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APPROPRIATE TECHNOLOGY IN THE CONTEXT OF THE REDIRECTION OF
LDC INDUSTRIAL DEVELOPMENT STRATEGY: CONCEPTS AND POLICIES*

by

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1) As its title implies, this paper is focussed on the relationship between the "appropriateness" of technology and the pattern of industrial sector growth in developing countries. We will proceed by first, in Section I, attempting to define the problem so as to make it easier for analytical dissection. In Section II we will present the heart of our analysis by contrasting ideal with real world conditions for the subject under discussion. Finally, Section III is devoted to drawing out a number of policy conclusions hopefully useful to the deliberations of this meeting of UNIDO's Consultative Group on Appropriate Industrial Technology.

I - Some Suggested Basic Principles

2) The basic proposition we start with is that the typical LDC's objective is one of "growth with equity". We shall not be concerned here with the issue of whether it is the absolute or the relative improvement of the standard of life of, say, the lowest 40% of the population which really matters. But we do accept the notion that the satisfaction of the basic needs of the major poverty groups in the country focussed, of course, on the rural areas, is part of the society's objective. While we cannot in the context of this paper go into the detailed reasoning for the assertion which follows, we, moreover,

assume that there need be no inherent conflict between the achievement of greater equity and the maintenance--even improvement--of the rate of growth of income. The subordination of efficiency to income distribution and employment is a theme which seems to run through the UNIDO documentation and should, in our view, be guarded against. The analysis and policy conclusions which follow in this paper will be based on the assumption that a redirection of industrial sector strategy and the deployment in that context of appropriate technologies as defined here is not a device simply to ensure that "benefits are spread" or because the satisfaction of basic needs is now considered "more important than efficiency." We acknowledge that such conflicts may exist in nature, but claim that we should worry about them "when we get there". In the meantime, assuming that they do always stare us in the face all too often leads to imprecision in the analysis and, most importantly, is not in keeping with the empirical record in at least a few deviant LDC cases, e.g. some of the smaller recently industrialized developing countries of Asia.

3) Especially in the so-called "garden variety" of labor surplus developing countries which continue to have an overhang of unemployed and underemployed in both its agricultural and informal urban sectors we now have enough "counterevidence"¹ to support the theory that the generation

¹The interested reader is referred to G. Ranis, "Development and the Distribution of Income: Some Counterevidence", Challenge, September/October, 1977 and John Fei, G. Ranis, S. Kuo, "Growth and the Family Distribution of Income by Factor Components", Quarterly Journal of Economics, February 1978.

of employment, of improvement in the distribution of income, and an acceleration (rather than deceleration) of the rate of growth are complementary rather than competitive objectives. By complementarity we do not, incidentally, mean complementarity after the production dust has settled via the, always limited, ability of governments to redistribute through taxes or public works programs; it is, rather, our assertion that, in the mixed economy, a redirection of the growth path itself can eliminate what often appears to be a conflict situation. Given that most of the developing countries do continue to be concerned with a problem of inadequate labor absorption in both their industrial and agricultural sectors--and given the possibilities of a growth path which is more participatory and employment intensive than that encountered in many actual country cases over the past two decades--we will in this paper thus maintain the assumption that we need not worry about trade-offs among the objectives of growth and the satisfaction of basic needs. It should, however, be clear that not everything that follows applies to all developing countries; and that a typologically sensitive approach to the problems posed by this meeting is warranted. We shall not, however, attempt such an approach in this paper but focus our attention on the more "typical" case.

4) Secondly, what we mean by an appropriate technology choice is very much in keeping with the definition employed in previous UNIDO documents leading up to this Consultative Group meeting. In our words, it is the selection of technologies appropriate to the maximization of the society's aforementioned objectives, given the society's capabilities. Explicitly

this means that the appropriateness of technology choice includes not only technique choices but also product quality choices, and that both of these must be defined relative to the society's time specific capabilities as well as to its time specific objectives. Especially if we can abstract from the possibilities of conflicts among the objectives-- as we have asserted we can--the "right" mix of appropriate techniques and appropriate goods either known to man or, better, devisable by man should be able to improve performance in terms of employment, the satisfaction of basic needs, the overall family distribution of income and the rate of growth. While this definition of appropriateness is evidently tautological, it is far preferable to be tautological than to be wrong. To put the case more positively, "the" appropriate technology will vary according to differences in capability, endowment, income, tastes, as well as over time within a given society. Moreover, while there is a presumption in the labor surplus developing economy in one direction or another, the appropriate technological process is not always labor intensive and the appropriate good is not always a basic good. This is most obviously true if we account for the possibility of trade. There is even a lesser validity to the cultist presumption that technologies appropriate to developing countries must always be somehow "traditional" or at best "intermediate" and never "modern".

5) The empirical presumption is that the more severe population pressures, the larger the population, the greater the shortage of capital and of skilled labor, the more likely that appropriate technology will fall at the labor intensive end of the spectrum, and the more likely that

appropriate goods will be congruent with goods satisfying the basic needs of the lower income domestic population. But it should be emphasized that the empirical evidence would also lead us to conclude that appropriate technologies are as likely to be "modern" and labor intensive, if current vintage machine paced, as of the "traditional" or "second-hand machinery" variety. They can be modern and labor intensive or modern and capital intensive, use imported or domestic core technology, make use of extensive local adaptations or not. In other words, advanced or improved technologies should not be equated with advanced country technologies nor, modern with capital intensive, or traditional with labor intensive. Nor do poor people necessarily always wish to buy expressly poor people's goods. Taste preferences can be changed as much by cultural imperialism as by policies of autarchy and self reliance. There are, in other words, no easy, comfortable answers independent of the place, the tastes, and the capabilities. What "appropriate technology" can and should do is serve as a useful tautology in the sense of sensitizing officials and planners to the existence of a wide potential array of processes and quality bundles which can be selected and/or devised to best suit the particular circumstances.

6) A third principle on which this paper is based is that the redirection of industrial development strategy must be part and parcel of the deployment of appropriate technology as defined above. It is not quite valid that one follows from the other but in fact they must be simultaneously determined. In other words, we cannot deal with the restructuring of industrialization patterns without sensitivity to the additional options

available via appropriate process and/or appropriate goods selection from the international shelf of knowledge and/or the devising of new such options via the application of indigenous ingenuity either "on top of" what is already available in the storehouse of importable human knowledge or without benefit of such stimulation.

