INDUSTRIALIZATION IN THE DEVELOPMENT WORLD: PROCESS CYCLES AND THE NEW GLOBAL DIVISION OF LABOUR

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Introduction

The rapid diffusion of technology and manufacturing processes to less developed nations has been one of the most significant developments in the interaction between advanced and less developed countries in recent years. Industries that were almost exclusively concentrated in the most advanced nations less than three decades ago are now commonplace in many developing countries. Thus, while technology transfer has been limited in many cases, and research and development activities have been mostly nonexistent, the internationalization of manufacturing has nevertheless been significant for an increasing number of less developed nations. This has been most obvious in the volume of exports produced by these nations, the domestic substitution of imports, and the generation of employment and skills for their labour force. The increasing internationalization of manufacturing activities has also had a significant impact in certain manufacturing industries in the most advanced nations. Plant closings, industry flight, and high unemployment have become a major concern of our time in such industries as electronics, textiles, apparel, and others involving many assembly-type operations. The significance of these changes for the advanced nations has been brought to our attention by Fröbel et al. [16] and Grunwald and Flamm [20] on West German and U.S. manufacturing industries and their diffusion to less developed nations.

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One of the major difficulties confronting location theorists has been that of finding suitable theoretical constructs that can adequately explain these evolutionary shifts in the location of industries. The overwhelming emphasis placed by modern location theory on static paradigms has been a major obstacle in this respect, and has resulted in considerable neglect of the broader, evolutionary perspective. It is therefore not surprising that location theorists have come to view the product cycle, a concept long developed and applied in the fields of marketing and international trade, with increasing interest in recent years. While the first explicit application of the product cycle to industrial location was Vernon's [53], on the diffusion of multinational enterprises abroad, Thomas's [49;50] work was among the first to relate this concept to growth pole dynamics and technological change. This was later expanded by Hanson [21;22], Norton and Rees [37], Erickson and Leinbach [14], Sjafrizal [43], and Suarez-Villa [47], to explain shifts in the location of U.S. manufacturing to the Sunbelt and to nonmetropolitan areas. Case studies on specific firms and industries have also been provided by Krumme and Hayter [29] on aircraft manufacturing, and by Hekman [25;26] on the steel and the textile industries. Despite this rapid rise of interest, the product cycle nevertheless has important shortcomings that limit its application to the spatial domain. These shortcomings have been pointed out in the management and international trade literature by Penrose [38], Gold [19], Slome [44], Giddy [18], Vernon [54], and Day et al. [13], among others, and by Suarez-Villa [46;47;48] in the spatial literature, and will be a subject of discussion in the following section.

This paper will outline and discuss the manufacturing process cycle as a conceptual framework for the analysis of manufacturing diffusion to less developed nations. This approach reaches well beyond the narrow assumptions and scope of the product cycle, and can be related to the broader evolutionary perspectives of Schumpeter's [40] original contribution on the dynamics of economic processes, and to the more recent, post-Schumpeterian contributions of Georgescu-Roegen [17], Boulding [6;7], and Nelson and Winter [36]. Emphasis will be placed on the role of three major elements, labour, organizational environments, and technological change, and their relation to product and factor market conditions and evolution over a productive process's life cycle. In contrast to the product cycle approach, the manufacturing process cycle focuses on *processes* rather than products as the major vehicles of industrial change. This perspective is based on the Schumpeterian distinction between product and process innovation, and considers irreversible change to be one of the most important characteristics of productive processes [17:211]. The last section of the paper will discuss the three major elements of the process cycle in greater detail, relating them to industrialization policy strategies, and to the international diffusion of manufacturing activites.

Evolution of Industrialization: A Conceptual Framework

In its earliest form, the origins of the life cycle approach can be traced to Darwinian ideas on evolution and their diffusion to the study of economic processes. As early as 1914, economists such as Chapman and Ashton [11] were referring to a life cycle process in the development of manufacturing firms. These authors likened the growth and size of firms to the development of organisms, and applied this analogy to empirical studies on the development of English textile industries. Although such evolutionary ideas had attracted significant attention in the early part of this century, much of the early interest in economic change is usually traced to the development of the business cycle concept [52]. Secular economic change thus captured the attention of Kuznets [31] and Burns [9] in the nineteen-thirties. These works stressed the importance of short-term economic upswings and downturns rather than the irreversible character of developmental processes. Later, this approach was expanded and fused with a broader evolutionary perspective to study changes in product demand. Thus, the life cycle analogy became popular in the marketing literature, and was eventually expanded to include organizations and their internal functions [28;10;55;56]. This general approach was also adopted by less orthodox economists such as Boulding [6], in calling for a life cycle theory of the firm. Then, in the nineteen-sixties, the product cycle gained much attention in the area of international trade, particularly through the work of Vernon [52], Hirsch [27], and Wells [58]. These applications, although limited in many cases by the lack of adequate longitudinal data, nevertheless opened alternative vistas to the Heckscher-Ohlin paradigm and the comparative advantages approach.

