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Directions for the Twenty-first Century

TECHNOLOGICAL CHANGE AND OPPORTUNITIES FOR DEVELOPMENT AS A MOVING TARGET

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TECHNOLOGICAL CHANGE AND OPPORTUNITIES FOR DEVELOPMENT AS A MOVING TARGET*

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* The views expressed in this paper are those of the author and do not necessarily reflect the views of the UNCTAD secretariat.

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Executive Summary

This paper provides an interpretation of development as a process of accumulation of technological and social capabilities in developing countries that is dependent upon their ability to take advantage of different and successive windows of opportunity. The nature of such windows would be determined by evolving technologies in the leading countries of the world system. The interplay of continuity and discontinuity, which characterizes technical change, would open successive spaces of possibility – some narrower, some wider, some only sufficient for initiating development processes, and others for allowing significant leaps forward. The shifts in the direction of technical change associated with each technological revolution would provide the best opportunities for catching up.

At each stage, it would be vital to identify the changes in industrial power structures and the interests of firms in the advanced world in order to negotiate complementary strategies and establish positive-sum games. Success would result from recognizing, consciously or intuitively, the nature of each successive opportunity in order to capture whatever learning possibilities it offers and be better placed each time. Setbacks would be caused by holding onto old practices after the conditions which had made them effective have ceased to exist.

On the basis of this interpretation, the paper reviews the complementarity between the successive models of development implemented since the 1950s and the stage of deployment of the main technologies in the advanced world. In the same line of analysis, it looks ahead to the next period and its possibilities.

A key concept is that of the "techno-economic paradigm", defined as the set of all-pervasive technologies and generic organizational principles which shape and condition the opportunities of each period. Since each technological revolution leads to a change of paradigm, it is vital to understand its main characteristics, for they can be applied to rejuvenate most mature technologies, and used as a criteria for designing appropriate institutions and effective policies.

Following the logic of the flexible networks paradigm of the "Information Age", the paper emphasizes the need to strengthen human capital and increase capacity for innovation. It also holds that the State or market dichotomy is inadequate for facing the present challenges. In particular, the "strong State" would have to be reinvented applying the decentralized model of organization of the modern global corporation, with the local states taking a proactive role in wealth creation across the territory and the national State acting as strategic leader, consensus-builder and "broker" between the supranational and subnational levels.

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TECHNOLOGICAL CHANGE AND OPPORTUNITIES FOR DEVELOPMENT AS A MOVING TARGET

Carlota Perez

I. TECHNICAL CHANGE AND DEVELOPMENT

Technology has usually been treated as a specialized area in development policies, dealt with by separate institutions. Yet, as this paper aims to show, technology is much more than an ingredient in development strategies; it is a conditioning element of their viability.

Development opportunities are a moving target. Any serious observer of the development achievements from the late 1950s to the late 1970s will have recognized that import substitution strategies applied by one country after another led to gradual and significant advances. There was, in fact, increasing hope for continued success in the mid-1970s, when the combination of "industrial redeployment" and export promotion was showing and promising further and deeper advances. The subsequent failure and deterioration of the protected, subsidized model in most countries that tried to continue with it has swung the pendulum towards a complete denial of the achievements of such a model, and opened the way for upholding free markets as the only way to succeed in development, though proof of this is yet to come.

We argue here that windows of opportunity for development appear and change as successive technological revolutions are deployed in the advanced countries. Transfer of technology and of production facilities is only willingly undertaken if it promises mutual benefits. The reason why import substitution strategies were successful at the time was that they represented a positive-sum game for maturing industries in the developed world that faced technological constriction and market saturation. The advent of the information revolution radically changed such conditions, and created different viable options.

This interpretation examines development strategies from a different angle, which we believe to be particularly useful for the challenges of globalization and the "Information Age". The paper first reviews how technologies evolve in order to understand the conditions that generate development opportunities and to identify their nature. It then approaches the question of development as one of learning to benefit from such changing opportunities. This is illustrated with an overview of the successive development models of the last 50 years and a look at the challenges posed by the next stage of concentration of power in the global economy. Finally, some of the institutional requirements for coping with the new "flexible networks paradigm" are examined.

II. PRODUCT CYCLES, DEVELOPMENT AND CHANGING BARRIERS TO ENTRY

The role of imported technologies as stepping-stones to industrialization is a historically well recognized fact, on the basis of the experiences of the United States and of successive European countries in the nineteenth and early twentieth centuries. More recently, this role has been confirmed by the rapid emergence of Japan as a front-rank country and by the surge in development of the four "dragons" in Asia. Their success has been clearly associated with the absorption of technology from the more advanced countries, and with their own efforts to adopt, adapt, modify and gradually master the technical know-how involved (Freeman, 1987; Amsden, 1989). Yet, during the same recent period, many more countries have had little success while making apparently similar attempts to use imported technology for development. In fact, many countries, and whole regions, such as Africa and most of South America, seem to have lost much of the ground gained (Mytelka, 1989; Katz, 1996).

The causes of these different results lie partly in the particular policies applied and partly in the specific conditions of the countries in question. Even more profoundly, they are rooted in the nature of the windows of opportunity created by technological evolution in the core countries and in the capacity to take advantage of them, whether consciously or intuitively. We need, therefore, to draw on the abundant literature on how technologies evolve and diffuse.

A. The product life cycle and the geographic outspreading of technologies

One of the earlier attempts to deal with technological opportunities for developing countries was made by Hirsch (1965). Examining the behaviour of the traditional electronics industry in terms of the product cycle, he showed how advantages shifted in favour of the less developed countries as technologies approached maturity. Louis T. Wells (1972) graphically summarized the process, by examining the United States, in his review of the product cycle literature (figure 1).

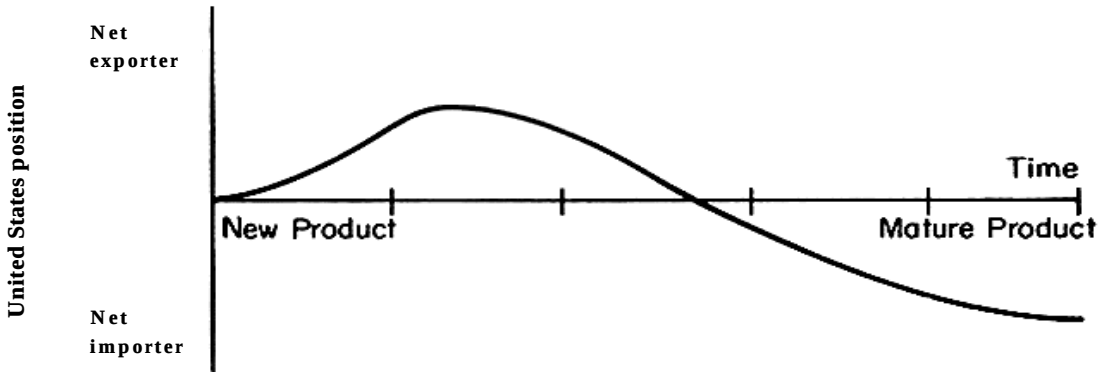
This outward migration from the country of origin to other advanced countries, and from there to the less advanced, revealed one of the processes behind Leontief's surprising finding that United States exports had a higher labour content than its imports (Leontief, 1953). This paradoxical situation of the technological leader at the time was thus associated with the changing characteristics of evolving technologies. In the early phases, technologies are likely to be more labour-intensive – they are higher users of relatively costly knowledge-intensive labour[1] than when they approach maturity and begin to use highly mechanized and automated processes.

As technologies mature, there are forces *pushing* them further and further out towards the periphery where, presumably, there are complementary forces *pulling* such technologies in order to unleash development processes. Although this applies mainly to consumer goods and to certain

[1] Hirsch (1965, 1967); Vernon (1966); and recently Von Tunzelmann and Anderson (1999).

Figure 1

The geographic outspreading of technologies as they mature



Phase I	Phase II	Phase III	Phase IV	Phase V
All production in United States	Production started in Europe	European exports to LDCs	European exports to United States	LDC exports to United States
United States exports to many countries	United States exports, mostly to LDCs	United States exports to LDCs displaced		

A schematic presentation of the United States trade position in the product life cycle

Source: Wells (1972: 15).

basic capital goods, it covers a wide enough range for it to serve as a starting point for our discussion.

B. Mature technologies are not enough for catching up[2]

Ironically, the advantage shifts to capital-poor countries when products become more capital-intensive. By then, tasks have been so routinized, as shown in phase four of the graphs in figure 2(a),[3] that managers are not required to have much previous knowledge or be highly experienced, while unskilled labour can be utilized. In addition, as technology and markets mature, comparative costs become a determining advantage.

