization are principally realizable in the presence of productivity growth via attainment of economies of scale, increased internal R&D investments, and a higher rate of technological diffusion within firms and their supplier networks. As for the reorganization of production in North America, the simplest assumption is that of segmented production, with resource extraction, mass assembly operations, and higher R&D and management functions all sited in different locations.

However, a much wider range of organizational responses is available to firms, such as just-in-time production (and its implications for proximity to suppliers), strategic alliances, multilocational production strategies, flexible specialization and the like (Eden 1991; 1994). Concern is being voiced that the North American trade regime provides strong incentives for manufacturers "to respond to market competition with a low-wage strategy, which will lower incomes and productivity over the long run, rather than [take] the more difficult path of producing quality products more efficiently."[1] This would create downward pressures on social and environmental standards in North America.

While the objective pursued by conventional trade policy is to increase the "allocative" or "Ricardian" efficiency of the economy, the rationale of development-oriented innovation policy is to increase the "growth" or "Schumpeterian" efficiency of the economy (Dosi, Zysman, and Tyson 1990, 25). A major task facing policymakers, practitioners, and innovation scholars in North America is to identify plausible routes to technological learning in open economies and assemble a collection of policy instruments that are relatively effective (i.e. likely to induce technological spillovers into the economy), efficient (i.e. do not entail disproportionately high costs), and acceptable under the prevailing trade regime.

3. Industrial Innovation and Canadian Competitiveness

Canada is a trading nation. Approximately 30% Canada's GDP is generated through international trade, and the combination of imports and exports amounts to half of Canada's GDP. Of the G-7 countries, only in Germany does international trade contribute a higher proportion of GDP. Although much of the discussion about innovation in Canada has been pitched in terms of adjustment to "globalization," Canada's international trade is mainly continental. About three-quarters of Canadian trade is with the United States, and more than half of this is intra-firm trade. Furthermore, Canadian international trade is highly concentrated. About 70% takes place via about 50 firms, half of which are of Canadian origin.

The search for competitiveness has created an eager market for indicators, yardsticks, and report cards in Canada. These provide sometimes paradoxical views on the state of Canadian competitiveness. According to the United Nations Human Development Index in 1992, Canadians enjoy the highest quality of life in the world. According to the OECD, Canada recently had the fastest increase in

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1 Faux and Lee (1992: 244); see also the discussion in Herzenberg (1993) and Eden (1994).

employment among the G-7 countries and the second highest growth rate. But the World Competitiveness Report's 1993 survey ranked Canada eleventh among twenty-two industrialized countries, down from fourth place just four years earlier. The World Competitiveness Report gave relatively high marks to Canada's financial system (3d place) and infrastructure (5th place), but low marks to Canadian science and technology strategies (16th place), quality of production technologies (15th place), trade diversification (20th place), quality of management (14th place), and investment in new equipment (21st place). Of all countries surveyed, only Britain's manufacturing base had deteriorated more dramatically than Canada's. Canada has lost an estimated half million manufacturing jobs since 1989, with manufacturing's share of overall employment falling to about 15%. The unemployment rate is about 11%, and by mid-1990s the net public debt/GDP ratio will have climbed to about 75% - up from about 30% at the beginning of the 1980s. Canada is carrying one of the highest per capita public debts among advanced countries.

Canadian competitiveness has been dissected and debated in an avalanche of reports and studies.[1] Many believe that Canada's overall technological effort is too modest, and R&D expenditures too heavily dependent on the public sector, to help realize Canada's aspirations to maintain an advanced economy. To get to the bottom of the competitiveness question, in 1990 the Federal government and the Business Council on National Issues commissioned Harvard Business School strategist Michael Porter to apply his renowned "diamond" analysis to Canada.

In The Competitive Advantage of Nations (1990) Porter says that a nation's goal is to improve the standard of living by increasing the growth of industry through increasing industrial productivity and through shifting resources to higher productivity segments. This will normally happen as industry works to reduce unit costs and differentiate products, but industry will not choose to do so unless faced with competition (rivalry) and opportunities for innovation in their markets. Nations are "competitive" if their firms can engineer not just cost improvements but also differentiation. International rivalry normally pushes firms down product streams toward highly differentiated products. This requires constant innovation on the part of the firm. Internationally competitive firms create a virtuous cycle in which reinvestment drives further growth through innovation and learning. Mass production strategies are abandoned to less-developed countries. The most appropriate national innovation strategy is one that encourages firms to compete at the high end of the market through innovation, product differentiation, and service delivery, in contrast to sole reliance on traditional