7) It is in this sense that an industrial sector cannot be compartmentalized into a modern industrial sector and a traditional industrial sector nor is it really feasible to think in terms of industrial sector strategy independent of what is happening in sectors outside of the direct purview of UNIDO, e.g. the agricultural sector. This will be illustrated more fully in Section II; but it is necessary here to emphasize the general equilibrium nature of the problem. At the same time we understand the need for us to focus on the industrial sector and to be as specific and as policy oriented as possible.

8) Finally, we will assume that it is no longer necessary to argue about the wide diversity of potential choices in industrial processes, i.e. the existence or non-existence of technologically viable alternatives in producing a given commodity. There does exist a wide range of alternative factor proportions for all but a small subset of continuous process industries, even in heavy industry and in the so-called basic input industries. It is now understood that there exists substantial flexibility in processes available in nature, even when alternative processes for the core technology are limited. Additional choices exist in the peripheral production activities, e.g. transporting, storing and packaging. In a wide range of industries on which UNIDO apparently

is intending to concentrate, from sugar refining to beer to textiles to shoes, there may be as many as five major choices on the core technology according to the evidence accumulating.¹ Finally, there is agreement that alternative organizational devices including the taking advantage of economies of scale at some stages of production while using subcontracts at other stages can provide substantial reductions in plant costs.

9) The new conventional wisdom about the wide range of process choices available even in the absence of major additional adaptive technology change within the LDC's is less firm in the realm of the range of alternative goods at a given level of SITC classification. The increased concern with "appropriateness" or "basicness" of goods as a form of technology choice can be translated into the decomposition of a commodity into a bundle of quality characteristics with planned as opposed to accidental variations in such characteristics possibly associated with substantial variations in the basic process choices, as well as substantial variations in price and thus in the possibility of purchase by different income groups within the developing countries.

10) It is, incidentally, curious that when economists talk about technology choice they are usually referring to process choices, while business executives are much more frequently concerned with small variations

¹D. Morawetz, "Employment Implications of Industrialization in Developing Countries", Economic Journal, September 1974; S. Acharya, "Fiscal/Financial Intervention, Factor Prices and Factor Proportions: A Review of Issues", IBRD, Staff Working Paper #183, 1974; A. Bhalla, Technology and Employment in Industry, ILO, 1975; G. Ramis, "Industrial Technology Choice and Employment: A Review of Developing Country Evidence." Interciencia, Vol. 2, No. 1, 1977; Frances Stewart, "Technology and Employment in LDC's" in Edgar O. Edwards, editor, Employment in Developing Nations, Columbia University Press, New York, 1974; and G. Ramis, "Industrial Sector Labor Absorption", Economic Development and Cultural Change, April, 1973.

in product choice, i.e. product differentiation. The basic premise in this paper will be that at any level of SITC classification the assumption of homogeneity in the bundle of quality characteristics attaching to a particular good may, in fact, obscure important residual sources of both consumer choice and factor input variability which can be taken advantage of in terms of both the utilization of the existing factor endowment and the provision of the so-called "basic needs" within the internal markets of developing countries.

11) One additional caveat should be placed on the table in this introductory section: It is not our view that, while, in nature, there exists a large number of nationally and internationally known alternative processes and quality bundles, stretching across all contemporary countries and across recorded time, these are somehow available "for the asking" if the situation within the developing country is such that the demand for them actively exists. We know that even when demand conditions are "right", i.e. we have a situation in which private entrepreneurs and/or public enterprise officials are really "pounding on the door" to find alternative processes and/or goods, there remain many problems on the supply side, including inadequate illumination of the shelf, high information costs, the problem of inappropriate technology, institutional impediments etc. Both the effective demand for appropriate technology and the effective supply of what is already known, even within a given LDC, cannot be taken for granted.

12) It is finally, in our judgement, a mistake to assume that there exists somewhere just the "right" process and/or just the "right"

product which can be selected and put down in a particular industry or country context. While the choice of a relevant technology already in use or one that has been used elsewhere may be a crucial first step-- and by no means an easy or costless one--modifications would almost always have to be made before such a process or product can be installed or consumed and become fully "appropriate" in a particular village. Such modifications or adaptations may constitute major technology adjustments "on top of" imported technology, or minor "twists" in what has been used or consumed elsewhere even within the same country. It should be clear that the adoption of an appropriate process or an appropriate good always requires a combination of selection of what is known to man, with major or minor modifications required to suit the always slightly different local endowment and taste conditions. Each public or private entrepreneur must make both these choices--often simultaneously-- whenever a production decision is contemplated. The quality of the decisions made at this micro level is mutually interdependent with the nature of the industrialization pattern chosen at the macro level. In the next section we intend to investigate the nature of this interdependence and to demonstrate that the full potential for the harnessing of appropriate technology to the societal objectives of "growth with equity" can only be realized in the context of a restructured industrial sector.

II.- The Pattern of Industrialization and the Role of Appropriate Technology: Real and Ideal Patterns of Interaction.

13) Perhaps the best way to proceed with an analysis of the nature of this interaction between the industrialization strategy followed and the

potential for the unfolding of appropriate technology as a handmaiden to the effort is to contrast some of the real world patterns and problems which have emerged with what, in a small subset of LDCs, has been demonstrated to be something approaching a more ideal if by no means optimum pattern of interaction. This two step analysis may prove useful in terms of pointing up the critical areas for possible policy action by governments and international agencies in the final section of the paper.

14) Beginning with the aggregative level and viewed from an historical perspective, it would be generally agreed that the last quarter of a century of industrial growth in the developing countries has been a period of transition growth in the Kuznets sense in which the majority of LDCs have attempted to shake themselves loose from their agrarian, in some cases colonial, heritage of the pre-war period, largely through the capture of the foreign exchange proceeds from the traditional export enclave and their channelization towards a new protected and favored import substituting industrial sector. Typically such primary import substitution has been accompanied by the attempt to incorporate modern science and technology in the accumulating capital stock, usually but not necessarily always requiring a rather large minimum size in order that the requirement of economics of scale could be met. The record of the last 25 years in terms of the high rate of growth of LDC industrial sectors, especially in the large scale organized portions of the spectrum, is well known and need not detain us here. The policy mix adopted by most LDC governments during this period, from interest rate, to exchange

rate, to internal terms of trade policy, has all been aimed to help protect, abet and support this new industrial sector. As is also well known, the record of performance with respect to overall growth as well as with respect to the sharing of the fruits of growth during this same quarter century has been less than satisfactory. Typically the spread of modern science and technology has been limited to a small segment of the population, usually excluding much of the rural population and leading in many cases to a partial displacement of the raw materials based, colonial enclave to a modern technology based, industrial enclave. The causes of the limited technological spread from a theoretical point of view is quite naturally the major focus of our attention in this paper.