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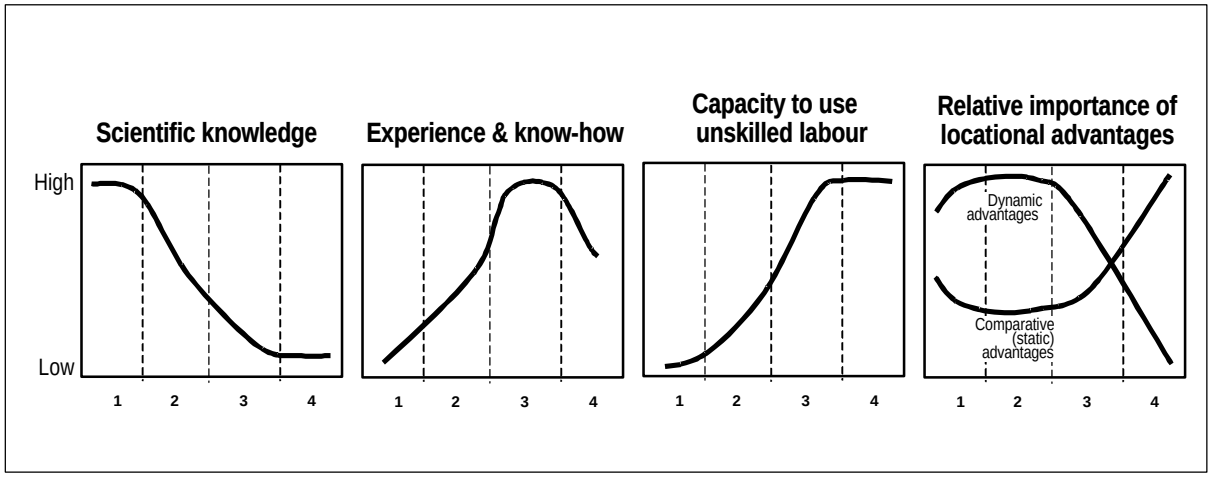
[2] Based on Perez and Soete (1988).

[3] Phase four can be roughly understood to encompass phases IV and V in figure 1.

Figure 2(a)

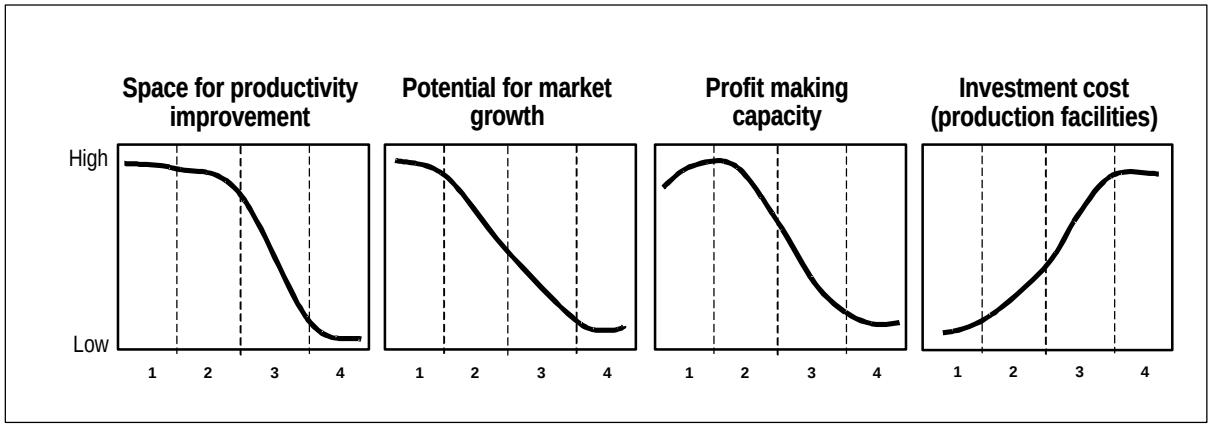
Changing requirements for entry as technologies evolve to maturity



Source: Based on Perez and Soete (1988) and Hirsch (1967).

Figure 2(b)

Changing potential of technologies as they evolve to maturity



Source: Based on Gerschenkron (1962), Cundliff (1973), Kotler (1980) and Dosi (1982).

Can a process of catching up be based on mature technologies? It is very difficult for several reasons. As shown in figure 2(b), mature technologies reach a point where they have minimal potential for profit making; they face stagnating markets and have almost no space left for improvements in productivity. Thus, in general, entering at maturity is expensive, not very profitable and not very promising. Nevertheless, it is probably the best starting point for creating a basic industrialization platform, generating learning capabilities, and setting up the main infrastructure and other externalities needed to support development.

However, catching up involves a dynamic development process, fuelled by local innovation and growing markets. This requires as early an entry as is feasible – surprisingly enough, apart from the mature phase of technologies, the other moment when weaker players confront surmountable barriers is not in phases two or three but rather in phase one. This happens to be the most promising entry point, since, as indicated in figure 2(b), potential profits are high, there is ample space for market and productivity growth, and investment costs are relatively low. Even R&D investment can often be lower than that of the original innovator.

One would think, however, that only firms in advanced countries would possess the high degree of knowledge required in this phase, as shown in figure 2(a). Nevertheless, when new products are part of the early stages of a technological revolution, the knowledge involved is usually publicly available (in universities or elsewhere). The recent example of Silicon Valley, and of the thousands of successful imitators locally and worldwide, serves to illustrate the phenomenon. In those cases, required previous experience is also low, and having it could even be a hindrance, because, as will be discussed later, technological revolutions bring with them new managerial models, making the old ones obsolete.

The other constraining factor is context-related. Dynamic advantages and externalities of various sorts, especially physical, social and technological infrastructures, as well as competent and demanding local clients, are important complements for success with new technologies. These elements can be built up by entering mature technologies, engaging in intense learning processes, and investing in improving the social and economic environment.

Could one then design a strategy for accumulating technological and social capabilities on the basis of mature technologies and then using this platform for entering new, dynamic, ones? Such possibilities are strongly dependent on the peculiar windows of opportunity created by successive technological revolutions.

Developing countries wishing to design viable strategies can benefit from a thorough understanding of the evolution of technologies in the advanced countries. The following section is an overview of the characteristic patterns of such evolution.

III. TECHNOLOGIES, SYSTEMS, REVOLUTIONS AND PARADIGMS

The evolution of technologies is a complex process; technologies are interconnected in systems, which are interwoven and interdependent, both among themselves and with the physical, social and institutional environment.

A great deal of learning is gradual and incremental. However, there is no inevitable progression towards an ever more advanced – and ever more unattainable – frontier; there are important discontinuities that become breaches permitting latecomers to leap forward. These take the form of technological revolutions, which create major shifts in the direction of technical change. They provide the means for modernizing most activities at the cost of abandoning many

of the previously accumulated managerial skills and part of the previous equipment with its associated expertise. The revolutionary new technologies provide entirely fresh opportunities for learning and catching up; and the interplay of continuous and discontinuous changes explains why and how windows of opportunity for development change over time.

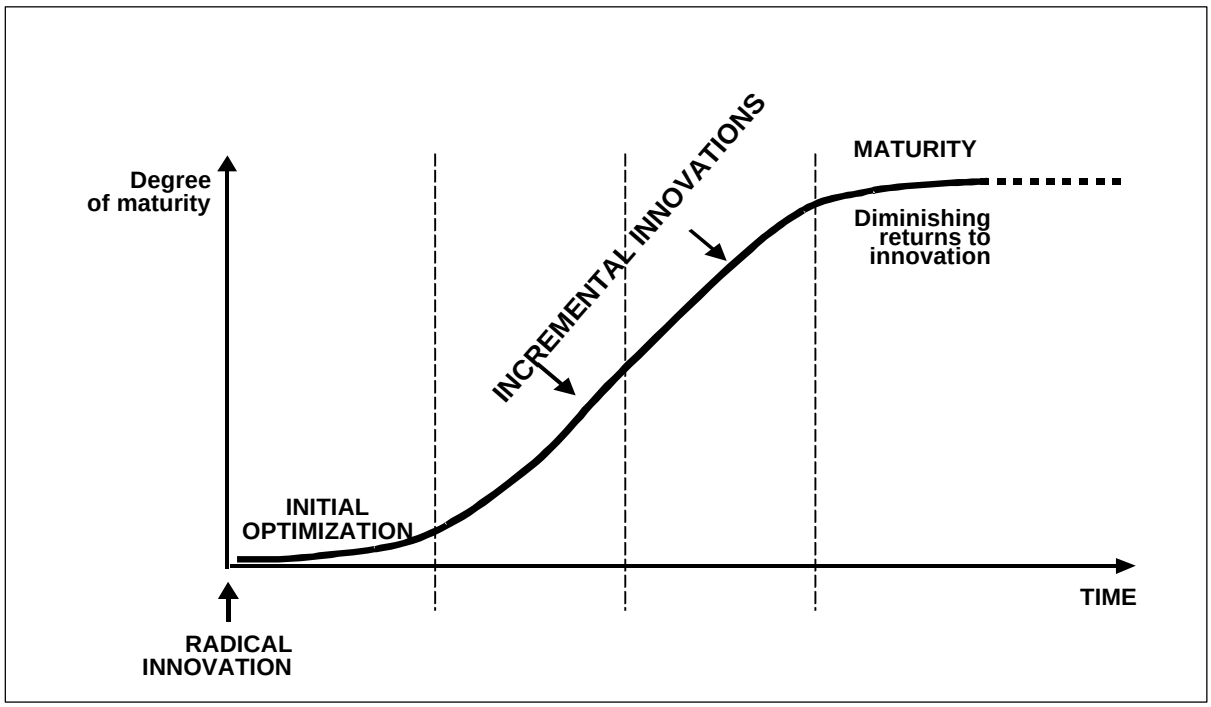
A. Technological trajectories and accumulated experience

Despite their individual specific variations, many technologies tend to follow a similar sequence in the rate and direction of change and in improvement, from initial innovation to maturity, which very roughly coincides, with the evolution of their markets, from introduction to saturation (Abernathy and Utterback, 1975; Dosi, 1982; Sahal, 1985).[4] Figure 3(a) represents the typical trajectory of a technology.