Although the product cycle has remained viable for over four decades, the study of manufacturing life cycles and their spatial implications requires a broader perspective than that adopted by most product cycle applications. A better approach to the study of regional and international manufacturing change can be provided by evolutionary concepts grounded in Schumpeter's conceptualization of the dynamics of developmental processes and their impact on socioeconomic structures and institutions. In modern

times, this perspective has been expanded and developed by Georgescu-Roegen's [17] views on the entropic properties of economic process, and by Boulding's [8] macroanalytic attention to various aspects of social evolution. The evolutionary approach has also received significant attention in Forrester's [15] application of systems modeling to the development process, and in Nelson and Winter's [36] application of natural selection to sectoral evolution and productive organization. To a considerable extent, the adoption and application of this broad approach can help overcome the most serious shortcomings of the product cycle. Thus, for example, the product cycle's exclusive concern with output and demand-side issues can be expanded to include other aspects of production. In such a scheme, organizational and managerial factors can be considered to be active determinants of the nature and evolution of productive processes [46]. This helps overcome the product cycle's theoretical groundings in static orthodox theory and its implicit assumption of managerial behaviour as fixed and automatic. Additional details and specificity may also be introduced through an evolutionary phasing scheme, thereby expanding its potential for empirical applications. Another important implication of this approach is the possibility of considering regional and subnational aspects in greater detail, through the introduction and linkage of internal organizational aspects with spatial questions. Finally, the possibility of considering policy questions and implications is an additional benefit, as policy strategies will likely vary with each developmental phase.

The manufacturing process cycle's focus on productive processes and organizational aspects creates a different set of conditions from those assumed by the product cycle. A focus on manufacturing processes rather than products is more stable, since the latter can always be differentiated to induce temporal regressions in their life cycles. Significant modifications to productive processes usually require considerable amounts of capital investment and internal reorganization, thereby ensuring greater stability over time. The characteristics of production processes also affect much more directly a firm's internal requirements and tradeoffs. It is thus possible for a given manufacturing process to produce several versions of the same product, introducing significant product differentiation, while its productive structure (labour, technology, organization) remains basically unchanged. Also, for most significant process innovations, internal organizational questions are more important, or at least as important as changes in product demand, and have greater impact on the firm's internal structure [36:chs. 4 and 5]. In this respect, Georgescu-Roegen's [17] conception of economic processes as irreversible phenomena

is very much a central assumption of the process cycle. In more pragmatic ways, the concept is also indebted to the work of Abernathy [1] and Abernathy and Townsend [2] in testing a life cycle model of production process development. A study of U.S. automotive engine plants verified these authors' assumptions on cyclical development and provided significant insights on the importance of process changes on productivity and innovation [1]. This was later complemented by Abernathy and Utterback [3] and by Hayes and Wheelwright [23;24] in their attempt to link general aspects of process innovation with the product cycle concept.

The manufacturing process cycle's attention to corporate organization and planning is still another distinctive element that can be related to questions of process innovation. The firm's strategic priorities are assumed to vary with each phase of process evolution, and are targeted towards objectives that are possible to attain and which also are important for firm survival. The changing character of these priorities is a feature of the process cycle that can be related to the work of Cyert and March [12] and Williamson [60] on organizational behaviour and managerial objectives, to Wilensky [59] on organizational strategies, and to March and Olsen [34] on risk-taking behaviour and uncertainty. It also has the potential to be linked in a dynamic way to significant aspects of Simon's [41;42] work on bounded rationality and to the work of Liebenstein [32;33] on selective rationality and X-efficiency. These aspects also allow for the consideration of variable market conditions as another important characteristic of the manufacturing process cycle [46;48]. At the same time, this allows for the possibility of relating the concept to the extensive literature on imperfect competition. In the discussions that follow, brief elements of oligopolistic competition, as elaborated in Bain's [4;5] and Stigler's [45] pioneering work on industrial organization, will be related to the manufacturing process cycle's evolutionary character.