15) Without going into all the quite well known reasons, it is quite clear that what has consequently emerged in the majority of LDC's is an unbalanced or biased pattern of industrial location which concentrates heavily on the large urban centers and effectively denies a wide range of technology choice to the rural communities. Moreover, even in the urban centers there is evidence of what might be called technology dualism typified by the coexistence of a small, relatively modern industrial sector side by side with a large, often called informal, industrial sector, with the so-called "modern" sub-sector absorbing typically only 5 or 10% of the urban labor force. These two phenomena, the urban concentration of industry and the dualism within urban industry, are related but separably identifiable characteristics which will be helpful to our analysis.

16) Let us begin with an understanding of the typically urban biased pattern of industrial location so frequently encountered in the garden variety of developing economy, i.e. an economy which includes a large agricultural and a relatively small non-agricultural sector subject to the conditions of substantial initial labor surplus. In such an economy, while farmers are spread spatially in terms of their pattern of location, workers in non-agricultural production are typically spatially concentrated. In fact they are often more spatially concentrated after independence than they were earlier, at a time when artisan and home industries had not yet been destroyed by either imported goods or later, the products of protected urban industries.

17) Part of this contrasting pattern of location as between farmers and industries is, of course, the economy of transportation costs. Farmers must live close to the land which they cultivate if resources are not to be wasted in the daily transport to work. The advantages of urban industrial agglomeration in terms of overheads, skilled labor supplies etc. are well known. While modern factories are located overwhelmingly at one or several large urban centers (e.g. Manila and Bangkok being the extreme real world examples) the exchange of industrial output for agricultural goods takes place via a network of sea and land transportation linking spatially scattered agricultural communities with these urban centers through a wholesale and retail commerce network. Effectively the rural areas are alienated from modern technology partially by the sheer impact of "distance".

18) It would be easy to produce statistics to show that industrial

concentration of this kind is quite common. A concentrated pattern of industrial location may be contrasted with a relatively decentralized industrial pattern in which the natural market areas served by each urban center are based on the principle of minimization of transport costs. In this instance, each market area represents something of a self-sufficient dualistic economy on a smaller scale. The urban centers for each market area produce non-agricultural goods in exchange for the agricultural goods produced by farmers within that region or the hinterland of that particular town. Such a contrasting pattern of industrialization obviously has three economic advantages: One, its industries can offer much more byemployment and higher incomes for the rural families which now do not necessarily have to migrate to distant urban employment centers (quite aside from the issue of excess migration in search of non-existent urban jobs). Secondly, the transport costs for the whole economy are lower as compared with the centralized pattern. Thirdly, urbanization costs, water, sewage etc., quite aside from the social problems, can be assumed to be substantially lowered as a consequence.

19) There are other less tangible but nevertheless much more important benefits on the side of the dispersed industry alternative. As is well known, if not necessarily emphasized in the context of this particular paper, the modernization of agriculture in terms of the absorption of newest techniques and inputs is greatly assisted by the presence of a modernized non-agricultural sector close at hand. Thus the idealized balanced rural growth process, with agricultural modernization generating and feeding, and being fed by, the simultaneous modernization of rural

industry represents an ideal in terms of both the spread of ideas, the mutual flow of modern inputs, and the mutual pressure for appropriate technology change.

20) Such a mutual transmission belt between rural actors within the dual economy is, of course, greatly facilitated when farmers can gain physical contact with the industrial sector, both via direct investment and banking or commercial contacts and through other real or imagined demonstration effects of various types. Farmers can typically be induced to have a more commercial outlook and to seek opportunities to better themselves, resulting in a higher rate of increase of agricultural productivity which is, of course, an important ingredient of any successful growth with equity process. The saving behavior among rural families can be influenced favorably as a consequence of the existence of more visible and understandable investment opportunities in the rural areas; and, last but not least, evidence indicates that it is the poorest rural families who often engage most in the agricultural byemployment opportunities offered by decentralized rural industrial and service activities, thus helping the income distribution improve (or at least not deteriorate, counter to Kuznets) during periods of rapid growth.

21) In the most successful cases of post-war growth with equity there is little question that rural industries and services did represent a major portion of the total industrial sector during the entire period of the most explosive growth of the 60's. Earnings from such activities initially made up 30% and finally accounted for as much as 50% of rural family incomes. Especially the dispersed location pattern not

only permits a more labor intensive and efficient growth path but also benefits the relatively poorest rural families most and is thus the most important contributor to an equitable pattern of growth. The Japanese historical record as well as contemporary Asian LDC's of the "Japanese type" are among those most relevant to the demonstration of this point. The role of appropriate technology as we have defined it in terms of both its process and appropriate goods dimension has been an important ingredient in these success stories.

22) While the advantages of a dispersed pattern of industrial location in terms of spreading technology and furthering the satisfaction of the basic needs of the majority of the rural population seem to be convincing, both in theory and fact, the question remains why this desirable pattern has not occurred in more of the developing countries. There are, of course, limits to the amount of decentralization that is possible and desirable in theory; thus the frequently encountered pattern of centralization is only in part due to man-made biases and is in part warranted as a function of basic economic forces. To the extent that a greater centralization of industrial than agricultural activity is a logical consequence of the different nature of two kinds of production activity we would not wish to change it. To the extent that concentration is "unwarranted" changes in policy may well be appropriate.