Figure 3(a)

The evolution of a technology

A technological trajectory



Source: Based on Dosi (1982 and 1988) and Wolf (1912).

[4] For text books on management, see Cundiff (1973) and Kotler (1980). For a comprehensive overview, see Coombs et al. (1987) and Dosi (1988). For a complete interpretation of the relationship between technology, economics and policy, see Freeman's (1974) classic on the economics of innovation, or the updated version of Freeman and Soete (1997).

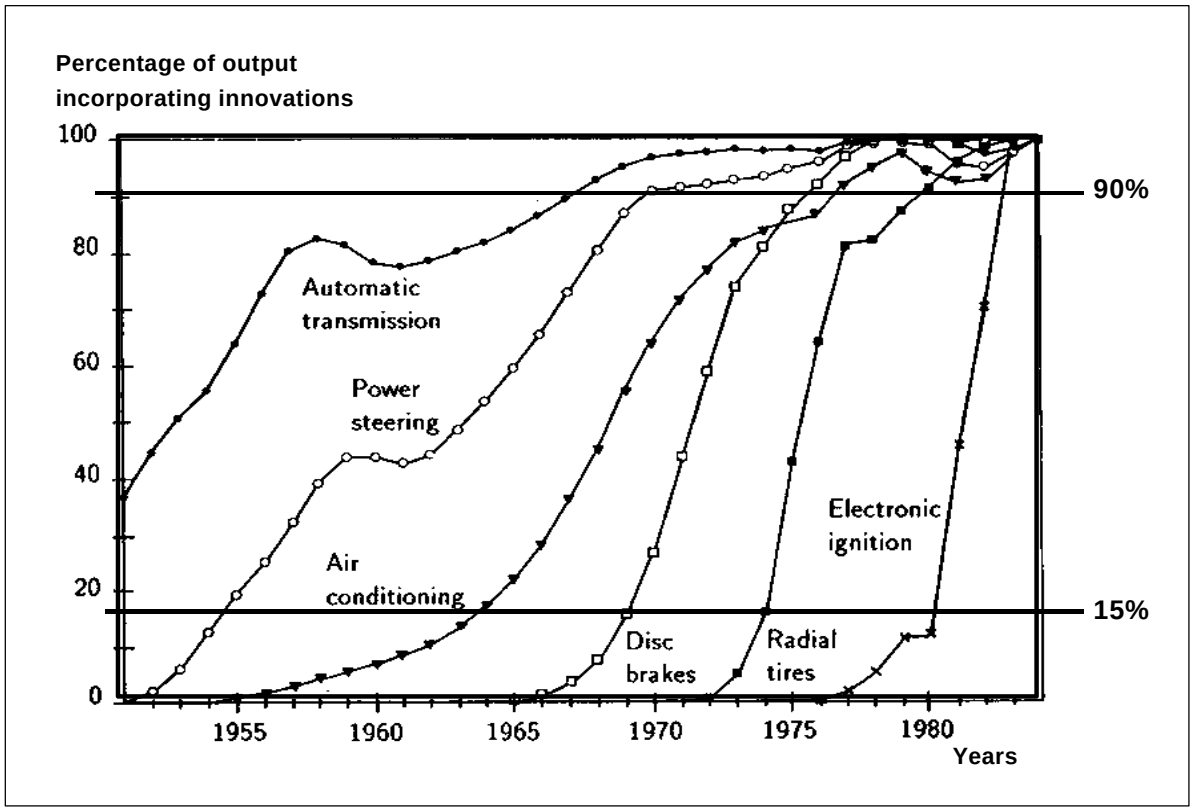
After a radical innovation gives birth to a new product that is capable of creating a new industry, there is an initial period of further innovation and optimization, leading to the acceptance of the product in the appropriate market segment. Soon, the interaction with the market determines the direction of improvements, often defining a dominant design (Arthur, 1988; David, 1985); from then on, as markets grow, there are successive incremental innovations to improve the quality of the product, the productivity of the process and the market position of the producers. Eventually, maturity is reached, when further investment in innovation brings diminishing returns. Depending on the significance of the product, the whole process can take a few years or several decades. In this latter case, "improvements" usually involve successive models.

After the early innovations, those who are developing the technology acquire advantages, not only through patents but also, and perhaps more importantly, through accumulated experience with product, process and markets. This confines the relevant knowledge and know-how within the firms and its suppliers, making it less and less accessible to entrants. Furthermore, this experience gradually increases the speed with which innovations can be adopted, so that the later ones are very rapidly incorporated, making it difficult for lagging followers to catch up. Figure 3(b) illustrates this phenomenon using the case of the automobile.

Figure 3(b)

Shorter life cycles of later innovations

The diffusion of successive technologies in the United States car industry



Source: Jutila and Jutila (1986) cited in Grubler (1990: 155).

B. Technology systems and the construction of social capabilities

Individual technologies do not grow in isolation but, rather, are interconnected in systems, building upon each other and taking advantage of what their predecessors created within the system, in terms of experience, suppliers, consumer learning and externalities (Freeman, Clark and Soete, 1982).

The evolution of technology systems follows a trajectory essentially similar to that of single products (figure 3(a)). The series of new *products* would be the "incremental improvements" to the system. In the first two phases, there are many truly major products with a long life cycle; thereafter, their numbers and importance tend to diminish, until the last ones are minor and short-lived (as in figure 3(b)).

Figure 4 presents a stylized example of the system of home electrical appliances, which begins with refrigerators, washing machines and vacuum cleaners, and then grows with a series of new products and successive models of the early ones. They all tend to reach maturity together with the introduction of the last minor innovations, such as with electric can-openers and carving knives. The figure also indicates how systems become rooted in particular territories through the growing network of parts and service suppliers, and the gradual construction of the regulatory framework and other institutional facilitators.

This growing interplay of "hard and soft" elements is part of what Abramovitz (1986) meant when he criticized the notion of development as simply the accumulation of capital and labour and when he emphasized the need for accumulating *social* capability. It is also related to the notion of national or regional "systems of innovation", formed by the interacting agents (Freeman, 1987; Lundwall, 1988, 1992).

The need to form these complex webs of mutually supporting activities and institutions explains some of the limitations involved in development based on the transfer of already mature technologies. It also strengthens the case of those who recommend building upon the existing traditions, local capabilities and knowledge of each specific territory (Porter, 1990). Finally, it shows the type of effort required for supporting the survival of pioneering firms in developing countries.

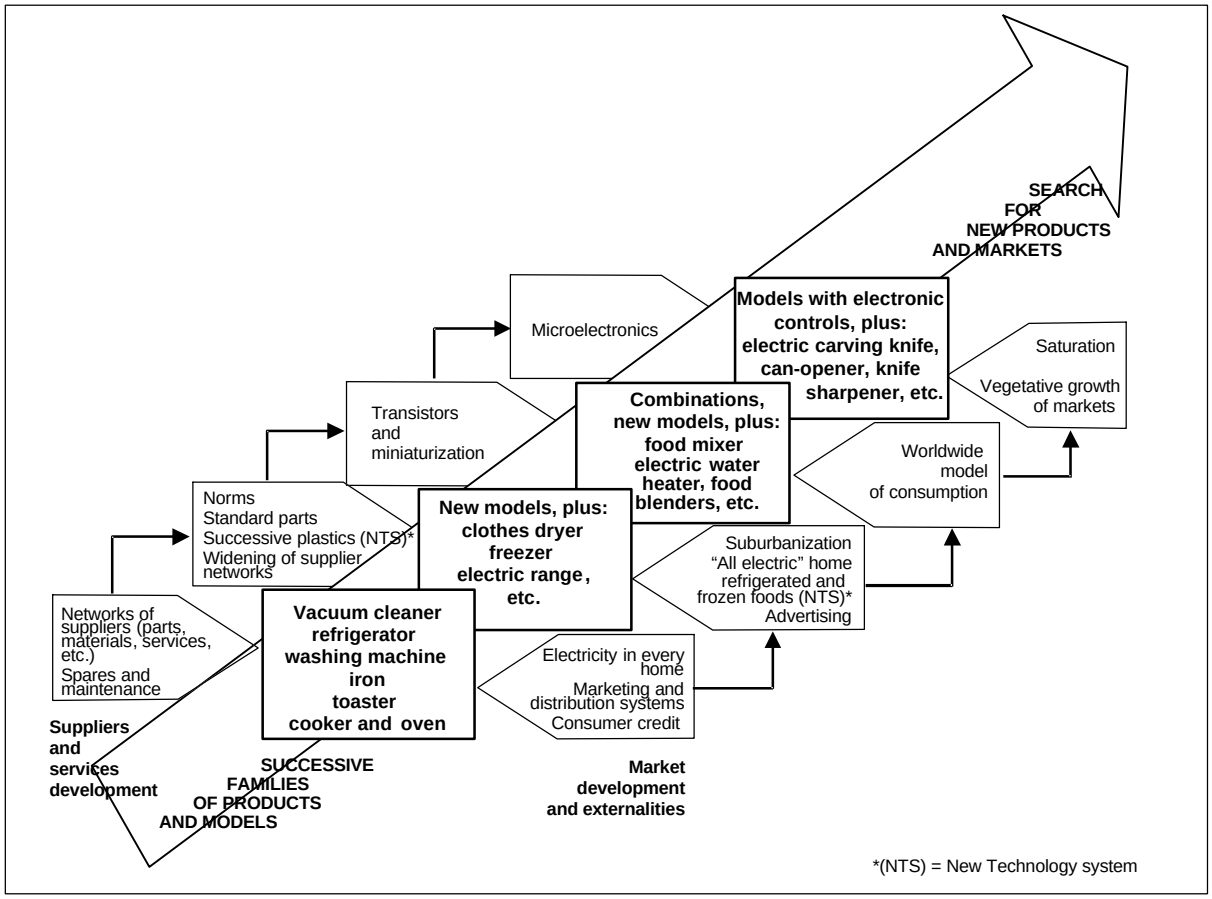
C. Technological revolutions and the interconnection of systems