Three major elements will be considered by the manufacturing process cycle: organizational environments, labour, and technological requirements. These elements will be related to factor and product market conditions in advanced and less developed nations. Agglomeration-oriented industries will be the most appropriate to consider with respect to these variables. As opposed to raw-material-oriented and complementary industries, the production processes of agglomerative industries are more heavily oriented toward assembly operations. These industries are therefore most likely to diffuse to developing nations, given the possibility of obtaining substantial labour cost savings. One of the drawbacks of this approach is, unfortunately, the need to introduce a very

significant amount of generalization on the characteristics of productive processes. This is, however, a problem common to any broad conceptualization, and reflects the need to establish the general relevance of the approach before considering the more involved microanalytic details. A second negative aspect of this framework is that historical circumstances and specificity leading to major changes in production processes cannot be adequately considered. Such events are, in any case, probably more appropriate for individual case studies. In this respect, the Schumpeterian distinction between dynamic, as opposed to historical, time is very relevant [17:136]. The emphasis on dynamic time will therefore stress the continuity of developmental processes as applied to manufacturing production and its diffusion to less developed nations.

Table 1 outlines the most significant variables and elements of the manufacturing process cycle. Five major variables are included in the organizational environment element. Of these, strategic priorities are assumed to undergo the greatest change from one evolutionary phase to the next. In this, as in all the other variables, production process development occurs mostly in the advanced nations, reflecting these countries' research and development priorities and market advantages. In general the firm's strategic priorities vary in the advanced nations from outward-oriented strategies related to market share expansion (phases B, C) to internal concerns on cost and efficiency issues in the late phases (D, E, F). With the diffusion of manufacturing processes to less developed nations (phase C), outward-oriented strategies similar to those applied earlier in the advanced nations are initially implemented. Transnational corporations are assumed to exercise an important role in this diffusion process, although alternatives such as the purchase of technology by private and state-owned domestic firms has also been common. A much slower evolution towards decline in less developed nations during the late phases may be assumed, given higher probabilities of trade protection and domestic oligopoly.

Managerial skills in the advanced nations are assumed to be relatively higher during the earlier phases, requiring greater planning and coordination skills (see Table 1). This condition reflects the firm's more prosperous market expansion possibilities. During the late phases (E, F), however, managerial skills are expected to be lower, reflecting their demand for applications to less complex, routine activities. This is also evidence of the very low possibilities for obtaining additional market share through aggressive marketing strategies. Managerial skills in the less developed nations are assumed to be generally lower than in the advanced nations during the middle phases (C, D), but may be on a similar level with those of the advanced nations during the late phases (E, F). These skills are also expected to be closely related to the marketing opportunities available to the enterprise. Marketing efforts are therefore also most intensive during the earlier phases of the process cycle, but will decline significantly in the late phases. Marketing potential in the less developed nations will generally be high during the middle phases, after the establishment of a manufacturing process, but may not, on the other hand, be fully realized due to demand constraints imposed by low incomes and a very skewed distribution of wealth.

Product markets in the advanced nations are generally assumed to be oligopolistic in the early phases, becoming more competitive at mid-life, and very competitive in the late phases (see Table 1). Entry barriers are therefore assumed to be strongest when quasi-monopolistic conditions exist, as in phase B [45:138]. Product differentiation also becomes more likely in phase D, and process substitution more probable in the late phases (E, F). Product markets in the less developed nations are, on the other hand, assumed to remain generally protected. Greater competition is nevertheless assumed to occur in the late phases in these nations. The overall scale of a productive process is also closely related to product market conditions. In the advanced nations, the productive process's scale is expected to grow very rapidly after a new product has found useful applications. Thus, in phase B, conditions for vertical integration may be strongest as the firm captures a sizable and growing segment of the market [45:135]. In the mid-life phases (C, D), vertical disintegration is expected to occur, along with the possibility of some horizontal integration through mergers and acquisitions. As competition intensifies, however, horizontal disintegration will also increase and may become more pronounced in the late phases (E, F). In the less developed nations, vertical integration is expected to be more pronounced, if allowed and promoted by institutional mechanisms, due to protected markets and the possibility of creating and consolidating missing forward and backward linkages. Horizontal integration may also develop strongly in the late phases in the less developed nations if competition increases, or if it is promoted by institutional arrangements. Whenever they are effective, domestic policy instruments in these nations may have substantial impact on these restructurings.