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[1] The issues on the competitiveness agenda range from human resources, science, finance, and policy processes, to cultural values and rules of international trade. Forty-five recent reports and studies are described in Prosperity (1992); also useful is SCC (1992a).

cost-cutting, productivity-enhancing measures.[1]

Porter's thesis is that national competitive advantage is embedded in a "competitive diamond" of four essential attributes. These are: Factor conditions (labor, land, natural resources, infrastructure, labor skills, and services to industry); Demand conditions (the quality and strength of home-market demand for local industrial output. Porter attaches considerable importance to the presence of knowledgeable, demanding local customers); Related and supporting industries, especially the presence or absence of internationally competitive suppliers; and Firm strategy, structure and rivalry, which constitute the conditions in which companies are created, organized, and managed.

Porter says that firms have a "home base" where the key strategic decisions are taken and where the core product and process technologies are maintained. He says that if firms do not use their national "home base" in this way, they do not contribute to competitiveness of the national economy.

Porter's Canadian report, ominously entitled Canada at the Crossroads, argues that Canada is not doing so well in the new competitive environment (Porter, 1991). Five trends indicate underlying weaknesses: low productivity growth, high unit labor costs, persistently high unemployment, lagging investment in skills and technology upgrading, and an unencouraging macroeconomic climate for productive investments.

Porter observes that Canada is deficient in vigorous export industries. Most Canadian exports are in natural resources industries (materials and metals, forest products, and petroleum and chemicals), with some other successful exporters in transportation (mainly automobiles and avionics) and food and beverage industries (Porter, 1991). In other words, Canada is specialized in exports of unprocessed or semi-processed commodities. Many of the sales of the relatively higher value-added exporters, such as chemicals or autoparts, go to a very small number of parent firms in the United States. Porter concludes that in Canada, natural resource factor advantages are more important than innovation-related "created advantages," and that an abundance of natural resource-related factors does not necessarily lead to new factor creation, it leads to specialized resource firms. One might

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1 Porter proposes a four-stage model of national competitiveness development in which capacity to construct advantage grows progressively greater: 1. Factor driven countries draw most of their comparative advantage from basic factors of production. 2. Investment driven countries compete on the basis of standardized products on the basis of foreign technology that has been acquired and adapted. 3. Innovation driven countries appropriate and improve foreign technologies and also create their own. At this stage local clusters of industries become "wider" and "deeper." 4. In wealth-driven countries substantial outward financial investments lead to a loss of domestic clusters and loss of market share.

expect an indigenous capital goods industry to service the resource industries, but this has not happened in Canada.

Furthermore, Canadian domestic demand plays a minor role in the development of internationally competitive Canadian firms; the American market and American suppliers predominate. Domestic rivalry is usually not significant in internationally competitive Canadian industries, nor do these industries develop local clusters of upstream and downstream linkages. Canadian regional development policies prevent geographical concentration of firms, and foreign direct investment in Canada has reduced the importance of supporting industries through intrafirm transactions or vertical integration. Moreover, Porter notes that few non-North American firms have developed a "home base" type relationship with Canada. Porter irked defenders of continental economic integration when he suggested that high levels of foreign direct investment in Canada are an impediment to international competitiveness. Canada has one of the highest levels of foreign ownership of industrial assets of any advanced country, raising the question of "the extent to which foreign ownership inhibits the development of a national innovation system and, indeed, whether a national innovation system is necessarily preferred to integration into an international system" (McFetridge 1993: 320).

Porter's analysis provoked a debate about the appropriateness for small countries of the "national diamond" competitiveness framework. Canada's home country diamond "does not have the answers to explain Canada's international competitiveness," say D'Cruz and Rugman (1992), who are concerned with the strategic behavior of MNCs operating from small, open economies. To be applicable to Canada, the Porter model needs to be corrected "for the nature of foreign direct investment in Canada, the value added in Canada's resource industries, and the relevance of Canada's home country diamond in an integrated North American economic system" (ibid.). In a stream of publications, Rugman and D'Cruz have put forward a series of critiques of the Porter model in particular and of the more generally held belief in Canada that policies to promote indigenous manufacturing or high technology firms firms are critically important.