23) The limits of any so-called "warranted" centralization of industrial activity may be most easily understood if we assume the extreme case of having the land space of a developing economy partitioned into a very large number of very small market areas. Some of the arguments

which we have listed in favor of a dispersed pattern of industrial location now become even more pronounced. If the market area is small enough, for example, every farmer can gain easy access to the urban center or town within walking distance. In fact, the very distinction between rural and urban will become obliterated when individual markets shrink towards a point. Our intuition tells us that there is indeed good reason for any rationally organized economic system to reject such an excessively decentralized pattern of industrial location. Proceeding beyond intuition, we can imagine that, if there is a uniform population density, as the number of market areas increases and the size of each individual market shrinks the total size of the population in each market declines; other things being equal this leads to a decline in both the agricultural and non-agricultural populations roughly in the same proportion. This does not have serious consequences for agricultural production which is usually characterized by constant returns to scale, since agricultural labor productivity can thus be maintained at the same level. But in non-agricultural production which is characterized by increasing returns to scale, at least in some industries, the shrinkage of the market area becomes a distinct disadvantage at some point as it prevents efficiency of large scale production from being realized. Thus we can clearly see that excessive industrial decentralization will ultimately be accompanied by the decline in industrial labor productivity. Thus, from the theoretical point of view at least, an ideal or equilibrium market area must be related to the interaction between two types of forces, the economy of transportation costs favoring smaller market areas, on the one side,

and economies of scale favoring larger market areas, on the other. The existence of warranted or unwarranted patterns of industrial concentration can then be analyzed in relation to these dimensions. For example, if the industry is appropriate to a particular economy is characterized by conspicuous efficiency of large scale production and/or if transportation costs are relatively small, it is quite economical to adopt a more centralized pattern of industrial location. If we are willing to associate appropriate processes with a more decentralized medium and small scale industrial sector strategy and the prevalence of "inappropriate" imported technology with an urban enclave-oriented industrial sector strategy we see the beginnings of the nature of the interaction between the two main foci of our analysis. There is even less difficulty in associating appropriate goods with the relatively absence of pronounced economies of scale in the rural industry case.

2.) A second dimension determining the ideal amount of industrial sector dispersion has to do with the distribution of population in the rural areas and its productivity from the point of view of the market demand side of the equation. The output of each dispersed industry must, after all, be purchased by the local population,¹ especially the farmers within each market area. Ceteris paribus, a centralized industrial location may be focussed on the narrow elite markets of urban consumers and/or the wider export markets, while a pattern of decentralized

¹Except for the unlikely case of an export market--which may apply to the specialized handicraft type of goods.

industrial location will not occur unless agricultural productivity in combination with the numbers of farmers and their dispersed location provides sufficient purchasing power to support local industries.

25) In summary then, there are at least the following economic forces that determine the pattern of industrial location in an idealized or "warranted" sense: one, the extent of the efficiency of large scale production; two, the population density and dispersion; three, the performance of agricultural labor productivity; and four, transportation costs relevant to the particular topographical situation and industry.

26) In this sense of a "warranted" amount of industrial sector dispersion there is imbedded an idealized role for both dimensions of appropriate technology previously defined. To the extent that conditions exist which permit a decentralized industrial structure, there is likely to be more scope for appropriate goods to serve local markets in a balanced rural growth context. The appropriate process choice will, of course, differ depending on the extent of industrial dispersion, with a likelihood of some association between capital intensity and the prevalence of economies of scale. The basic point here is that there is always a warranted level of industrial sector concentration or dispersion with which appropriate technology may be associated. Where the problem arises which may require alterations in policy is when the extent of concentration is excessive or "unwarranted" in terms of the four dimensions previously referred to, and thus the appropriateness of technology either in the urban or rural industrial context is threatened.

27) A second dimension for analyzing an industrial sector's development pattern refers to the extent of technological dualism within the urban industrial sector--to a lesser extent also/the decentralized industrial sector in the rural areas. While this dimension is related to that of industrial dispersion it may be conceptually separated in the sense that transportation costs and population density become less relevant or essential parameters here. In assessing the importance of industrial technology dualism we are really entering the area of industrial organization within the urban sector of the economy.

28) Technological dualism as well must be viewed in historical perspective since it appears in the context of an LDC in transition from agrarianism into the epoch of modern growth. Viewed in this context, we can again note that such dualism, which is often viewed as a catastrophe, may be absolutely unavoidable since modern industry as it first appears on the post-independent LDC scene must exist side by side with preexisting medium and small scale industries. Thus, one of the reasons for this co-existence is simply due to the fact that the former is part of the baggage of the late comer, while the latter has always been there. The economy as we observe it is thus always in disequilibrium or transition. Large scale industry typified by the higher complexity of scientific and technological engineering principles supporting higher capital/output, capital/labor and labor productivity ratios almost always exist side by side with medium and small scale industries with lower capital/output, capital/labor and labor productivity

ratios. The large factories typically employ only a relatively small fraction of the total urban labor force and contribute a relatively large fraction of the value added. A large number of relatively small firms employ a large fraction of the urban industrial labor force and make a modest contribution to value added. This bi-modal distribution leaves little typically to the intermediate-sized firms.

29) Possible good reasons for the existence of technological dualism may be seen either from the point of view of the static efficiency of resource allocation or from the viewpoint of innovative capacity in the dynamic sense. With respect to the former, we may expect a certain product differentiation or division of labor between the medium and small scale and the large scale firms each producing different kinds of quality bundles attached to certain SITC classified goods. The deployment of technology which embodies a multitude of modern scientific principles, i.e. finer grades, quality, standardized products, are usually associated with goods catering to the incomes and tastes of higher income classes. The opposite is true of the products of medium and small scale units often addressed to the lower urban income families appropriate to the varying tastes and incomes of this group, as has always been the case before the transition to modern growth began.

30) In addition to this natural division by quality bundle characteristics there may be good reasons, of the input-output variety, for a division of labor between large, medium and small firms in the urban areas, for example in producer goods markets. Medium and small scale

firms may also produce inputs for the large industries which utilize economies of scale in the marketing and purchasing phases as well as at certain production levels, while subcontracting to a decentralized labor intensive production structure at other levels. In other words, production complementarities may be part of the explanation for the harmonious or "warranted" co-existence between large and small firms in the same industry in the urban areas of the typical LDC.

31) In this static context, the relative weight of large, medium, and small scale firms is a function of per capita income increases, the technological competence of entrepreneurs and the skill of the labor force. Thus, even when markets are "perfect"--not a very likely event in any real world context--the co-existence of large and small firms can be harmonious in terms of resource allocation efficiency, while the weight of the modern versus the non-modern subsectors of industry are determined by growth relevant forces.