Labour questions are also a major element of the manufacturing process cycle. In the early phases, employment in the advanced nations is expected to grow rapidly, as a result of market expansion. It is then expected to stabilize in the middle phases, while

Table 1

THE MANUFACTURING PROCESS CYCLE IN MDC/LDC* CONTEXTS
FOR AGGLOMERATION-ORIENTED INDUSTRIES

	Phase A	Phase B	Phase C
I. ORGANIZATIONAL ENVIRONMENT			
1. Strategic Priorities	MDC: R & D productivity maximization	MDC: Market extent maximization	MDC: Market share maximization LDC: Initial market penetration
2. Overall Managerial Skills	MDC: Limited to R & D operations/productive applications	MDC: High organizational and coordinative skills/overall corporate planning	MDC: High promotional skills/ overall corporate planning LDC: Preliminary planning of organizational entity
3. Marketing	MDC: Non-existent	MDC: Rapid build-up of sales/ service networks	MDC: Well developed sales/service networks LDC: Creation of sales/services networks
4. Product Markets	MDC: Non-existent	MDC: Semi-monopolistic/high concentration	MDC: Oligopolistic/decreasing concentration LDC: Monopolistic/oligopolistic
5. Operational Scale & Organization	MDC: Limited to R & D	MDC: Very rapid growth/vertical integration	MDC: Growing/large scale/vertical disintegration starts LDC: Start-up phase/rapid growth
II. LABOUR			
1. Overall Employment	MDC: Non-existent	MDC: Rapid growth	MDC: Growing LDC: Rapid growth of very small labour force
2. Skills	MDC: Highly skilled professionals or technicians	MDC: Biased toward professional/technical occupations	MDC: More balance between professional/technical & blue-collar LDC: Moderately-skilled blue-collar
3. Costs	MDC: High	MDC: Rapidly increasing	MDC: Increasing/unionization LDC: Increasing but much lower than in MDCs
III. TECHNOLOGY			
1. R & D	MDC: Very intensive/product innovation phase	MDC: Developing productive applications/process innovation starts	MDC: Improving productive applications/process innovation at mid-life LDC: Non-existent
2. Capital Equipment	MDC: Non-existent	MDC: Rapid installation and expansion	MDC: Moderate-high expansion/ automation starts LDC: Limited
3. Financing	MDC: Very inaccessible	MDC: Very accessible	MDC: Very accessible LDC: Accessible
4. Raw materials	MDC: No demand	MDC: Rapidly increasing demand	MDC: High demand LDC: Increasing demand

* MDC: most developed countries; LDC: less developed countries.

Table 1 (cont.)

	Phase D	Phase E	Phase F
I. ORGANIZATIONAL ENVIRONMENT			
1. Strategic Priorities	MDC: Mass production efficiency and scale economies maximization LDC: Market share maximization	MDC: Labour cost minimization LDC: Market share conservation	MDC: Overall cost minimization LDC: Mass production efficiency maximization
2. Overall Managerial Skills	MDC: Sub-organizational planning & coordination LDC: Overall subsidiary coordination and planning/ promotional skills	MDC: Limited to day-to-day operations/labour relations LDC: Sub-organizational coordination	MDC: Very limited LDC: Routine coordination
3. Marketing	MDC: Relatively less important LDC: Expansion of sales/service networks	MDC: No extensive efforts/ saturated markets LDC: Limited expansion	MDC: Practically non-existent LDC: Growth limited by socio-economic conditions
4. Product Markets	MDC: Competitive/product differentiation may start LDC: Oligopolistic if protected	MDC: Very competitive/product differentiation more likely/ product substitution possible LDC: Limited competition/high concentration	MDC: Very competitive/product substitution more likely LDC: Competition increases/ medium-high concentration
5. Operational Scale & Organization	MDC: Stable/large scale/ subcontracting common/ horizontal integration LDC: Rapid growth/vertical integration	MDC: Scale reductions/horizontal disintegration LDC: Limited growth/horizontal integration starts	MDC: Decline/plant closings LDC: Limited growth/horizontal integration
II. LABOUR			
1. Overall Employment	MDC: Stagnant LDC: Growing/moderately large labour force	MDC: Stagnant or declining LDC: Leveling off/large labour force	MDC: Declining LDC: Stagnant
2. Skills	MDC: Deskilling starts LDC: Mostly blue-collar	MDC: Mostly blue-collar LDC: Lower-skilled blue-collar	MDC: Lowly-skilled LDC: Lower-skilled blue-collar
3. Costs	MDC: Increasing/unionization more active LDC: Increasing or stagnant	MDC: Stagnant or decreasing LDC: Stagnant or decreasing	MDC: Decreasing LDC: Stagnant or decreasing
III. TECHNOLOGY			
1. R & D	MDC: Less important/process innovation ends LDC: Non-existent or very limited	MDC: Very limited if present LDC: Non-existent or very limited	MDC: Non-existent LDC: Non-existent
2. Capital Equipment	MDC: Increasing automation LDC: Limited/more labour-intensive	MDC: Further automation limited/obsolescence LDC: Labour-intensive	MDC: Capacity reduction/ obsolescence LDC: Labour-intensive
3. Financing	MDC: Accessible LDC: Accessible	MDC: Less accessible LDC: Less accessible	MDC: Not accessible LDC: Less accessible
4. Raw materials	MDC: Demand growing at decreasing rates LDC: Rapidly increasing demand	MDC: Decreasing demand LDC: Demand growing at decreasing rates	MDC: Relatively low demand LDC: Stable demand