D'Cruz's and Rugman's analysis of Canadian competitive advantage is based on the recognition that most Canadian firms are concentrated in sectors or production phases in which cost reduction is the primary competitive strategy. Canada's ten leading export industries are automobiles, pulp and paper, vehicle components, commercial vehicles, non-edible agricultural products, non-ferrous metals, crude oil, cereal products, natural gas, and motors, turbines, and pumps. With the exception of the automotive sector, Canadian export performance "is not determined by an ability on the part of its manufacturing sector to compete in international markets. It depends instead upon the output of the natural resource sectors" (D'Cruz and Rugman 1992: 21). Also, Rugman and D'Cruz take issue with

Porter's selection of strategic industrial clusters. In Fast Forward: Improving Canada's International Competitiveness (1991), they identify ten subregional clusters accounting for the bulk of Canadian GDP and note that seven of the ten clusters are in the resource sector or in wage-sensitive production phases of manufacturing.1 They view competitiveness in these industries as largely determined by productivity growth, which in turn is driven by factor costs, especially wage and capital costs. In other words, indigenous advanced-technology development is not regarded as important in these sectors' competitiveness.

The problem of staples-driven economic development is the central theme of Canadian economic history. Trade in primary products is a very slowly growing segment of world trade. This is partly because barriers to entry are relatively low, encouraging exports from the Third World and soon from the former Soviet Union. Of equal concern is the phenomenon of "dematerialization" of production, in which information-rich, highly engineered components such as optical fibers, ceramics, or high-strength composites replace simple commodity-based components.2 Because of competition and dematerialization of production, the long-term trend for commodity prices is down. In 1992 the Economist "reported that real commodity prices were at their lowest level since the magazine began calculating an all-item index in 1845" (Pestieau 1993: 2). Canada has specialized its international trade in a small range of slow-growth commodities concentrated in the North American market.

Canadian resource firms typically develop firm-specific process innovations which provide advantage. They maintain technical currency through procurement of foreign machinery, licenses, patents, and foreign producers, and when they do undertake R&D it is frequently abroad. Thanks to their cultural or geographic proximity to American and British technology markets, Canadian multinationals "are probably among the fast 'technology followers'" (Niosi 1983, 189). However, compared to their competitors in other countries, Canadian firms distinguish themselves by choosing to compete more on the basis of cost than on the basis of innovation. For example, a recent study of innovation strategies in the Canadian non-ferrous metals sector found that R&D spending had declined in the 1980s, remaining at less than one percent of sales, while R&D spending in comparable Japanese and European firms had doubled to more than two percent of sales (SCC 1992b). This behavior reflects deliberate strategy, not just costs of production. According to Japanese and Finnish

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1 The clusters are Western forest products, Alberta energy, Prairie farming, metal mining, Ontario automotive, Ontario manufacturing, Toronto financial, Eastern forest products, Montreal aerospatial, and Atlantic seafood.

2 On dematerialization see Ardekani (1990).

managers of mining companies quoted in the study, conventional business operations generating half or more of total revenues received only a small fraction of the R&D budget, while research on higher value-added activities - new materials and new products - received up to ninety percent of the R&D budget.1

A second key shortcoming of the Porter model when applied to small, open economies, according to Rugman and D'Cruz (1993), is that one cannot measure the international competitiveness of smaller countries in terms of export shares because "much of the business of smaller countries is conducted abroad (through foreign direct investment) within the larger triad markets of the United States, E.C. and Japan - where the action is." Porter does not count overseas sales by the subsidiaries of Canadian-owned multinationals in export share data, giving the impression of poor Canadian export performance. Dunning (1993) points out that there are three kinds of cross-border commercial interactions: arm's length trade, inter-firm cooperative agreements, and foreign direct investment. He argues that Porter has substantially underestimated the importance of globalized production, especially the cross-border value added activities of transnational firms, much of which takes place as intrafirm trade.

Canada is an important exporter of capital. Canadians invest abroad almost as much per capita as Americans. Between 1987 and 1991 about $5.4 billion was invested in the country annually, while about $6.6 billion was invested outside the country annually. In 1990 the foreign direct investment stock in Canada stood at $125.3 billion and the Canadian direct investment stock abroad stood at $86.7 billion (U.N. 1993). In 1990 Canada had some 1300 indigenous MNCs. Even the resource industries are footloose. Between 1980 and 1990, incoming foreign direct investment stock in the primary sector in Canada increased only slightly from $4.6 billion to $5 billion, while Canadian outward direct investments in the primary sector increased from $2.7 billion to $5.7 billion.