32) There may be another more dynamic reason for the co-existence of large and small firms, i.e. the existence of technological dualism in the urban industrial sector of developing countries. This has to do with the growth of entrepreneurship, either public or private, in the course of the transition growth process. While this area tends to be speculative in nature, with limited empirical and theoretical basis, the growth of industrial entrepreneurship may be attributed in large part to "learning by doing" processes rather than formal education. The co-existence of large and small firms may therefore signify the co-existence of large and small entrepreneurs whose

interactions constitute the learning process by which the society's technological capability is itself improved. For example, as a late-comer in terms of the international technology scene the contemporary LDC often receives the most modern technology from advanced countries through various routes, e.g. through the multinational or arm's length trade in capital goods. It may be a valid conjecture that the larger, more experienced entrepreneur is more likely to be on the frontier of the modern technology which is simply transplanted from abroad. In contrast, the medium and small scale entrepreneur is likely to be less quality and more cost conscious and more careful in his search for the type of technology which is more suitable for the adaptation to indigenous factor supply conditions. The transmission of modern technology from large to medium and small entrepreneurs does occur in most urban industrial settings and is somewhat comparable to the transmission of modern technology spatially from the urban centers to the rural communities via a diffusion cum adaptation process.

33) The importance of large versus medium and small scale firms within the urban industrial sector is also very much related to the phase of development an LDC has reached. During primary import substitution, when nondurable consumer goods are the main industrial sector product, the need for large scale industry and most modern technology is less pronounced than in the secondary import substitution subphase when durable consumer goods, capital goods and processing techniques come to the fore.

34) In brief, the existence of technological dualism does not

necessarily signal that something is "wrong" in terms of industrial sector strategy or that the technologies being adopted are somehow inappropriate either in process or product terms. There may be good reasons for the existence and persistence of technological dualism within the industrial sector of the LDCs; and this phenomenon may be perfectly consistent with appropriate technology choice.

35) Where the problem does occur is when, in terms of both of the dimensions of industrial sector strategy already referred to, there are excesses most frequently caused by policy interventions. We are all familiar with the unwarranted extent of industrial concentration in the urban areas of developing countries, as demonstrated by the Manila and Bangkok cases already referred to. Similarly, we are all familiar with the undue emphasis on the protection and favorite treatment bestowed on large scale urban industries and the relative neglect accorded to medium and small scale industries in most LDC's. When such excesses do occur distorting the industrial sector growth pattern, it is also highly likely that technologies become more and more inappropriate. The same kinds of government intervention, which distort the overall pattern of industrial development are also associated with inappropriate technology choices both in terms of product quality bundles and process selection. For example, while such forces as population density, the natural resource endowment, the size of the country and the initial extent of labor surplus may be viewed as basic institutional and/or economic/geographic background factors, such other forces as the sensitivity to scale efficiency, the extent of agricultural productivity increase over time

and/or the extent of government interventions in factor and product markets do appear to be amenable to policy influence. The same thing is true for the entire market for appropriate technology in both its demand and supply dimensions. Let us finally therefore, before proceeding to some of the conclusions for policy in Section III, examine the intertwined causes of the frequently encountered distorted industrial sector growth strategy and of the inappropriate use of technology associated with it. It is, in other words, the excessive or unwarranted centralization of industry in urban areas and the excessive dominance of large scale firms within these areas which is usually associated with the most inappropriate technology choices in the typical developing economy case. They are both likely to be spawned by the persistence of, frequently well intentioned, packages of government policy intervention intended to encourage and accelerate industrialization.

36) One dimension of this problem which has received a good deal of attention has to do with the distortions of relative factor prices and relative commodity prices occasioned by the usual import substitution policy syndrome. Such relative price distortions affect not only output mixes and thus the mix of industries and their location--favoring the capital intensive, the urban oriented and the large scale--but also technology choices in both the process and quality bundle sense. It is also well known that this import substitution policy regime is intended to shift foreign and domestic resources into the new rapidly growing consumer good industries supplying the domestic market with goods previously imported from abroad. Strictly speaking, this is usually a case

of import imitation rather than replacement, in terms of the output mix, using most frequently largely unadapted imported technology.

37) It is equally well-known that when this particular subphase of development runs out of steam LDCs have customarily moved towards the replacement of previously imported capital goods, durable consumer goods and the processing of raw materials, implying a continuation, or even a stronger version, of the same policy regime. What is perhaps less well understood is the importance the introduction of additional non-competitive elements usually accompanying the distortion of relative prices, i.e. the impact of the creation of windfall profits on the basic nature of industrial sector growth and the basic nature of technology choice. The import licensing system, the overvalued exchange rate, the official low interest rates to favorite borrowers, the direct allocation of strategic materials, do not simply distort relative commodity and factor prices, but their more important impact on the subject under discussion here is that they create unequal competitive pressures for the favored, usually large scale and urban, versus the rest, usually small or medium scale and rural, industrial entrepreneurs. When a certain level of profits is virtually guaranteed to the industrialist merely by virtue of his place in the queue for whatever is being allocated, his need to locate himself near the fountain of favors, i.e. in the urban area, ^{is paramount,} and his desire or felt need to seek out the most appropriate technology becomes severely blunted. It is not just part of the profit maximizing calculus elevated to a religion by the economist but is clearly observable that once you guarantee the industrialists a basic cushion by virtue of government action they will feel a strong inducement

to spend their energies on ensuring their place in the queue rather than seeking the most appropriate industrial location, output mix or technology choice. Industrial organization terminology sometimes speaks of satisficing rather than maximizing behavior which results from this preference for "the quiet life" under the umbrella of government granted windfall profits.

38) The reason it has taken economists much longer to see the importance of this dimension of government intervention--as compared to the impact of exchange rate overvaluation, protection, minimum wage legislation, and artificially low interest rates on the relative use of inputs--is probably that it has less importance in the agricultural sector which still remains the dominant activity in most developing economies. The assumption of the small scale industrial entrepreneur patterned on the atomistic nature of peasant agriculture is, however, far from reality. Government restricts access in certain industrial sectors and grants windfalls in guaranteed markets in others; this permits firms to indulge their taste for prestige import imitation technologies and prestige import imitation quality bundles. In this way, the effective demand for appropriate technology is stifled by the intervention of government in the factor and output markets.