decline eventually occurs in the late phases (see Table 1). Employment in the less developed nations is expected to follow a similar, though less pronounced, pattern, as protectionism allows productive processes to survive their obsolescence to some extent. In the advanced nations, the demand for labour skills is expected to favour professional and technical employment during the early phases, followed by increasing preferences for less skilled labour, particularly in the late phases. As with employment, the evolution of the demand for labour skills is expected to follow a less pronounced pattern when compared to the advanced nations. This is partly a result of the greater availability and cost advantages of labour in developing countries, and of the lower overall skill levels found in the labour force. In so far as the factor intensiveness of productive processes is concerned, this is therefore expected to be more biased toward labour in the less developed nations. In general, labour costs will be expected to be the largest single item in the production cost structure of most processes [57;51]. This situation may, however, vary as evolution through the process cycle phases continues. Thus, for example, the importance of labour costs is bound to decline in relative terms when an industry is established in a less developed nation in the mid-life phases, primarily because of lower labour costs vis-à-vis other aspects of production.

Technology is the third major element of the manufacturing process cycle. In this respect, research and development activities are most important during product invention and innovation (phase A). The effectiveness of these activities is crucial, as they are most likely to determine the establishment, growth, and survival of any firm and the productive process it chooses to adopt. Phase A will therefore be particularly important for small firms and partnerships. After a successful invention has been introduced, process innovation may occur (phase B). This will involve the design of production tasks, routines and planning, to ensure that the firm's strategic priorities are met. In most cases, this is also likely to involve the introduction of new technologies and inventions in routine or day-to-day productive operations [35]. Process innovation will then be expected to end by mid-life (phase D), as competitive market pressures limit the resources that would normally be available for such activities.

In the less developed nations, research and development activities are assumed to be virtually nonexistent. Whenever present, these may be limited to aspects of process innovation that require the adaptation of imported technology to domestic conditions. Such adaptations may in fact be quite marginal in most cases, and will usually involve adjustments designed to utilize indigenous

resources and labour in greater proportions. In the advanced nations, fixed capital investment is expected to be most intensive during the early phase (B, C), as the scale of productive processes expands. Various degrees of automation may also be introduced, whenever feasible, as competitive market pressures increase. This would provide greater productive efficiency and would likely reduce labour costs. It would, on the other hand, also require significant capital investment that may only be possible whenever oligopolistic conditions exist. In the less developed nations, capital investment is assumed to be more limited than in the advanced nations, given the comparative advantages introduced by a large surplus labour force and the resulting lower labour costs. Capital availability for expansion may also be correspondingly stronger in the early phases in the advanced nations. Potential sources of capital may, however, be more limited as the production process matures and obsolescence approaches. Financing opportunities may thus be better available for the establishment of industries in developing nations during the mid-life phases of their manufacturing processes, given the more promising market expansion possibilities and the very likely oligopolistic conditions. In the case of transnational corporations, these financial resources may be available internally, and their eventual application may be influenced by profit repatriation opportunities. As with capital resources, the demand for raw material inputs is expected to follow a pattern of general increase in the early phases, followed by slower growth during the middle phases, and eventual decline during the late phases. Declining demand for raw material inputs may become most obvious as the obsolescence of a productive process sets in and the likelihood of substitution increases. A similar pattern may occur in developing nations, although perhaps more gradually, depending on the restrictions imposed on technology imports and the nature of market production.