The largest increases in outward FDI in the past decade are not in the primary sector however, but in low value-added segments of the secondary sector and in parts of the tertiary sector. In the former, the Canadian outward FDI stock increased from $17.3 to $46 billion between 1980 and 1990, with huge increases in FDI stock in food and beverages ($2.3 to $5.8 billion), paper ($2 to $10.5 billion),

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1 Similar trends were found in other sectors in Canada. The Canadian pulp and paper industry spent about four times less on R&D than its major American and European competitors. In the forest products industry, which is the largest source of Canada's trade surplus, relative levels of R&D spending were about half that of major competitors. Only two forest product firms conducted in-house R&D on solid wood products. Industrial R&D staffing fell from six hundred in 1980 to five hundred in 1990 (SCC 1992c).

coal and petroleum products ($.9 to $6.5 billion), metals ($5.5 to $14.2 billion), and other manufacturing ($.9 to $3 billion). Canadian outward FDI in the tertiary sector increased from $7 to $34.9 billion, with the largest increase in the financial and insurance industries ($3.7 billion to $24.7 billion between 1980 and 1990). In 1990 Canada had $86.7 billion of FDI outside the country, of which 61% was in the U.S., 21% in Western Europe, and 13% in developing areas (United Nations 1993).

Porter's model raises questions about how two-way FDI contributes to a "small" country's competitive advantage. This is a critical issue for "small" countries. In the past, incoming FDI has been considered much more significant than outward FDI in discussions of Canadian economic competitiveness. This is especially true in the context of understanding the accumulation of technological capability. A long debate within Canada has considered the pros and cons of incoming FDI and, in particular, its effects on domestic innovatory capability. Porter believes that outward FDI is valuable in creating competitive advantage, but that foreign subsidies are not sources of competitive advantage and that inward FDI is "not entirely healthy" (as cited in D'Cruz and Rugman 1993).

The opportunity to centralize operations and rationalize production in a regional market is especially attractive to manufacturing MNCs in mature or price-sensitive industries which "are among the leading proponents of the strategy to narrow product mix and expand production runs" (Litvak 1990, 118). However, a closer look at the often conflicting set of pressures toward globalization and localization shows that the strategic consequences of these pressures are not identical across industries. Some firms develop multinational or global, highly rationalized structures, and others develop transnational structures or purely local structures (Crookell 1990; Eden 1991). Multinational firms respond to changes in terms of ownership advantages, internalization advantages, and locational advantages; new information-based manufacturing technologies and trade policy changes also influence locational decisions (Eden 1991).

Because of these factors and the importance of the U.S. market, the Canadian "diamond" is not necessarily of primary significance to Canadian firms. They also must take into account the U.S. "diamond" and for this reason small trade-dependent countries like Canada, Denmark, and New Zealand must look at their competitive advantages in terms of the domestic "diamonds" of their principal markets. This requires a "double diamond" strategy (Rugman and D'Cruz 1993).
I have described at some length one of the debates on Canadian competitiveness to illustrate some of the ways that transnationalized production within the continental economy complicates the analysis of competitiveness. Integration into a larger system of innovation raises questions of how to make the best of proximity to this larger system.

4. "Green" Industrial Innovation

Although alarms about global environmental degradation have been sounded for the past three decades, the environmental situation today is different in four new ways (Rath and Herbert-Copley 1993: 7):

* rapid increase in the scale of pollution has accelerated loss of soil, species, clean water, and natural environments.

* tens of thousands of synthetic chemicals, most of which are untested as to toxic or environmental effects, are replacing natural pollutants.

* the transboundary impacts of environmentally disturbing human activities require international or transnational remedies that can be long and complex to put in place.

* because "the various environmental threats are inextricably linked, both in their causes and effects," they cannot be addressed or solved in isolation one from the others.

There is growing acceptance of the "precautionary principle" and the clean production paradigm in environmental management. The precautionary principle, which was endorsed by the Earth Summit at Rio de Janeiro in 1992, discourages attempts to establish environmental management strategies based on calculation of the pollution carrying capacity of the environment, with innovation aimed at waste management and production of end-of-pipe pollution abatement techniques. Instead, the precautionary principle advocates reduction to zero of all emissions of substances that are "persistent, toxic and liable to bioaccumulate...even where there is no scientific evidence to prove a causal link between emissions and actions" (Jackson 1991: 8).