Each technological revolution is a cluster of technology systems, which gradually create conditions for the appearance of further systems, all following similar principles and benefiting from the same externalities. Figures 5(a) and (b) sketch two such explosions of new technologies: the mass production revolution with its successive systems, crystallizing around 1910 and reaching maturity in the 1960s and 1970s, and the information revolution, diffusing since the 1970s.

Figure 4

Co-evolution of a technology system and its environment

Home electrical appliances



This process of upstream and downstream multiplication of innovations and technology systems represents the massive growth potential involved in each technological revolution. It is like the opening of a vast new territory for innovation, expansion and growth. The early innovations mark the "discovery," while the full "occupation" falls within the maturity and exhaustion phase.

Again, figures 3(a) and 3(b), stretching the "time" dimension, can be roughly seen as representing the life trajectory of a technological revolution, where the "improvements" are the successive new technology systems. Many major systems appear in the early growth period, and fewer and less significant ones as maturity is approached.

Figure 5(a)

The mass production revolution as a growing network of technology systems from the 1910s

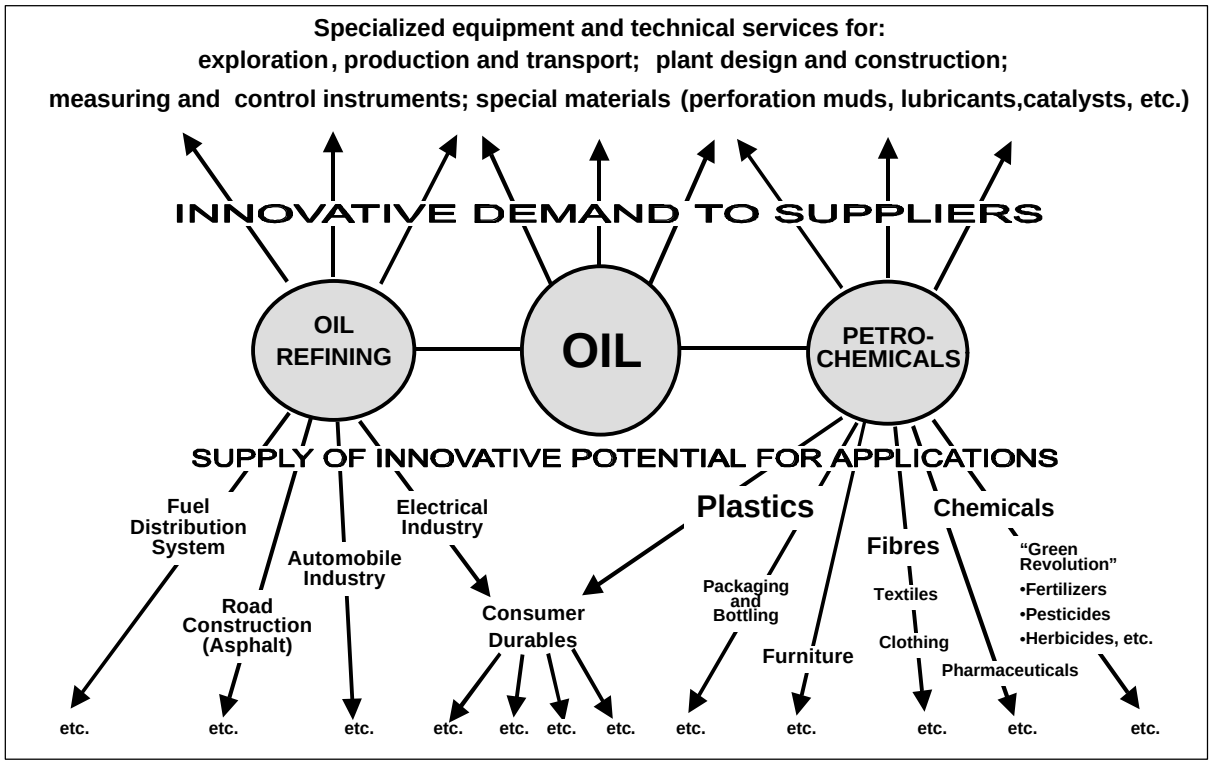
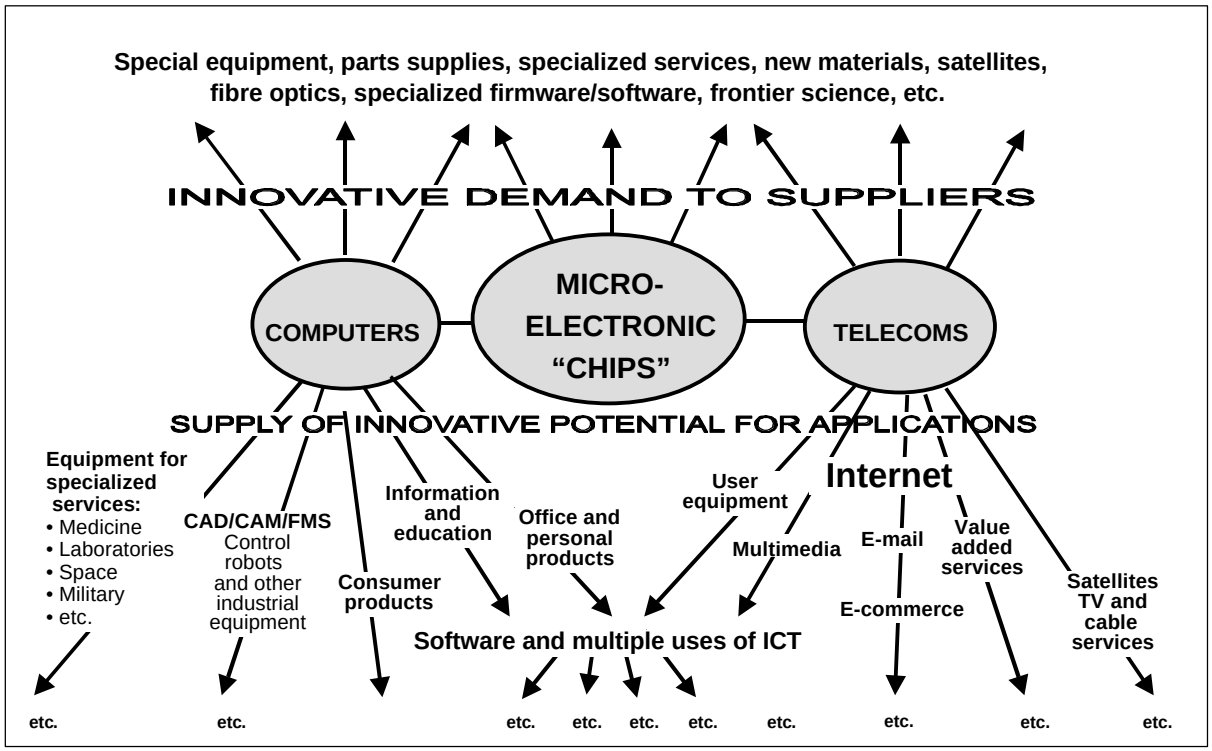


Figure 5(b)

The information technology revolution as a growing network of technology systems from the 1970s



D. Techno-economic paradigms and the rejuvenation of all activities

The existing mature industries, however, do not just stagnate or passively cohabit with the new ones. Each technological revolution provides generically pervasive technologies and new organizational practices resulting in a significant increase in the potential productivity of most existing activities. The principles behind this process are gradually articulated into an ideal best-practice model, which we have proposed to call a "technological style" or a "techno-economic paradigm" (Perez, 1983, 1985).[5] The result is a gradual rejuvenation of the whole productive structure, so that modernized mature industries can again behave like "new" ones.

This is one reason why those who expressed hopes in the "North-South Dialogue" of the late 1970s for the transfer of "old" industries to the developing world were disappointed. Since the 1980s, one industry after another has been modernized. Even the very traditional clothing industry has been upgraded, segmented and put on an innovative path (Hoffman and Rush, 1988; Mytelka, 1991).