Diffusion Factors and the New Global Division of Labor

Three major evolutionary factors are considered to affect the establishment and growth of manufacturing activities in less developed nations. These factors are key elements of the manufacturing process cycle and help shape the evolutionary path of productive processes in significant ways. Labour is a very important factor. In many manufacturing industries, labour costs are the most significant item as a proportion of total production costs. They are also the most spatially differentiated factor of production, particularly in the context of advanced nations, in more ways than any other input factor [57]. In this sense, labour skill

specifications and behavioural characteristics are important requirements of any production process, and may be considered to vary according to the evolutionary peculiarities of each process. In so far as the less developed nations are concerned, labour costs are generally lower than for the advanced nations. Table 2 presents estimates of average labour costs and working hours in 32 less developed nations that have undergone significant industrialization. Labour costs are found to vary from 25 to 3 percent of prevailing U.S. wages in the industry considered. Similarly, working hours are generally higher and promote greater labour productivity, given unit costs. These characteristics are a consequence of the labour surplus and underemployment problems that are so typical of most developing nations. They are also powerful attraction factors for the diffusion of manufacturing activities from the advanced to the less developed nations, particularly as production processes become more reliant on less skilled labour.

Table 2

REPRESENTATIVE WAGES AND WORKING HOURS IN SELECTED LDCs, 1979

Country	(a)	(b)	Country	(a)	(b)
Asia			**Latin America**		
Hong Kong	48-60	.14	Brazil	48	.10
India	48	.05	Chile	n.a.	.12
Inonesia	40	.07	Colombia	48	.06
Jordan	48	.16	Dominican Republic	44	.14
Malaysia	48	.05	El Salvador	44	.12
Philippines	48	.05	Guatemala	45	.10
Singapore	44	.12	Haiti	48	.05
South Korea	48-60	.07	Honduras	44	.08
Taiwan	48	.07	Jamaica	48	.26
Thailand	48	.05	Mexico	48	.22
Turkey	n.a.	.20	Panama	48	.16
Western Samoa	40	.12	Puerto Rico	48	.65
			St. Lucia	40	.10
Africa			Uruguay	48	.14
Egypt	42	.10	Venezuela	48	.17
Liberia	n.a.	.06			
Mauritius	45	.03			
Senegal	40	.15			
Tunisia	48	.12			

(a) Working hours per week.

(b) Hourly wages for unskilled labour, expressed as a share of U.S. hourly wage (electronics manufacturing).

Source: Author's calculations, assisted by individual country censuses.

In general, it may also be expected that a majority of production tasks in the less developed nations are relatively less complex, with the possible exception of capital goods manufacturing. This characteristic is related to the relatively lower and scarcer labour skills. Organizational capabilities, a second important factor affecting the diffusion of manufacturing to less developed nations, is also of generally lower quality and scarcer, and is closely related to the lower complexity of production tasks. Contrary to the assumptions of orthodox economic theory, organizational skills in manufacturing are highly differentiated spatially, particularly with respect to less-developed/more-advanced nation comparisons. It is therefore not surprising that many manufacturing operations in less developed countries allow for the relatively more profitable substitution of labour for machinery. This is often accomplished through the application of somewhat obsolete technologies that are more labour and managerial skill-saving. If the evolutionary trend of most production processes can be considered to be less organizational-skill-intensive as their application advances through time, then the diffusion of manufacturing to less developed nations in the later phase of the process cycle is a logical consequence.

Technological change is the third major evolutionary factor affecting the diffusion of manufacturing activities. Most technological advances or applications in the less developed nations occur through the transfer of technology from industrialized nations. Conditions in these nations are therefore generally more favourable for assembly-type operations and less so for highly technological and complex tasks, given scarce labour and managerial skills, and the prevailing conditions in educational and scientific institutions. Innovations in production may in most cases be related to experimentation in the utilization of labour rather than in the design or application of completely new tools or equipment. The rate of technological transfer to the less developed nations may thus be considered to depend, first, on the rate of change in production processes, and on product differentiation in the advanced nations. The accelerated development of new generations of productive processes and techniques can therefore increase the diffusion of manufacturing activities. An example of this may be found in the production of semiconductors in electronics, where the evolutionary development of its manufacturing process has been accelerated through the phases of the process cycle. Second, production processes that comprise highly mechanized or automated operations but which also have certain routines that cannot be automated are rendered more profitable by locating in the labour surplus nations. In such cases, the reliance on labour for the performance of non-automated tasks may occur because of

the substantial capital investment required to automate, and the possibility that these investments may not be profitable, given possible rapid changes in production process technology. Semiconductor manufacturing is, again, a good example. Two major operations can be easily automated (production of masks and wafers), while a third (assembly and testing) has generally been labour-intensive. Typically, it is this portion of semiconductor manufacturing that has spread most rapidly to the less developed nations. Increasing demand for products whose manufacturing processes have these characteristics can further accelerate their diffusion to less developed nations.