The clean production paradigm advocates approaches such as product lifecycle assessment and closed-cyle industrial ecological design to foster across-the-board prevention of pollution in industrial systems (Dethlefsen, Jackson, and Taylor, 1993; Hirschhorn, Jackson, and Baas, 1993). The principles of "clean production" are precaution (i.e. reduction of anthropogenic inputs into the environment), prevention (i.e. extend the analysis of environmental implications of production as far upstream as possible), and integration of environmental protection measures across system boundaries (i.e. integration of protection measures into the production process) (Jackson 1993b).
The U.S. Environmental Protection Agency defines pollution prevention as "source reduction" that eliminates or reduces pollutants through improvements in equipment, technology, processes or procedures, redesign or reformulation of products, substitution of raw materials, and "improvements in housekeeping, maintenance, training and inventory control." Recycling, re-use, and end-of-pipe

pollution control are excluded. The Technology Innovation and Economics Committee of the U.S. National Advisory Council for Environmental Policy and Technology advocates a hierarchy of technological approaches to environmental improvement: "in order of desirability, these are: technologies that prevent pollution (including waste minimization and source reduction technologies), recycling technologies, environmental control [i.e. end- of-pipe] technologies, and cleanup [i.e. remedial] technologies" (EPA 1991).

Distinctions between minor and major forms of technological innovation suggest ways of distinguishing between tactical and strategic approaches to technological change. Tactical interventions aim to accelerate the incremental improvement of the environmental efficiency of existing industry by reducing wastage and increasing recycling. They would put in place policy and economic incentives and disincentives, management paradigms, and investment and training strategies to produce many small improvements on a broad front. Strategic interventions would aim to innovate substantially improved technologies, radically improved technological systems, or new technoeconomic paradigms.

The distinction between innovation of minor and major magnitude is being taken up by national and international policy and program agencies. For example, the OECD advocates a three-pronged transition to the "fourth industrial revolution," the clean industrial production revolution comparable to the steam, steel-electricity, and electronics revolutions.

* The first thrust is to induce incremental improvements in industrial performance by acting to identify, deploy and implement existing cleaner technologies through provision of information, removal of barriers to trade and implementation, government purchasing programs, and so on.
* The second thrust is to accelerate technical and technological change by acting to promote innovative development and widespread implementation of new generations of cleaner technologies, through enunciation of coherent goals and policies such as Japan's New Earth 21 Plan or the Netherlands' National Environment Policy Plan Plus, which sets long term environmental quality goals;
* The third thrust is to sustain environmentally sound industrial innovation by acting to ensure that cleaner technologies become and remain the basis for economic development in the long term through education and collective action, innovation of cleaner technologies, etc. (OECD 1993, ix-x).

The conjunction of innovation policy and environmental policy is relatively recent. Environmental sustainability has not been a major consideration among mainstream innovation policy and management researchers. Winn and Roome (1993) recently searched the core R&D management literature of the past two decades for work on environmental issues, and identified only nine articles. Clarke and Reavely's (1993) 10,000-item bibliography of core science and technology management literature contains references to only 31 documents that focus explicitly on environmental issues.

Similarly, the literature on "green" innovation policies is relatively small and dispersed among the literatures on environmental management, environmental economics, risk assessment, and economics of innovation.

As in any policy area, one wishes to know what the policy objectives are and what they should be, which instruments are deployed and why, and what are their effects, including costs and benefits; one also wishes to understand the policymaking process. Key environmental policy instruments for industry are regulations, technical assistance to firms, economic instruments such as tax and liability arrangements, consensus-building processes such as roundtables, and international agreements.1 A comprehensive pollution prevention environmental policy regime should include 1) technical assistance programs; 2) education and training; 3) financial incentives; 4) increased use of liability regulations; and 5) "regulations specifically requiring the development of waste reduction plans and the submission to governments of regular reports on their progress in waste reduction" (Baas et al. 1992: 14; Yakowitz and Hanmer, 1993).

Regulation is the most widespread mechanism of public control of industrial environmental performance. Most research on the effects of environmental, health, and safety regulation is designed to determine its effects on productivity and profitability. In a review of this research, the Office of Technology Assessment (1994) concludes that environmental regulation was responsible for 10 to 15 percent of the productivity slowdown in the U.S. in the 1970s, but that "other factors (such as technology changes, investment, and training) were more important" (p. 325).

Of growing interest is research on the effects of environmental regulation and standards on the rate and direction of innovation for the improvement of the design of regulations and standards. Promotion of acquisition of environmentally improved industrial technology is becoming an important environmental policy goal. The structure of incentives and disincentives to invest in minor or major forms of industrial innovation having some relation with environmental sustainability is clearly of central importance. The design of environmental policy from an innovation policy perspective must ensure that counterproductive policy measures from other domains, such as subsidies for energy, water, or local raw materials, are detected and dealt with.2

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1 Ashford (1993). A more comprehensive taxonomy of innovation policy measures which might be applied to environtally sustainable industrial innovation is provided by Rothwell and Zegvold (1985).