39) A second and related conclusion brings us back to the fact that successful agricultural modernization is an indispensable prerequisite for a dispersed pattern of industrial location. If there are no markets in the rural areas as a consequence of expanding agricultural labor productivity there is no surplus for the financing of rural

industry nor demand for the products of such industry. The stagnation of agricultural output is often a consequence of distortions in the terms of trade against agriculture, a frequent part of the import substitution policy regime. This policy, intended to favor industry, is thus likely to defeat the very possibility of an industrial sector growth pattern conducive to the selection of appropriate technologies and appropriate goods. The existence of an active rural consumer goods demand represents a sine qua non especially for the production of "basic goods", i.e. goods with the appropriate bundle of quality characteristics.

40) A closely related problem deals with the unequal impact of tariff policy with respect to the urban versus the rural industrial sectors. Typically, during the colonial period the imported "over-specified" variety of a particular good, e.g. textiles, was permitted to enter duty-free but could not always successfully compete with the more appropriate good produced and sold in local markets--even though the latter activity was by no means a very dynamic one. With import substitution this particular commodity was now fully protected. Thus the urban overspecified good produced by the large scale industrial sector was given absolute protection either by tariffs or quantitative controls, not only to substitute for the previously imported good but to provide the necessities for the entire domestic market. As a consequence, the beginnings of a domestic appropriate goods industry, whether based on artisan or handicrafts production, were often destroyed rather than supported and encouraged in the course of early import substituting industrialization efforts. To cite but one example, in

the Philippines import substitution permitted textile manufacturers in Luzon, which were highly inefficient, to effectively compete with what little demand there was, as a consequence of agricultural stagnation, in the outlying areas of Mindanao. The typical narrowly focussed import substitution path of industrialization thus has as one of its consequences the suppression of a potential domestic market for appropriate goods in the rural balanced growth sense.

41) Entrepreneurial activity is consequently more likely to be focussed on the narrow demand of the enclave industrial elite as well as, in some cases, on export markets--which are typically, however, difficult to penetrate in the absence of export subsidies, given the inefficiencies of the system. When terms of trade liberalization as between sectors does appear, for example in West Pakistan in the early 60's, the spectacular growth of rural engineering industries beginning with pump and tube-well production in the wake of Pakistan's agricultural output export is well known.

42) It should be pretty clear that a dispersed pattern of industrial location is especially relevant to conditions of a rather high population density and wide dispersion of that population across the countryside. The higher the population density, the smaller the optimum market area. In the more thinly populated regions of the developing world the optimum market areas tend to be rather large. In those cases it is not feasible nor economical to go in for the strongly dispersed pattern of industrial location. It is from this point of view that the analysis of this paper, as well as the policy conclusions which follow, apply most

concretely to both East and Southeast Asia and parts of Latin America, and less to Africa and other parts of Latin America.

43) A valid conclusion from our analysis above would be that appropriate technology choice for the relatively more thinly populated regions of the world should be associated with less conspicuous scale efficiency and choice of commodities than in the relatively more densely populated countries. This is not intuitively obvious but follows directly from the fact that the wrong choice i.e., the production of commodities which are strong in economies of scale, would result in unduly large market areas in these countries and thus be likely to deny the country the advantages of rural-urban interaction which is most pronounced in a dispersed pattern of industrial location, as we have mentioned earlier.

44) It follows, finally, from our analysis that the definition of a market area signifying an economic community involving active participation by the urban as well as rural populations, physically centered on a central marketing town or city, is very much a function of the social overhead structure, especially transportation. Therefore the existing network of roads linking marketing towns to the neighboring villages is of extreme importance for any viable decentralized industrialization pattern. Conversely, when feeder roads are underdeveloped, while the national transportation network emanating from the large cities is well developed, spatially centralized pattern of industrial location will ceteris paribus be encouraged. A similar point can be made where, as for example in countries like Indonesia and the Philippines, there has been a tendency to sacrifice inland transportation at the expense

of inter-island coastal transports, all of which favors the concentrated pattern of industrialization and the kind of technology choices which are associated with it.

45) Thus far we have emphasized the interactions between appropriate technology and the nature of the industrialization pattern mainly as the overall policy environment affects both and their interactions, thus encouraging or discouraging the search for appropriate processes and products. But even when the idealized situation is approached where only the "warranted" amount of centralization of industry and technological dualism in urban industry is bound to prevail, and where the overall policy environment is such that industrialists of all sizes are clamoring for appropriate processes and appropriate goods, there are still problems on the supply side which need to be briefly considered.

46) Again in theory there exists, of course, an ample storehouse of human knowledge encompassing every known combination of factors to produce a given specified good, plus every known alteration of the bundle of qualities incorporated in a commodity at some level of industrial classification. This would give us a potentially large number of production points on the assumption that there are always eager and able industrial entrepreneurs, public or private, "knocking at the door". The problem that has been increasingly emphasized is that such a shelf of international technology from which the appropriate mix can be selected really does not exist in reality. For one there is a simple lack of illustration or information in the hands of the individual decision maker, especially the small and medium scale industrialist, who cannot

afford the search costs involved in rummaging among the large range of points on the production possibility set across rich and poor countries and across recorded industrial history.

47) Secondly, there is a problem of institutional and policy interventions on the supply side as well, characterized, for example, by the extent of private appropriability of technological information. While obtaining and diffusing technological information in textiles may be more like in atomistic agriculture and relatively easily accessed, the cloak of patents, licencing, trademarks etc. often means that technology choice points both with respect to process but especially with respect to product alternatives are not likely to be readily available to all actual or potential industrialists. Within some of these less competitive industries information channels are likely to discriminate against medium and small scale firms while the transfer within multinational corporation channels or among joint venture partners proceeds more smoothly. Thirdly, the type of diffusion channels, from large to medium and small scale, which ideally exist do not necessarily function very well when institutional impediments such as the tying of aid to particular country procurement and/or commodities, the particular influence of machinery salesmen, the special trade relations with the ex-colonial mother country, the use of foreign engineering consultants, all create networks which tend to focus on a small subset of the total potentially available technology possibilities set.