All of these three major evolutionary factors are related to the specific characteristics of manufacturing processes and to their development over time. Organizational capabilities can nevertheless modify evolutionary trends related to a manufacturing process's advance through its life cycle. Internal organizational tactics and effective product differentiation can thus retard process substitution trends. However, patterns of manufacturing process evolution and substitution can seldom, if ever, be reversed. Varying rates of evolutionary advance will apply to different processes in the same manner as their diffusion and allocation in the international division of labour develops. In this respect, policy mechanisms have been and can be used to accelerate the establishment of certain industries better than others, depending on perceived national needs and conditions [39;30]. Indeed, most of the growth of manufacturing activities in less developed nations can be traced to the conscious formulation and implementation of some form of industrialization policy (Table 3). While the effectiveness of many of those policies has been questioned, it must nevertheless be recognized that when their objectives matched the realities of a country's locational attraction, the results obtained have been impressive. Countries such as Brazil, Mexico, South Korea, Taiwan, Hong Kong and Singapore are important examples of effective industrialization policy applications.

Five major industrialization policy strategies have been applied in less developed nations (Table 4). Export-oriented industrialization policies were promoted by many nations during the past decade as a means to increase foreign exchange earnings, improve trade balances, and promote diversification of their manufactured exports. Because in most cases export-oriented industries have to compete with products manufactured in the industrialized nations, their labour, managerial skills, and technological requirements can be expected to be high and may approximate those of similar manufacturing processes in the advanced nations. World market factories (usually established by transnational corporations) and industrial export enclaves have been common vehicles

Table 3

AVERAGE ANNUAL PERCENTAGE GROWTH RATES OF MANUFACTURING PRODUCTION, 1960-1980

	Industrialized Nations[a]			Less Developed Nations[b]		
	1960-68	1968-74	1974-80	1960-68	1968-74	1974-80
Light Manufacturing[c]	4.5	4.3	1.1	4.4	6.6	4.6
Heavy Manufacturing[d]	7.0	5.9	0.5	8.6	10.2	7.3
All Manufacturing	6.2	5.3	0.8	6.1	8.2	6.1

[a] U.S., Canada, Japan, Western Europe, Australia.

[b] Asia, Africa, Latin America.

[c] Food; Tobacco; Textiles; Apparel; Furniture; Paper; Printing and Publishing; Leather; Electronics; Instruments.

[d] Chemicals; Petroleum; Rubber and Plastics; Stone, Clay and Glass; Primary Metals; Fabricated Metals; Machinery; Transportation Equipment.

Source: United Nations, *Monthly Bulletin of Statistics*, 36 (1982), and previous years.

for the implementation of export-oriented industrialization [48]. In the latter, manufacturing operations that are no longer profitable in industrialized nations may become the norm. If so, then the labour and managerial skills and technological requirements of export enclave industries can be expected to be significantly lower than for world market factories that are more capital intensive and serve both international and domestic markets in the less developed nations. Thus, in so far as the spatial distribution of export-oriented industries is concerned, it may be expected that the major locational tradeoff will be between labour costs and shipping costs of inputs to the manufacturing site, and of products to market.

Industrialization strategies related to the preliminary processing of raw material exports have also been an important focus of policy attention. Although their primary motivation has been to increase foreign exchange earnings, the creation and intensification of forward linkages has been an equally strong objective. Their requirements of labour and managerial skills, and technology, can be considered variable, depending on the degree of international competition and demand for the necessary raw materials. When such competition comes mostly from the advanced nations, skills and technological requirements can be significantly higher than when such competition is derived from other less developed nations. The spatial distribution of these operations can therefore be expected to correspond to the distribution of natural resource

Table 4

INDUSTRIALIZATION STRATEGIES AND REQUIREMENTS

Strategy	Labour Skills	Organizational Capability	Technology and Innovation	Process Cycle Phase[a]
1. Export-oriented	medium	high	medium to high	D-E
2. Preliminary processing of raw material exports	medium	medium to high	medium to high	C-D-E
3. Import substitution	medium to low	medium	medium	C
4. Basic industry (capital goods)	high	high	medium to high	C-D
5. Small-scale domestic (labour-intensive)	low	low	low	E-F

[a] Phase to which manufacturing process utilized may most likely belong.

endowments. Generally, locational considerations may favour a raw material processing strategy, since the weight reductions effected by processing will reduce shipping costs. The only possible tradeoff may be related to the cost of any inputs, inclusive of technology, that may be required to maintain processing activities.