2 On proposed environmental tax reform in Canada see Gillies (1994).

The traditional approach to control of industrial pollution is through implementation of end-of-pipe (EOP) technologies, the main effect of which is to displace the pollution charge from one medium to another. Concomitant with this approach to environmental industrial technology policy are regulatory regimes based on concepts of environmental assimilative capacity or critical pollution loads.[1] Historically, "technology diffusion has played a limited and subordinate role to regulation, permitting, and compliance in the regulation-based environmental management system" (EPA 1992: 15). This is because the regulation-based environmental policy systems of the 1970s encouraged investments in pollution control technologies rather than in environmental improvement of processes, products, housekeeping, and materials handling. Permitting and compliance regulatory frameworks created a demand for add-on pollution abatement techniques, a demand reflected in national S&T policies. In the former West Germany, for example, governmental support for R&D on clean technologies focussed largely on invention of end-of- pipe pollution abatement techniques (Bongaerts and Heinrichs 1987). Once investments have been made in end-of-pipe pollution control technologies, there is little incentive to adopt the more comprehensive pollution prevention management paradigm. Furthermore, suppliers of pollution control solutions may resist movement toward a precautionary policy regime: "experience in the U.S. has shown this to be a significant issue, because the end-of-pipe approach has advocates and a large industry selling the hardware of pollution control (e.g. scrubbers, incinerators, waste treatment plants)" (Hirschhorn 1992: 11).

Regulations "must be explicitly designed with technological considerations in mind - that is, they should be fashioned to elicit the type of technological response desired" (Ashford 1993: 296). The regulatory design "should combine an assessment of the innovative capacity of the possible responding industrial sectors with levels and forms of regulation tailored to that capacity. The entire process should reflect a realistic evaluation of the best possible achievable technological goal" (ibid. p. 289). The EPA's National Advisory Council for Environmental Policy and Technology emphasizes that disincentives to technological innovation and adoption environmentally improved technologies must be removed from regulatory permitting and enforcement (EPA 1992, 1991).

Technical assistance to firms for improvement of environmental performance is another public policy instrument which has led to recent institutional innovation in Canada and the United States. Technical assistance institutions can be classified on a four-point scale of increasing involvement in a firm's decision-making (Doyle 1992). At level one, the technical assistance institution provides information and networking services. There are many public and private environmental technology databases and

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1 On attempts to found environmental management regimes on scientific understanding of the behavior of various pollutants in the environment see Chadwick and Nilsson (1993).

referral services available, including ICPIC, the International Cleaner Production Information Clearinghouse. At Level Two, in addition to providing information the technical assistance institution brokers specialized services such as business planning, market assessment, and identification of financial sources. Many Chambers of Commerce and Business Innovation Centers operate at this level. At Level Three, the technical assistance institution provides technical and financial infrastructure support, including (for example) operation of incubators, prototyping services, technical services, and arm's-length financial assistance. This is a hands-on technical assistance role that requires proactive behavior on the part of the institution. An example of a Level Three institution in the United States is NETAC, the National Environmental Technology Applications Corporation. NETAC provides business evaluations, technology evaluations, regulatory and intellectual property assistance, training, and technical services such as testing and demonstration. It also has a product evaluation center specialized in bioremediation technologies. At Level Four, the institution participates directly in the firm through equity investments and close technical and management ties. An example is the Finnish National Fund for Research and Development (SITRA), an independent public fund of about US$ 100M with the mission to take research to market. It supports new ventures through minority equity participation (Doyle 1992).

Overall, "an important lesson from the United States is that cleaner production outreach programmes can take many different forms. There is considerable variation in the pollution prevention programmes managed by the 50 states. The programmes are located in a variety of institutions and provide a diverse array of services" (UNIDO/UNEP 1992: 7).

Deliberate transition to cleaner production at the firm level can begin with a waste audit, the "first step in an on-going programme designed to achieve maximum resource optimisation and improved process performance. It is a common sense approach to problem identification and problem solving" (UNEP/UNIDO 1991b). The waste auditing procedure advocated by the United Nations agencies:
* defines sources, quantities and types of wastes being generated;
* collates information on unit operations, raw materials, products, water usage and wastes;
* highlights process inefficiencies and areas of poor management;
* helps set targets for waste reduction;
* permits the development of cost-effective waste management strategies;
* raises awareness in the workforce regarding the benefits of waste reduction;
* increases management's knowledge of these processes;
* helps to improve process efficiency (UNEP/UNIDO 1991b: 3-4).