48) Finally, perhaps the most important obstacle, at least in this observer's opinion, to an effective supply of alternatives from which

the appropriate technology choice can be made, starts with the recognition that no piece of technology and no quality bundle-defined good on the total international shelf is ever quite ready to be put in place or consumed in some given local market context. While differences in resource and other environmental conditions, as well as in tastes and demand patterns could be minor, I am very much impressed with the importance of human and natural "third factors" which can never be fully taken into account in the context of a blueprint description of any technology option. As a consequence, the dynamic ability to make minor adaptations or "twists" on what already exists somewhere in the full storehouse of human knowledge is of extreme importance. Such innovative capacity may be found in the repair shops of the large urban company, in public sector R & D institutes, or in the much less romantic confines of a rural industrial repair shop or even the village blacksmith or foundry. What is at stake here is the presence or absence of a technical problem solving capacity often associated with repair and maintenance functions, in the decentralized industrial sector, and tied up with the intra-firm sociology of decision making and appropriate technology change in the larger scale urban industries. It is this capacity to respond to suggestions from the floor or the machine-tool shop for varying production processes in the multinational corporation subsidiary, on the one hand, and the encouragement of small, non-spectacular adjustments in rural industry processes and the specification of goods, which enhances substantially the range of potentially useful points in the total technology possibility set.

49) While we recognize, of course, that the selection and adaptation of technology usually go hand in hand, it is important to separate them analytically. It is also necessary to recognize that the institutional capacity of a society to make intelligent choices from a static array of technologies, both in the process and commodity sense, and the societies' capacity to make these twists and adaptations are not necessarily identical. Both are based on different dimensions of a country's scientific and technological literacy.

50) As Kuznets and others have pointed out, the causal chain of discovery does not always run from science, a universal good, to technology which may be a national or even regional good, but may run from a problem that needs to be solved at the technology level back to science. It is by now increasingly understood that an adaptive national technological capacity was required to make best use of the genetics-related international research on new seed varieties because moisture, soil and temperature conditions are never quite the same and can never be simulated fully. We are only beginning to realize that even in industry, if to a lesser degree, the same lesson holds, i.e. humidity conditions may affect textiles, pasture conditions affect leather production, and the chemical quality of the water supply affect plastics production. This is in addition to the presence or absence of third factors such as a particular skilled manpower input, a particular overhead requirement, the sulphur content of the petroleum source, etc.

51) Almost everyone today accepts the importance of the impact of appropriate technology choices both on growth and on the greater satisfaction of basic needs; but they remain profoundly unsure as to how much of industrial technology can be or should be home grown, how much of it should be imported, how much of it should be imported and adapted. They are even more uneasy with respect to the volume of R & D resources to be committed to science and technology as the underpinning for appropriate technology choice and for guiding the future direction of appropriate technology change. While the human capacity to choose appropriate technology wisely, and, dynamically, to improve the existing knowledge in a more appropriate direction may be differentiable, an institutional network intended to serve the idealized functioning of a developing country's industrial sector in the context of our discussion should probably contain both elements. That is to say that the information gathering and the illumination of existing choices cannot and should not be divorced from the capacity to make adaptations and improvements on what is already known at a point in time.

52) The historical industrial development experience of two such disparate cases as the United States and Japan underline the fact that not every industrialization effort, by a late-comer country in particular, needs to be one of pioneering frontier science; but, in order to be successful, it must be characterized by a definite capacity to absorb science as a necessary input for the selection and adaptation process. Such a capacity to ask the right questions and use science and technology wisely is more likely to be national rather than

supra-national. It is related to the educational system as well as to the types of interventions or lack thereof practiced by governments. The same historical perspective also teaches us--as the experience of Japan and United States once again illustrate-- that the same countries are quite likely, in their later, more mature growth phase, to acquire a routinized capacity to advance the frontiers of science. Our necessarily general point here is simply that the direction and sufficiently broad spread of scientific and technical education represents an important adjunct to a flexible enough economic and institutional environment to permit appropriate technology choices to be continuously made and amended over time. Let us finally, in Section III, attempt to summarize the policy conclusions which flow from this thumb-nail sketch of the elements of an idealized system, in terms of the interactions between industrial sector strategy and the resort to appropriate technology in that context.

III - Some Conclusions for Policy

53) Based on the above, if rather sketchy, analysis of the morphology and the interactions between industrial development patterns and the likely utilization of appropriate technology, both in the static and dynamic sense, we may draw a number of equally general conclusions with respect to the direction public policy might take:

- 1) A typological approach is indicated for analyzing the problem in a particular LDC country situation. Such a typological

approach goes beyond the generally accepted notion that large and small countries must be differentiated in terms of the importance of trade, and that natural resource rich countries must be differentiated from natural resource poor countries. The key element here is that such dimensions as the size of the country, the extent of labor surplus, the spatial concentration or dispersion of the population, as well as the extent and nature of the transportation network, along with the level of agricultural productivity, represent important differentiating characteristics. Together, they can provide the analyst and policy-maker with some country-specific or at least typology-specific notion of the ideal amount of industrial sector dispersion for any given commodity mix--which is simultaneously determined in the light of normal considerations of international comparative advantage. While population density, natural resource endowments, and other institutional or economic/geographic factors are not amenable to policy controls within any feasible planning horizon, such other forces as technology choice sensitive or less sensitive to scale efficiency and the motivational environment facing individual entrepreneurs are amenable to policy influence. In between there are such elements as agricultural productivity change and the extent and nature of investments in rural infrastructure which are very much open to influence, even though changes can't be achieved overnight. In brief, at this very general level, industrial sector policy must be viewed as a typologically sensitive issue depending on the underlying conditions that prevail in

the country at a particular point in time.

ii) Still at a general level, it is thus clear that a dispersed pattern of industrialization requires that attention be paid simultaneously to the agricultural sector at least in the normal or garden variety of developing country. This is by now well understood but needs to be emphasized in the context of the ability to provide the necessary conditions for a dynamic rural industrialization alternative. In the absence of a comprehensive view of rural development--as opposed to "separate" agricultural and industrial action plans--it is fair to say that all efforts to provide special artificial incentives for rural decentralization are unlikely to work.

iii) Countries with a rather high agricultural population density meet one of the conditions for a viable, dispersed pattern of industrial location. Industries more suitable for such a spatially dispersed pattern of location are likely to be characterized by a tendency towards constant returns to scale. In this way appropriate goods can be produced for local markets using appropriate processes and providing secondary employment for rural families.

iv) A relatively equal spread across the country-side not only of roads but also of power, communications, and education facilities etc. represents an important component of a policy permitting an efficient industrialization pattern to establish itself. The establishment of rural industrial estates can be helpful--with emphasis not on subsidizing rural industry, a la the history of

India's Khadi Industry, but on providing for a fairer game. Power rates, for example, while they should not be subsidized overall but carry their own weight, might well be equalized as between urban and rural areas rather than, as is frequently the case in today's LDC's, favoring the urban location of industry. In a very similar fashion, we may note that the typical concentration of educational facilities, from primary school on up, will not only encourage premature and wasteful trends of migration to urban areas ahead of available job opportunities but provide a disincentive for skilled labor to move out from the cities into the rural towns.

v) One way to ensure that there is no unwarranted or excess centralization of industry and/or unwarranted or excess technological dualism within urban industry is to reduce--though it is usually impossible to eliminate--the distortions introduced by artificially low interest rates, overvalued exchange rates, etc. While such distortions are frequently a necessary part of the early import substitution phase the critical issue is the flexibility with which this policy regime is established and its duration. To the extent the infant industry argument has validity--and we believe it does--the arguments about efficiency of the industrialization pattern and of the technology chosen may have to give way for a time to the need of "getting the job done" and permitting the nation's new industrialists to "learn by doing".