E. A paradigm shift as a change in managerial "common sense"

The techno-economic paradigm articulates the technical and organizational model for taking best advantage of the potential of the technological revolution. It provides a new set of "common sense" principles guiding the decision-making processes of entrepreneurs, innovators, managers, engineers and investors towards maximum efficiency and effectiveness in new and old activities. For those who had been successful with the previous paradigm the adoption of a new one can be devastating. Apart from requiring the abandonment of hard-earned experience, it feels as if the world were turned upside down (Peters, 1989; Coriat, 1991). Figure 6 illustrates how the shift from the mass production paradigm to the flexible networks model transforms management criteria in all activities – from product choice and design, through organizational structures, to forms of operation and personnel relations.

Phenomena such as globalization and the trend towards political decentralization are also strongly related to the change of paradigm, to the new possibilities it offers and to the most effective way of taking advantage of them. Thus, the Schumpeterian description of technological revolutions as processes of "creative destruction" can be seen to apply beyond the economy to politics and institutions.

The process of change is not easy; the transition to the new practices can take two or three decades. But in the long run the new paradigm becomes common sense, to the point of being considered natural and normal.

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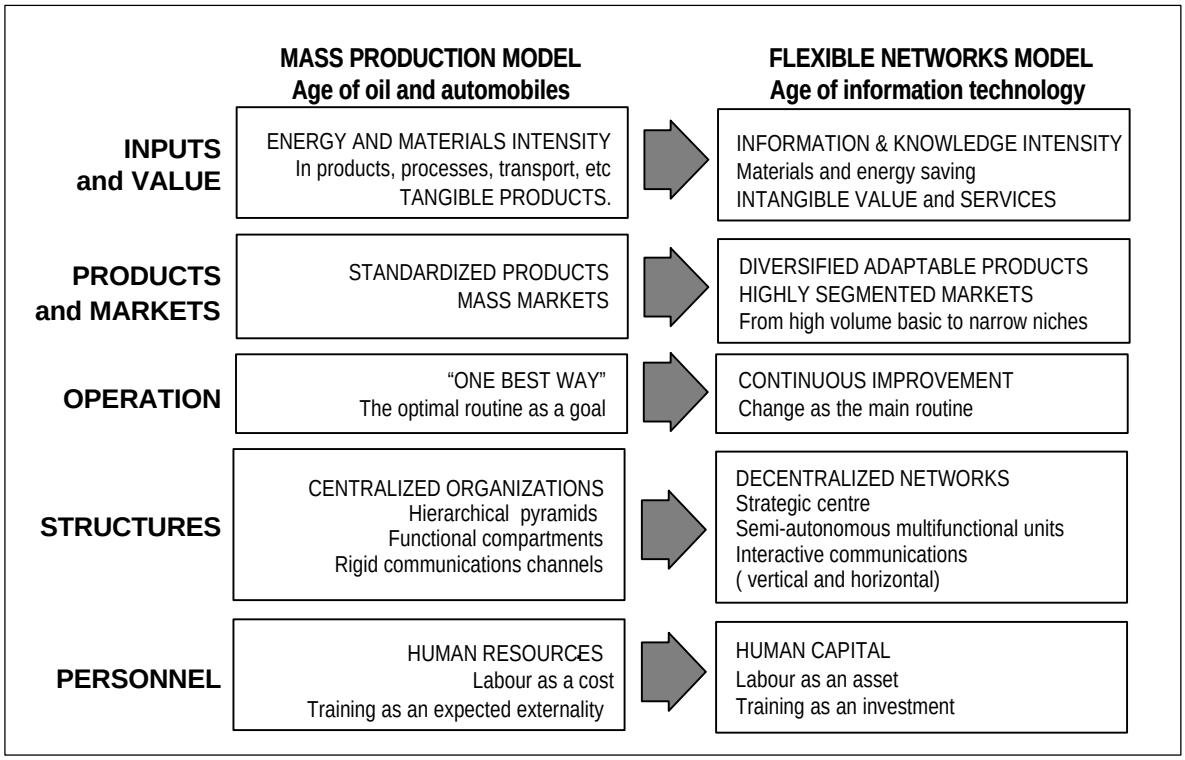
[5] The term is meant to serve as an umbrella concept connecting to the notion of "technological paradigms" proposed by Dosi (1982) to refer to the trajectories of individual technologies.

Figure 6

A change of paradigm

A change in technological and managerial "common sense"



Newcomers, or those who had not been very successful with the previous paradigm, can redirect their efforts towards learning the new practices, while the established leaders are "unlearning" much of the old and adopting the new. Much of the experience and considerable amounts of investment become obsolete and need to be replaced. This is a painful and prolonged process and newcomers may have some advantages, which can be reinforced by early investment in infrastructures and adoption of adequate facilitating institutions.

IV. DEVELOPMENT AS LEARNING TO TAKE ADVANTAGE OF CHANGING OPPORTUNITIES

The picture we have been trying to paint, with the widest of brush strokes, is one of technological evolution as characterized by continuities and discontinuities rooted in the nature of competition in the capitalist system. On a micro-level, each radical innovation represents a discontinuity followed by continued evolution, until the constriction of the space for increasing productivity and profits gives rise to other radical innovations. On the macro-level, technological revolutions erupt in the economic system, bringing whole constellations of new products, technologies and industries. These major discontinuities induce great surges of growth, which swell initially in the core countries, gradually encompass and rejuvenate most of the previously

existing industries, and finally spread out towards the periphery, while another great surge takes shape and erupts in the core.

Developing countries are thus running after a moving target. It not only moves constantly ahead but it also shifts direction about every half century. Ruling out autarchy as an option, development would be about learning to play this constantly shifting game, which is also a power game.

Could this be another version of dependency theory? It certainly involves a notion of North-South centre-periphery complementarity. At the same time, however, it presents the possibility of breaking the vicious circle of underdevelopment through appropriate policies. Followers who understand the game and play it well might find a way of leaping forward and catching up. The favourable conditions for such an outcome would occur during the periods of paradigm shift.

A. Paradigm transitions as double technological opportunities

For about 20 years or more, during the transition, there is a coexistence of old and new technologies. The bulk of already mature technologies of the previous paradigm is stretching, suffering from constriction of productivity and markets, and spreading out geographically to survive, while the new ones are exploding, flourishing and growing at high rates with huge profit margins. This leads to centrifugal trends, where the rich, modern and successful get richer, and the poor and weak get poorer. Yet, paradoxically, it is at this period, with the worst social and economic conditions, that the best opportunities appear.

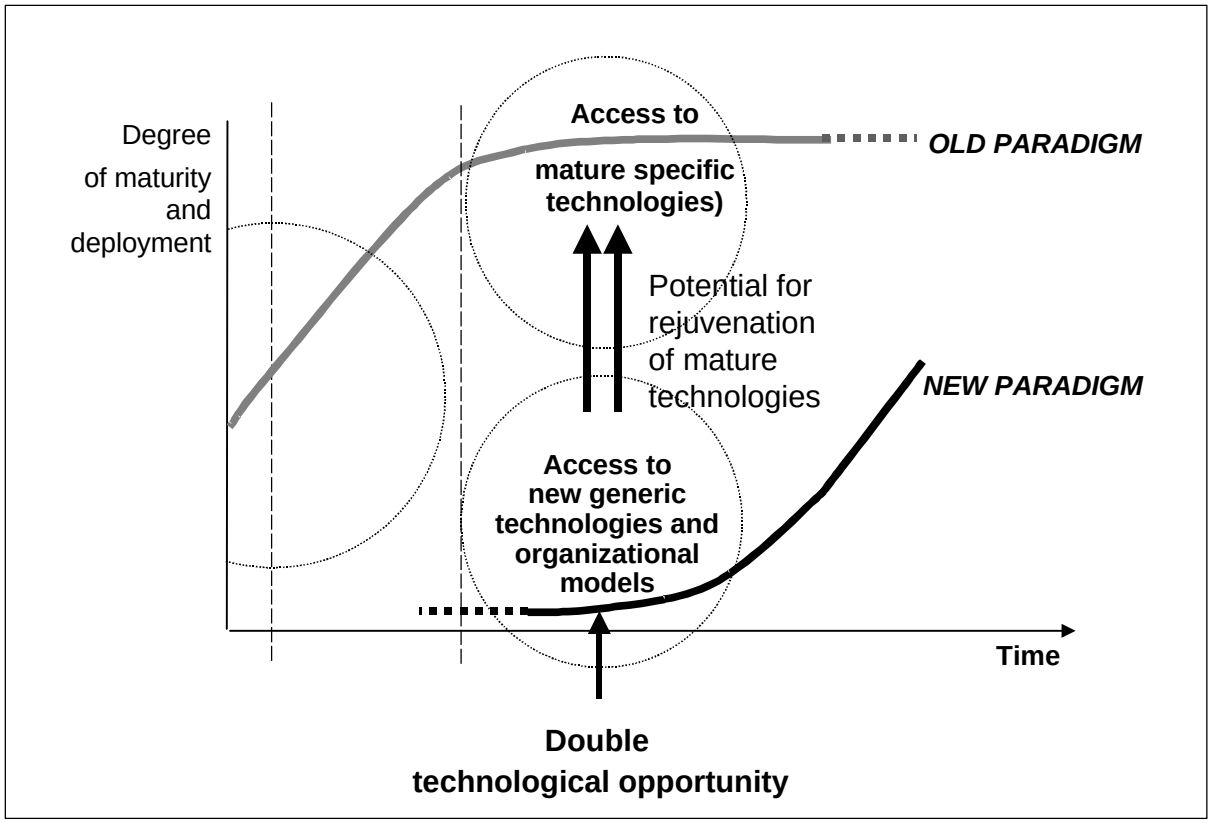
This period of paradigm transition provides the simultaneous opening of the two widest windows of opportunity: phase one of the new technologies, and phase four of the old (figure 7).