The result of a waste audit is the development and implementation of an action plan to reduce waste and improve production efficiency which, if implemented, can provide significant economic benefits to the firm, as indicated by the findings of the Dutch PRISMA program, one of the programmatic models for UNEP/UNIDO cleaner production programs. The PRISMA waste auditing procedure identified about 200 hundred pollution prevention options among a group of corporate participants. Only 30% of these options implied technological modifications; 30% implied improvement in housekeeping procedures, 30% implied changes in materials and raw materials, and 10% implied product modifications (Huisingh and Baas 1991: 28; see also Dieleman and de Hoo, 1993).

Taken together, housekeeping procedures, material inputs, production technologies, and product parameters constitute "industrial practice." Significant benefits can be gained from incremental improvements in existing industrial practice, especially in relatively backward subregions of North America where the stock of equipment and the skill sets of workers and management are all likely to be farther from good practice than in technologically dynamic subregions.

The precautionary principal and the clean production paradigm hint that they can move toward major changes of technology systems through many incremental improvements in production and transformation of management philosophy. Also of interest is the development of new R&D-based production systems in which ecoefficiency is a critical design parameter. The capacity to create technologies has never been greater in industrialized countries. The world is currently on the brink of a new technoeconomic paradigm based upon information and image technologies, biotechnology, new materials, and a range of improved energy technologies. The technical characteristics of radically different technologies for long term environmental sustainability are still largely speculative, and the environmental implications of various configurations of the emerging technoeconomic paradigm are only beginning to be explored (OECD 1991; Freeman 1992).

It is not so simple to identify kinds of "clean" or environmentally sound technologies the promotion and diffusion of which are to be encouraged. Since no currently known technologies are perfectly clean or entirely environmentally sound, cleanliness or environmental soundness are relative. The key characteristic of cleaner technologies is that they are cleaner than prior technologies with respect to materials flow, energy efficiency, or toxicity. Cleaner technologies:

* extract and utilize natural resources and prepare products as efficiently as possible;
* use as little energy and raw materials as possible per unit of product output and per unit of utilization (useful lifetime) of the product;
* generate products with reduced or no potentially harmful components;
* minimize releases to air, water, and soil during fabrication and use of product;
* ensure that any residua of production and use which are generated are managed in an

environmentally sound manner;
* ensure, for non-perishable goods, that product durability and lifetimes are maximized insofar as practicable; and, after the useful function is ended, products or their key components are recoverable insofar as possible (OECD 1993: 2).

These characteristics can apply to many techniques and practices across the entire range of industries. As a World Resources Institute report observes, "today the climate for innovation seems uniquely rich, poised between technological revolutions in progress and others just emerging" (Heaton, Repetto, and Sobin 1991: 7). A huge reservoir of untapped technological potential in biotechnology, materials, and informatics exists which could increase energy efficiency and reduce waste production. A World Resources Institute report proposes environmentally critical technologies for the United States1 and proposes environmental technology policy initiatives which include a federal Institute for Environmental Technology, new funding arrangements to support environmental technological innovation, new missions for national laboratories, new patterns of R&D cooperation, new arrangements for international cooperation, regulatory reform, and reorientation of existing programs (Heaton, Repetto, and Sobin, 1992).

Most industrialized countries have taken measures to stimulate innovation of new generations of environmentally sound technologies. The Japanese are probably the most ambitious in this respect. Their "New Earth 21" plan aims develop a new industrial paradigm to restore the Earth's natural functions over the next century by returning the emission of global warming gases to pre-industrial revolution levels. They have established RITE, the Research Institute of Innovative Technology for the Earth, for development and global promotion of next generation environmental technologies. RITE is applying advanced technologies to problems of renewable energy, energy efficiency, new manufacturing processes, and capture and fixation of carbon dioxide. Germany, the Netherlands, Italy, and Canada are other industrialized countries which have established national initiatives to support development of strategic environmental technologies.

A number of recent authors incorporate the precautionary principal into frameworks for action. Simonis (1989), for example, identifies three strategic elements of environmental modernization of

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1 These are: energy capture (photovoltaics, geothermal, solar thermal electricity, nuclear fission); energy storage and application (batteries, superconductors, hydrogen storage, heat storage, fuel cells); special energy end-uses (transportation, buildings); agricultural biotechnology; improved agricultural techniques; manufacturing monitoring, modeling, and control; catalysis; separations; precision fabricatyion; materials design and processing; information, communications, and computing; and contraception.

industrial society: ecological structural economic change (notably actions to delink growth from environmentally relevant input factors); preventive environmental policy; and ecological orientation of environmental policy. Robins and Trisoglio (1992) propose ten priorities for an eco-industrial policy: establish a strategic vision, manage structural change, shift to circular industrial ecosystems, design products for needs, build human capacity, ensure corporate accountabilty, use market mechanisms for industrial transformation, guide technological development, foster sustainable livelihoods, and build global partnerships.