Import-substituting industrialization was a major focus of development policy formulation throughout the postwar era and up to the early 1970s. Its primary motivations were the accommodation of internal consumer and producer demand by replacing imports with domestically manufactured goods, and the creation of employment opportunities. Its implementation was always most effective whenever import-substituting industries could be backwardly-linked to indigenous raw material sources. Generally speaking, these industries, if protected from external competition, can become relatively less efficient in comparison with world-market-oriented operations. For this reason, their requirements of labour and managerial skills and technology may be expected to be lower than those of export-oriented industries. Relatively greater labour-intensiveness and lower skills requirements may also make these industries better suited to help the underemployment and labour surplus conditions, but at the cost of having limited possibilities for export. The global distribution of these industries is generally conditioned by the presence of domestic markets large enough to produce the minimal necessary scale economies and, in some cases, by the existence of backwardly-linked raw material sources.

A basic industry or capital goods manufacturing strategy may be implemented to provide the necessary backward or supply links to import-substituting consumer industries and to create forward links to the raw materials processing industries. If export-oriented, these industries may also increase foreign exchange earnings while fulfilling political and national strategic priorities. Because these processes usually involve complex operations, their requirements of skills and technology may frequently be high. A fifth and less important type of industrialization strategy has been small-scale, labour-intensive manufacturing. These industries are usually the focus of policies devised to promote manufacturing in rural areas, with the objective of stemming urban-bound migration, improving rural-urban income distribution, and increasing sources of employment in backward regions. These industries may also be part of a wider rural development strategy that seeks to promote agriculture-related manufacturing. Skill and technology requirements may generally be considered to be significantly lower than for all of the previous industries considered. The spatial distribution of both capital goods and rural small-scale industries can therefore be expected to be significantly conditioned by

the availability of indigenous resources, given their importance as productive process inputs and the difficulties of importing those resources in less developed nations.

Conclusions

This paper has presented the concept of the manufacturing process cycle as a framework for the analysis of manufacturing change and its diffusion to less developed nations. Three major factors, labour, technology, and the organizational environment, have been outlined and are considered to be significant in determining the diffusion and establishment of manufacturing activities in less developed countries. It is assumed that these factors are intimately related to the evolutionary dynamics of manufacturing processes and that their change and interaction with policy mechanisms over the life cycle of such processes determine how the international division of labour in manufacturing is shaped.

Although the conceptual discussion has emphasized the general relevance of the manufacturing process cycle rather than its microanalytic details, additional work on these aspects needs to be seriously considered. It is hoped that this will result from an increasing scholarly interest in the evolutionary approach. The need for empirical applications of this framework is also an important and necessary concern. Obstacles to empirical testing of the concept at an international, multi-country level are, unfortunately, very difficult to overcome. There is, for instance, a general lack of adequate and compatible longitudinal data to compare individual country performances on manufacturing diffusion and growth. The lack of sufficient data at adequate levels of detail of the industrial classification is also a serious obstacle. This problem is further compounded by the confidentiality restrictions imposed by most nations whenever substantially detailed industrial data are required. Considering these obstacles, it is likely that empirical analyses of relatively limited periods of time may be the best that can be hoped for at the present time. An additional difficulty is the very limited amount of adequate empirical knowledge on the effectiveness of the various industrialization policy mechanisms and the lack of appropriate data to undertake such analyses.

When the rapid internationalization of manufacturing industries is broadly considered, it is possible to determine that, while the emphasis on the objectives and scope of industrialization strategies has changed from import substitution to export promotion, the established evolutionary hierarchy in the diffusion of manufacturing processes to the less developed nations has remained virtually stable. This hierarchy may be assumed not to have been significantly affected by the acceleration of evolutionary paths in certain industries, such as electronics, and their more rapid diffusion to less developed countries. Invariably, the diffusion of manufacturing skills and technology may be assumed to occur in the mid-life phases of the process cycle, when competition in the advanced nations becomes more intense and the need to increase market areas becomes imperative. From an evolutionary perspective, it may therefore be seen that the early and more innovative periods of any productive process, when linkages to research and development are strong and essential, are most likely to occur and remain in the advanced nations.

Other aspects of the manufacturing process cycle also need to be considered in greater detail. For example, the question of phase transitions deserves additional study. Other details on the mechanisms affecting the international diffusion of manufacturing, whether generated by institutions or the market, need to be considered, along with their application over time. Questions related to entrepreneurial supply in the host countries and their influence on diffusion rates and the evolution of manufacturing processes should also be of considerable interest. Finally, a better understanding of which industrialization policies can be most effective in each phase of the process cycle is also important. Policy strategies and their impact on national economic priorities, such as the promotion of investment in manufacturing, labour absorption, and the introduction of missing forward and backward linkages can, for example, be related to the development of industries and their manufacturing processes. It is hoped that this article will stimulate additional interest and empirical research on these questions.

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