We had argued earlier that although mature products can serve to achieve growth for a while, they are not capable of fuelling a process of catching up, because they have basically exhausted their innovation space. During paradigm transitions, however, there is a powerful opportunity to leap forward. The new generic technologies and organizational principles can be used to modernize and rejuvenate mature technologies (and even old traditional ones), as with the automobile and other industries in Japan, shipbuilding and steel in the Republic of Korea (Shin, 1992), surgical instruments in Pakistan (Nadvi, 1999), fresh flower exports in Colombia and fresh salmon in Chile (for these and other examples see ECLAC, 1990).

It is also possible to try a direct entry into the new industries, as many firms in the developing world did in microelectronic products and software, during this transition. The challenge is to survive phases two and three successfully. Many early shining stars disappeared in the process. As we have seen, staying in the race demands growing support from the environment, constant innovation, intensive investment and probably very skilful manoeuvring in

Figure 7

The transition as the best opportunity to leap forward



terms of markets and alliances, for example memory chips in the Republic of Korea, disk drives in Singapore, Asian computer clones, and other successes – although each had particular conditions.

In this specific transition, a very strong third possibility appeared in the context of globalization. In contrast with how the industries of the mass production paradigm deployed nationally first, before moving internationally, many industries in this paradigm have operated globally from phase one. This has opened the possibility of participating in global networks in many different ways and with varied arrangements (Hobday, 1995; Radosevic, 1999). It has also made it possible to produce locally for global trading companies, either as single firms or through cooperating clusters (Schmitz and Knorringa, 1999; Schmitz and Nadvi, 1999; see also IDS Collective Efficiency Research Project).

B. "Dancing with wolves"[6] or the issue of power structures

An understanding of the conditions of access to technology is not complete without addressing the question of power structures. In fact, changing barriers to entry are closely related to the levels and forms of competition and concentration in the industry in question. The nature of each phase marks the behaviour of the firms involved and gradually modifies their focus and their interests.

Table 1 provides a stylized summary of the changing patterns of competition and power structures, which can typify evolving industries, their technologies and markets. It also indicates, the "width" of the window of opportunity in each phase and the conditions demanded of aspiring entrants, be they dependent (i.e. joining the strategy of owner firms), or autonomous firms acting as direct challengers in the market.

Obviously, such a schematic attempt cannot account for all cases. Nor is it within the scope of this short paper to discuss the necessary variations and subtleties. The table can, however, serve as a basic framework for making a few important points.

- Since there are always products and industries going through the various phases, it is important to be informed and aware of the stage of evolution of the technologies and of the patterns of competition, in order to assess the interests and strengths of possible partners or competitors. This allows the evaluation of a firm's assets and possibilities, and improves decision-making and negotiating tactics.
- However, the stage of deployment of the technological revolution also matters. Since technological revolutions lead to the co-evolution of many successive systems, during the early period there tend to be many new important technologies in phases one and two, whereas in later periods there is a predominance of technologies approaching maturity (phases three and four) until they overlap in the next transition. So individual windows of opportunity are strongly shaped by the wider context. This affects both entrepreneurial and national strategies.
- Finally, the choice of dependent or "autonomous" entry is very much determined by a firm's conditions. But it also demands a good understanding of the evolving power structures, in order to identify the present and future interests of the incumbents. The weaker the player, the more important it is to learn to dance with the powerful "wolves" (and even to distinguish between wolves and how to attract them).

Of course, not all technologies are open to negotiation; sometimes, real success may lead to confrontation and zero-sum games. What should be avoided is negotiating mutual benefit arrangements as if they were confrontations. Failure to identify the interests and needs of the prospective partners risks aiming at the wrong target, and is likely to waste the value of one's assets.

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[6] Used in a similar sense by Mytelka (1994).

Table 1

Changing competition patterns and power structures facing aspiring entrants as technologies evolve

Stylized summary

PHASE IN THE LIFE TRAJECTORY OF THE PRODUCT AND ITS TECHNOLOGY				
	1. Introduction	***2. Early growth***	***3. Late growth***	***4. Maturity***
FOCUS: Competitive factors	PRODUCT QUALITY TEST OF MARKET	PROCESS EFFICIENCY ACCESS TO MARKET	SCALE AND MARKET POWER	DIMINISHING COSTS
COMPETITION and POWER	MANY CHALLENGERS Uncertain outcome	Industry taking shape; firms growing and battling for markets; EMERGING LEADERS	Drive for concentration; GIANT COMPLEX STRUCTURES; Oligopolies, cartels, etc.	FINANCIAL POWER looking for profitable outlets and stretching solutions
Dependent entry				
Window "SIZE"	***NARROW***	***VERY NARROW***	***WIDENING***	***VERY WIDE***
BASIS for DEPENDENT entry	COMPARATIVE OR DYNAMIC advantages, COMPLEMENTARY ASSETS	Interesting MARKET Competence as SUPPLIER or advantageous access to resources or markets	Significant MARKET Existing or created EXTERNALITIES or other sources of profit propping	Comparative COST ADVANTAGES Access to FINANCE LEARNING CAPABILITIES
Character of DEPENDENT or ALLIED ENTRY (usually initiated by the owner)	ALLIANCES; MUTUAL BENEFIT NEGOTIATIONS for sharing complementary capabilities and/or assets (to strengthen competitive potential)	As SUPPLIER or COMMERCIAL REPRESENTATIVE	AS PART OF THE STRUCTURE (as supplier, producer, distributor or in whatever role fits the power and expansion strategy of the owner firm)	PRODUCTION AGREEMENTS or JOINT VENTURES in mutual benefit negotiations (transfer of mature technologies and of market access)
Autonomous entry				
Window "SIZE"	***WIDE***	***NARROW***	***VERY NARROW***	***WIDENING***
BASIS for attempting entry	KNOWLEDGE: capacity to imitate and innovate (without violating patents) LOCAL KNOW-HOW for creating a special niche	KNOWLEDGE PLUS EXPERIENCE in process technology and markets (brand names or privileged access to markets important)	EXPERIENCE, FINANCIAL MUSCLE and MARKET CONTROL Comparative COST ADVANTAGES LEARNING CAPABILITIES COPYING capacity	Comparative COST ADVANTAGES LEARNING CAPABILITIES COPYING capacity
Character of AUTONOMOUS ENTRY (initiated by the challenger)	"FREE" COMPETITION FOR MARKET ACCEPTANCE possibly for dominant design; patents often important	AGGRESSIVE COMPETITION for growing and profitable markets Possible ALLIANCES	TAKEOVER OR EXCLUSION of previous weaker players, possible CARTELS	COMPETE WITH OTHER LOW-COST ENTRANTS Buy (or copy) mature technology and "know-how" or MAKE REJUVENATING INNOVATIONS

Historically, rapid growth and economic development, whether catching up from behind or forging ahead to the front ranks, have usefully occurred as a result of successful processes of

technological development (Lall, 1992; Bell and Pavit, 1993; Reinert, 1994; Freeman, 1994; Von Tunzelmann, 1995). These have usually been based on playing *successive positive-sum games* with those ahead, and being prepared to change the game as the context and the structures evolve.

V. PAST EXPERIENCE AND THE NEXT WINDOW

Looking back at the recent history of the developing world and the various strategies applied, we can recognize how, consciously or intuitively, something akin to positive-sum games was constructed between the interests of advanced country firms and those of developing countries. An analysis of this experience can help us look ahead with more informed criteria for the future. Nevertheless, as always happens with the lessons of history, it is crucial to distinguish between recurrence and uniqueness. There are patterns of change that recur in each paradigm, yet each paradigm is basically unique and must be analysed with its peculiar features.

A. Inventing and reinventing development strategies

In the 1950s the modern era of conscious "third world" State involvement in the industrialization process began in earnest. It was a time when an increasing number of mass production industries were in their third phase: seeking extended markets, pursuing economies of scale, forming oligopolies and opening international outlets. Import substituting industrialization (ISI), subsidized and protected behind tariff barriers, became a positive-sum game. The international companies multiplied their markets by exporting much greater quantities of "unassembled" parts to their affiliates abroad, which, in addition, had higher profit margins; these "screw-driver assembly" plants provided a learning context for management and workers in the developing countries. The resulting demand for roads, ports, transport, electricity, water and communications stimulated modernization and fostered the growth of many complementary capabilities.

By the mid-1960s, limitations of the ISI strategy began to surface in some of the countries, at the same time as many products and industries in the advanced world were reaching phase four. Transfer of technology and export promotion came to be seen as new mutually beneficial policies. It began with the transfer of mature technologies to national Governments combined with local capital and production for re-export from low-cost labour locations. By the 1970s, transnational corporations (TNCS) were engaged in "redeployment" generating a significant flow of exports to the advanced world. "Miracles" in Brazil and the Republic of Korea and "export processing zones" in many countries made it seem as if a new international economic order was emerging. The "North-South Dialogue" became the place where such hopes were negotiated.