Corporations in the 21st century will find it essential to be able to innovate and operate competitively while operating in an environmentally responsible manner. Shifts in thinking about the strategic importance of ecoefficiency are already apparent among businesses (Davis and Smith, 1994). In one recent survey of 200 senior executives in the US, 90% said that environmental considerations were part of their strategic planning process. In another survey of 250 European companies, almost three quarters were found to have specific plans to improve environmental performance. A 1991 report from the Canadian Federation of Independent Business states that 99% of their members are concerned about the state of the natural environment, and that 60% have made, or are about to make, significant changes to their businesses to respond to environmental concerns. The Canadian Standards Association has been working to develop environmental management systems analogous to the ISO 9000 series of Quality Management Standards.

5. Conclusion

The sustainability and competitiveness agendas are addressed by specialized actors in policy networks, lobbies, researchers, government agencies, and some non-governmental not-for-profit institutions. Ultimately, attainment of the twin goals of environmental sustainability and economic competitiveness may well require a much deepened understanding of these complex issues among the public. This is partly because movement toward sustainability and competitiveness requires a multitude of behavioral changes among citizens, and partly because the magnitude of necessary changes requires well-informed voters in democratic political systems. While most of the discussions about sustainability and competitiveness focus on policy and economic incentives, the roles of the public - as consumers, as voters, as civic actors - are important as well. The competitiveness agenda makes an strong set of demands on social values and business culture. If Canada and the United States develop what has been called a "high growth, low employment" economic trajectory, successful social adjustment to technological change will require new social and political skills.

The sustainability agenda is analogous. North American consumers say they want to preserve the environment, but "green" marketing does not always elicit the expected responses, and citizens are "wary of the environmental costs they might have to pay as taxpayers, consumers, or workers" (MacEvoy, 1992).

With the exception of markets, mechanisms and instruments of deliberate social choice, especially ones that are feasible under regimes of democratic governance, are a relatively unknown part of the "selection environment" that might lead to ecoefficient industrial innovation. For example, the notion of cleaner production does not rest upon a narrow doctrine of technical efficiency, but on a deeper ambition to gauge the social appropriateness of products (see Jackson 1993b). Philosophers of industrial metabolism and industrial ecology are attempting to locate principles of extrafirm regulation in efficient systems of transactions among firms, while a current of research attempts to locate the principles of a strong socially determined "selection environment" in processes of social negotiation of technical change.1

Freeman (1992) points out that the issue of eco-efficient industrial production hinges on estimates of the feasibility with which an "accelerated orientation of the science-technology system in the desired direction can be brought about." As far as common resources are concerned, "sustainability of the system wll depend more on social institutions controlling access than on production technologies" (Lynam and Herdt 1989: 396). But we have decreasing degrees of freedom as we move from the scientifically conceivable to the technologically feasible, and from there to the economically viable and the socially acceptable (Perez 1983).

In this paper I've tried to contextualize the competitiveness and sustainability issues in terms of the North American system of innovation, which is constituted largely of flows of trade, people, technology, and investment across North America, bilateral scientific relations between the major regional power and the two smaller countries, and trade policy rules embodied in a formal agreement. Scientific or technical collaboration at the North American level is quite modest. Undoubtedly the nodes of the regional innovation system are in technologically dynamic metropolitan areas. The

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1 See for example Irwin and Vergragt (1989). Radical social innovation for environmental sustainability is especially problematic. Massive changes in lifestyles and consumption would require social engineering, coercive policies, or extremely rapid social learning on an unprecedented scale. On the efforts (largely in Northern countries) to define frameworks for "green" political action see Eckersley (1992) and Dobson (1990). On the question of the politics of the social transition to sustainability see, for example, Kassiola (1990), especially chapter 9, "Social Transformation into a Transindustrial Community."

contours of the North American innovation system are still indeterminate, depending largely on the innovation strategies and behavior of the corporate world and governments in the North American economic space.

For the "smaller" countries of the region, integration into a regional innovation system has particular advantages and disadvantages. Two outstanding questions have to do with business strategy in the new North American economic space, and the scope, aims, and ambition of innovation policy within or pertaining to this space. A number of other issues such as the technological dimensions of regional economic security, the special problems of less-developed regions of North America, the regulation of competition and monopolies at the regional level, and the promotion of ecoefficient industrial innovation remain to be addressed. The ultimate issue is the degree to which ecoefficient industrial production is competitive in the North American or global context.

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