By the early 1980s the scene changed again. Many products of the microelectronics revolution which had erupted in the early 1970s were reaching phase two. The Japanese had rejuvenated the automobile industry and their new organizational paradigm was radically transforming its competitors in the United States (Altshuler et al., 1984) and Europe.

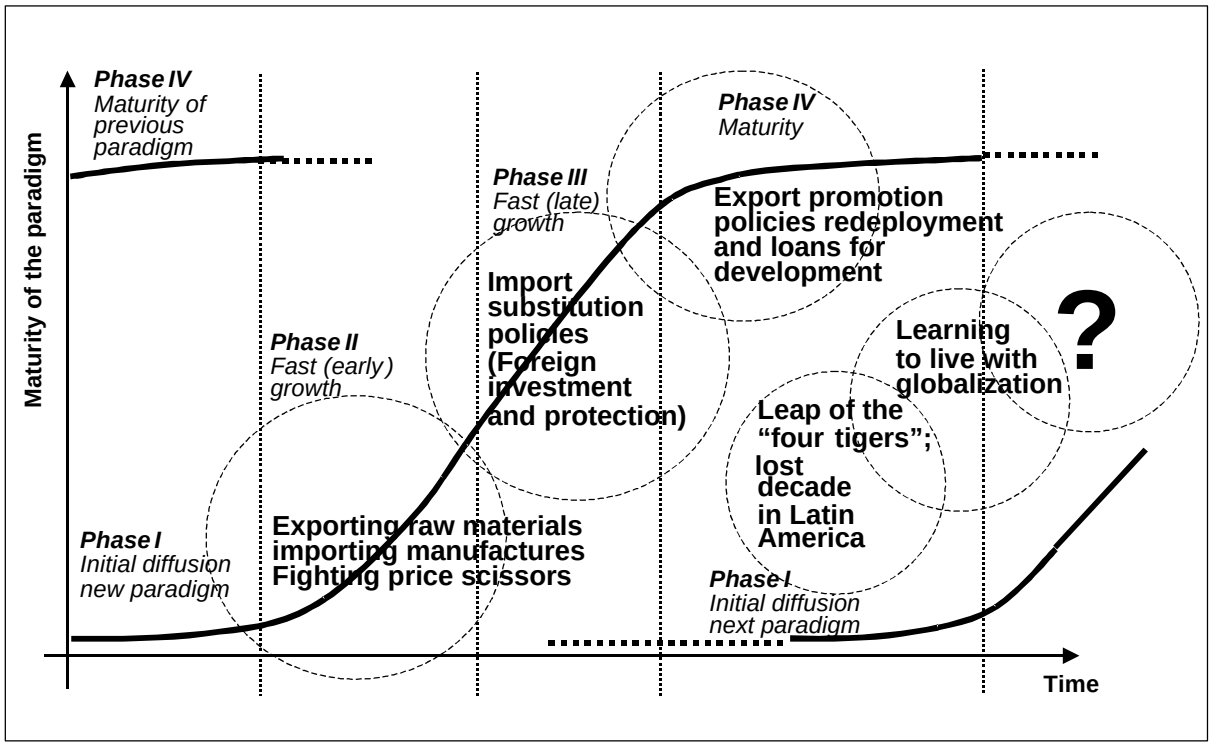
"Stagflation" accompanied maturity in most of the old industries in the advanced world, export markets began to shrink and the debt crisis set in. A new strategy had to be designed.

However, most of Latin America failed to do so, and lived through the aptly designated "lost decade". The "four tigers" in Asia, on the other hand, took the leap forward by capturing market after market from behind and at the edges of the fast growing revolutionary industries. They also rejuvenated mature technologies with modern practices and joined the networks of global firms as original equipment manufacture (OEM) suppliers of parts and components. The intense learning, and the emphasis on human capital and on the active absorption of technology which was behind these achievements cannot be overstated (Amsden, 1989, ch. 9; Pavit and Bell, 1992). This was in sharp contrast with the much more passive "transfer of technology" practices still common in most Latin American and African countries, as well as in the rest of Asia during that period. Figure 8 presents a summary of how development strategies from the 1950s adapted to the windows of opportunity created by the evolving paradigm.

Figure 8

Opportunities as a moving target

Successive development strategies along the phases of successive paradigms



The 1990s have been marked by the structuring of emerging industries and the widespread modernization of existing ones. As one industry after another reached phase two, the fierce competition for market positioning set in. The construction of global corporations and global markets, the battle to set the dominant design and other standards, the weaving of complex webs of collaboration on a worldwide scale, the strengthening of the market power of brands, the search for locational advantages, both dynamic and static, the interest in adapting products to specific market segments and the tendency to "outsource" and other connected phenomena have created a wide range of possibilities depending on the conditions and disposition of the players.

Developing country experiments have been extremely varied both in practice and results. They ranged from the modern "*maquiladoras*" and OEM contracts, through various joint ventures and alliances to the fiercely competitive independent Asian firms (Hobday, 1994). There has also been a flourishing growth of interconnected local clusters in specific industries (such as Indian software) with export market successes. During this period, the "four tigers" moved another step forward, setting up production in other countries of South-East Asia and China. The successful strategies have generally implied *learning to live with globalization.*

Each of the previous successive strategies has had advantages and disadvantages, benefits and harmful effects. Some countries have made big leaps, and others small ones or none at all; some have maintained the advances gained, others have lost them and fallen back. Some of the setbacks may be due to sticking to policies when they were no longer effective. Admittedly, the overall results are discouraging. This can lead to disillusion or to recognizing the extreme difficulty involved in bridging the chasm and the need for a deeper understanding of the issues.

B. Confronting the next stage

The new century will sooner or later see the creation of conditions for the full deployment of the wealth-creating potential of the Information Age.

The 1990s has been a decade of experimentation everywhere – inside and outside global firms, in countries, regions, cities and localities, in the economy, in Governments and other institutions, and in various levels of society. As a result, the "common sense" of the flexible systems paradigm has spread widely and is becoming the normal way of seeing and doing things – many industries are reaching phase three of their trajectories. Agreements, mergers, acquisitions, takeovers and other arrangements are likely to lead to the worldwide concentration of each industry in a few mega-firms or a few global alliances (Chesnais, 1988, 1992; Bressand, 1990; Klepper and Kenneth, 1994; Castells, 1996). Furthermore, the growing power of intermediation, through control of access to clients, could be leading to a modern version of the old "trading companies" based on the power of information and telecommunications (Bressand and Kalypso, 1989; Kanellou, 1999). These giant firms might become huge global "umbrellas" encompassing worldwide diversity, covering all segments – from the luxury and speciality niches to the cheapest standard product or service – purchasing and selling across the planet and locating each activity wherever advantages are greater.

For the developing world, the next stage may be a very complex period of adaptation to the new emerging power structures. For firms, localities, regions and countries, learning to play positive-sum games with these giants may be the nature of the next window of opportunity. Attempting local or regional networks, either independently or by connecting with global networks, could still be a possibility based on very specific local advantages. Of course, those countries and firms that have accumulated capabilities in technology, organization, marketing and negotiation will be much better placed for locating themselves favourably under the "umbrellas" or audaciously outside them. Cooperation between firms, regions or countries can strengthen the bargaining power of both strong and weak actors and agents.

We are suggesting, then, that the design of successful strategies, requires assessing the conditions and accumulated capabilities of the country, region, firm or network in question, in order to take advantage of the next (not the previous) window of opportunity, while recognizing, adopting and adapting the potential and the features of the relevant paradigm. The last section will review some of the implications of these features.

VI. APPROACHING DEVELOPMENT UNDER THE PRESENT PARADIGM

Accelerated growth of firms, localities or countries depends on the availability of *a rich technological potential* and *an appropriate form of organization* to take advantage of it. Whatever the point of departure, and whatever the goal to pursue, success in these times is likely to hinge on how deeply the logic of the new paradigm is absorbed and creatively adopted and adapted at all levels of society.

The earlier centralized pyramids of mass production effectively served firms and Governments, universities and hospitals, private and public organizations of all sorts. For more than two decades now, modern firms – global or local – have been profoundly restructuring and rapidly learning the advantages of networks and of learning organizations (Nonaka, 1994; Senge, 1990; Lundvall, 1997; see also DRUID Project Website). The time has come for Governments to experiment in the same direction. In the next section, we touch upon some aspects of the necessary transformation.

A. Technology at the core of development strategies

It is widely recognized that the Japanese surge ahead involved exercises in technological foresight to collectively signal the path ahead, and intense learning, training and innovating efforts (Peck and Goto, 1981; Irvine and Martin, 1985). The advance of the "four tigers" from behind also involved widespread education and learning (Ernst et al., 1998). Furthermore, successful global firms have redesigned their structures and practices to favour continuous learning, and improvement. Knowledge management (Nonaka, 1995; Burton-Jones, 1999; Lamoreaux et al., 1999) is becoming a key concern – not only do such firms organize regular training at all levels; some have even set up their own "universities" (Wiggenhorn, 1990).

For a developing country to believe that significant advances are possible without equivalent efforts is an illusion. There is no shortcut to development without people's mastery of technology, in the simple sense, of social, technical and economic know-how. This was blurred by the peculiar conditions of import substitution policies, which for a time made it possible for many countries to achieve impressive growth performance by investing in mature plant and equipment, without intensive learning efforts.

In this particular paradigm, developing capacity to handle information and knowledge for innovation is more central than ever. Perhaps the most relevant meaning of the expression "knowledge society" (Castells, 1996; Mansell and Wehn, 1998) is the creation of conditions for access and use of information by all members of society. Therefore, strengthening the individual and social learning capacities for wealth creation becomes an essential way of enhancing development potential.

Consequently technology must be at the core – not at the edge – of development policies. In practical terms, this implies a different way of conceiving strategies, and demands a complete rethinking of both the education and training systems and of science and technology policies.

Educational reform needs to upgrade and update the technical contents, and, perhaps mainly, effect a radical transformation in the methods, goals and tools to make them compatible and relevant for the future (Perez, 1992; ECLAC/UNESCO, 1992). It must: allow students to take responsibility for their own process; emphasize "learning to learn" and "learning to change"; encourage creative teamwork and learning to formulate problems and evaluate alternative solutions; find ways of giving access to Internet and computers; and provide conditions for acquiring the ability to ask questions and process information.

Those skills are becoming the basis for participating in the modern workplace, where firms face a constantly changing environment with continuous improvement practices. They also enable persons and groups to manage the growth of their own wealth-creating capabilities, as employees or entrepreneurs, and provide the necessary organizational abilities for improving their communities and organizations, as group members or as leaders.

The other crucial transformation regards the science and technology (S&T) system, which was created by most developing countries as a set of government institutions in charge of technological development. Experience showed that the use of these capabilities for actual innovation in production was very low. Given the mature technologies with which most industries worked, there was little capacity to absorb the results of these laboratory technologists. The ensuing frustration when trying to build the university-industry "bridge" led most research technologists to become adjuncts of the scientific community and to adopt their methods, time-scales, values and attitudes.

In the new context, it is necessary to move in two directions: invest substantially in research for the future and steer technology towards the direct and immediate improvement of the production networks and of the quality of life.

This move from a "supply-push" S&T system to an interactive network with producers has warranted the term National System of Innovation (NSI – Freeman, 1987; Lundvall, 1988) defined by Freeman (1995) as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies".

This assumes the NSI to be a social rather than a governmental construction. It includes the environment in which innovativeness is stimulated and supported; the quality of the links between suppliers, producers and users; the education and training system; diverse public and private organizations facilitating technical change; the laws, regulations, and even the ideas and attitudes towards technology and change Arocena (1997).

B. Reinventing the "strong" State[7]

It should by now be clear that the markets versus State debate is unsuitable for dealing with the concrete problems discussed here. Both are needed, though redefined and in a new combination. In any case, after the discussion above, it is clear that, for a lagging country, a successful development strategy under the logic of this paradigm, and especially in the face of global mega-firms, is bound to require vast cooperation among firms and between them and the State at various levels.

Although the size and complexity of the task require a strong State, the all-powerful "national State", as it developed after World War II, needs to be redefined and reinvented, probably along lines similar to those applied by modern global corporations.

Nobody believes that the central management of a giant corporation becomes weak when it decentralizes and gives high autonomy and decision-making power to its product, plant or market managers across the world. Computers and telecommunications have made it possible to exercise strong leadership over a vast and growing structure made up of semi-autonomous units, following strategic guidelines. Interactive information channels make it possible to monitor and control highly complex networks with strongly differentiated components.

The new shape of the needed strong "public sector" can imitate those networks. As in the past, once technology helps define the optimal shape of organizations, it can be applied effectively, even without the technology. This, in turn, prepares the terrain for the incorporation of modern technology when required. The central national State can exercise its leadership by inducing the convergent actions of the various social actors towards a commonly agreed general direction of change. It can play a crucial role as "intermediary" between the growing global or

[7] See Reinert, 1999; Wade, 1990; Osborne and Gaebler, 1993.

supra-regional levels and the increasingly autonomous regional, local and even parish or community levels.

There is also a process of "diffusion of power" (Strange, 1996). Networks of private interests, units of civil society, global firms, communications media, organized interest groups, non-governmental organizations and others, are increasing the diversity of development agents and their interlinkages, nationally and globally. The capacity of the national State must serve as "broker" within the country and between the various supra-national and sub-national levels for promoting and negotiating a fair game for all. It could exercise more effective authority if it acted as consensus- builder among the various players with real power to influence the course of events.

C. Thinking global, acting local

The new seat of the proactive development State is, in our view, the *local* government. The old "central plan" idea of promoting a set of national industries to generate the wealth to fund social advance needs to be reconsidered. Obviously, each country must have some important activities, strongly connected to world markets and keeping up with the technological frontier so as to propel growth and produce the necessary foreign exchange. However, the time and the conditions are ripe to abandon the illusion of a "trickle down effect" and move towards the direct involvement of the whole population in wealth-creating activities.

The capacity of the present paradigm for a variety of products and scales, its power to increase the quality and efficiency of all sectors and activities and, most of all, its accessibility to all human beings enabling them to learn how to constantly improve themselves, their work and their environment, make it possible to envisage a more comprehensive form of development.

There are already many examples of local governments identifying the "vocation" of the community, promoting consensus, involving local and foreign firms, banks, the education systems and other actors to promote development projects (Tendler, 1997; Gabor, 1991; The Illinois Coalition, 1999). There are also local networks of small- and medium-sized firms collaborating in business and technology for the export markets (Nadvi and Schmitz, 1999). The study of interaction in these "clusters" has suggested the term "local systems of innovation" (Cassiolato and Lastres, 1999), although in our view it would be more appropriate to call them "territorial networks of innovativeness".

There is also the incredibly successful experience of specialized banks giving "micro-credits" to help men and women in urban and rural areas to set up income-generating activities (Otero and Rhyne, 1994). This is gradually breaking the myth of "jobs" as the only way to improve the quality of life of whole populations by moving towards multiple forms of individual or collective entrepreneurship. In order to address the plight of rural communities, the old pro-urban and pro-manufacturing biases will need to be abandoned (Fieldhouse, 1986:152; Mytelka, 1989), and local governments empowered with the resources and technical support to address directly the issue of improving local living standards. These "localized" activities can often

connect as suppliers with the networks of global corporations or become part of the support network of the big exporting activities of the country.

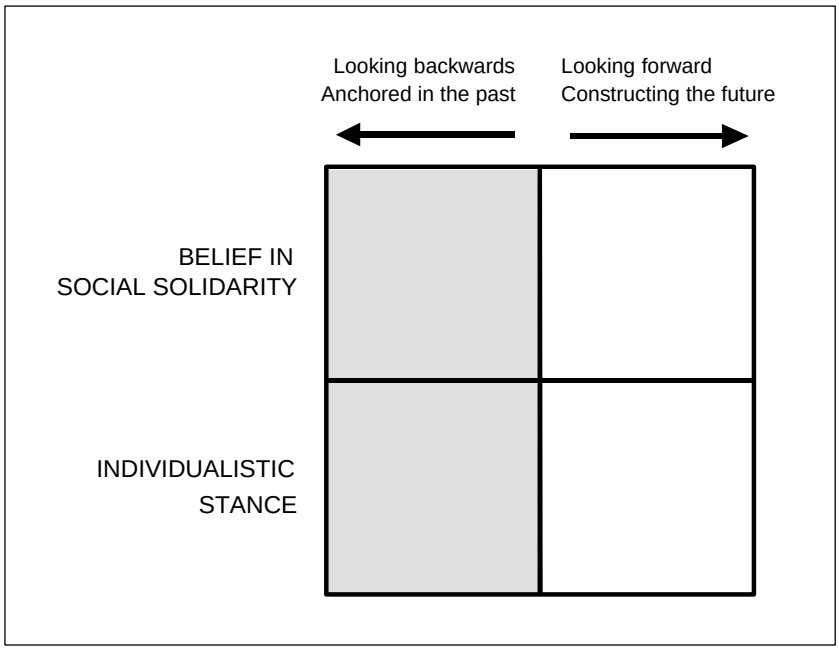
D. Modernity and values

Of course these are political decisions, but the actual choices are not always clear. Historically, in every paradigm transition, the usual definitions of "left and right" become confused. Each of the groupings suffers an internal divide between those that stick to the old ways of reaching their goals and those that embrace the potential of the new paradigm and gear it to their ends (figure 9).

Figure 9

Political positions in the transition

A simple location matrix



In the previous transition, between the two World Wars, the homogenizing "social" character of the emerging paradigm of mass production was so strong that even Nazism called itself National Socialism. Equally, the strong role of a centralized State was so crucial that government intervention in the economy along Keynesian lines – so fiercely opposed in the 1920s and 1930s – was fully adopted after World War II, even in the most liberal nations. Unfortunately for those convinced of the need for social solidarity, neo-liberalism is the only consistent programme that has embraced the present paradigm. Though there are thousands of isolated experiments with forward-looking practices, such as participatory democracy and local consensus-

building, we have yet to see a coherent experience or proposal that can serve as a modern alternative to pure markets. Without it, in our view, there may be world growth, but there is probably little hope of a widespread surge in development.

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