The critical question is, whether, at the end of this period, the political possibility exists for a gradual liberalization in these various markets. Such liberalization would not only lead to a better static choice of technology but an important reduction of the temperature in the satisficing industrial sector hothouse, and thus encourage the kinds of decisions dictated by the underlying economic factors previously referred to. While this has been said many times, it is nevertheless true that in the absence of an effective demand for appropriate technology, in terms of the shift from satisficing to maximizing behavior, and a reduction in the veil between market and shadow prices, there is very little chance that the above kind of optimally decentralized industrial structure, optimal extent of industrial dualism, plus optimal use of appropriate technology in that context, can even be approached. Gradually more realistic relative factor and output prices seem to be a necessary if not sufficient condition for the achievement of growth with equity in the garden variety of developing economy. In the absence of marked improvements in this general environment, "direct actions" to induce a different industrial sector strategy and a more appropriate use of technology will not work.

vi) As a corollary of the last point, we, of course, recognize the substantial political as well as economic obstacles in the way of making transitions from more control to less control-oriented policy syndromes. Such changes usually have to overcome strong vested interests in the industrial entrepreneurial community

as well as among civil servants. It should be emphasized that the direction of policy is more important than the achievement of any textbook ideal, and that it is important that the policy trend be consistent, avoiding the back and forth oscillation which cause too much uncertainty and probably yield the worst results in the mixed economy setting.

vii) A second corollary requires us to emphasize the importance of avoiding continued distortions in the internal terms of trade against agriculture since, as we have already emphasized, we attach great importance to the increased rural purchasing power as a precondition for balanced rural growth including rapid expansion of both industrial and agricultural appropriate goods production for local rural markets.

viii) The above set of liberalization policies to ensure a more effective demand for a restructured industrial development pattern and the use of appropriate technology in that context is, of course, largely a matter for domestic appraisal and decision making. Outside agencies can help by providing advice, illumination, sensitizing and technical assistance, when and if asked. They may also be helpful in providing capital flows to help ease countries through any frequently difficult policy reform period by providing a cushion in terms of both resource and psychological impact.

ix) Turning now to the supply side of appropriate technology in the context of a restructured industrial sector, an institutional network focussing simultaneously on both static information and

dynamic R & D capacity should be encouraged. Even within a country it is unfortunately often necessary to "reinvent the wheel" as between one region and another; certainly among LDC's and between DC's and LDC's information sharing could be greatly improved. It is likely that the place to start is with the networks within the developing countries themselves, either by redirecting existing institutional capacity towards these more mundane tasks--and by the same token away from "breakthrough" science and technology efforts--or by creating new capacity focussed on these particular tasks. As we have already stated, we believe that the same networks which carry information about the so-called shelf of alternative processes and alternative appropriate goods should also have the R & D capacity to help individual entrepreneurs, public or private, to effect the inevitably necessary adaptations. Information, adaptation and diffusion networks are conceptually of one cloth.

x) What is likely to make sense institutionally is the establishment of some institutes of excellence for particular major industries, with generic R & D going forward but linked up with local adaptation and dissemination centers throughout the country. Some of the national centers of excellence might well become regional with time--not by asserting their rights, but by virtue of their performance. The local adaptation and dissemination centers could, in turn, be linked to rural development banks or even inserted into the supervised credit functions of a commercial rural branch banking system.

xi) As to financing, it is well established that the limited amount of current expenditures on R & D in most LDCs is substantially misdirected. Thus, we would argue that the redirection of current allocations to LDC science and technology institutes, preferably by restructuring existing institutions and their motivation cum objectives structure, or by creating new frameworks where necessary, should yield ample resources. This is also one area where seed money, advice and stimulation by international agencies and donors can be most helpful. It is perhaps a better way to proceed than to attempt to imitate, on the industrial front, what has been quite successfully accomplished in the agricultural field by means of the international crop research institutes and their linkages to country-based adaptive research institutes.

xii) The suggested redirection of R & D should include a focus on the scaling down of advanced economy technology as well as more attention paid to the sociology of the adoption of technology change within different kinds of industries and firm types and sizes. This latter point is informed by the fact that many adaptive technology changes that have occurred in the more successful developing countries have emanated from the repair shops and factory floors rather than from the official R & D establishments. Thus the structure of the firm and its ability to reward suggestions coming up the line may be an important consideration.

xiii) The record of transnational enterprises in this overall

context is very much in dispute. Their supposed superior scanning capacity across countries, on the one hand, is pitted against their supposed tendency to use, and misuse, patents, trademarks, and licensing arrangements by tying up technology with other items of transfer, rather than effectively choosing the processes and goods most appropriate for a particular host country. Current suggestions to promote a greater amount of "unbundling" and fuller information should be supported. Transnational enterprises could possibly also be induced to use their own information channels, which are quite substantial, to permit appropriate technology adaptation experience to be shared across subsidiaries in a given developing country, with emphasis on principles rather than specific sensitive proprietary information.

xiv) A particular target of attention should be support to capital goods capacity, especially at the decentralized industrial level within the LDC's. Some such capacity, of course, already exists in most LDC situations in the form of repair shops, foundries, village blacksmiths etc. Not only is the machinery industry, especially of the mechanical type, quite labor intensive but the absence of substantial economies of scale makes the industry a natural choice as part of a decentralized industrialization strategy. The impact of an indigenous capital goods capacity on the flexibility of processes and quality bundles in the various industries serving the domestic market, which are customers of the capital goods industry, is likely to be substantial.

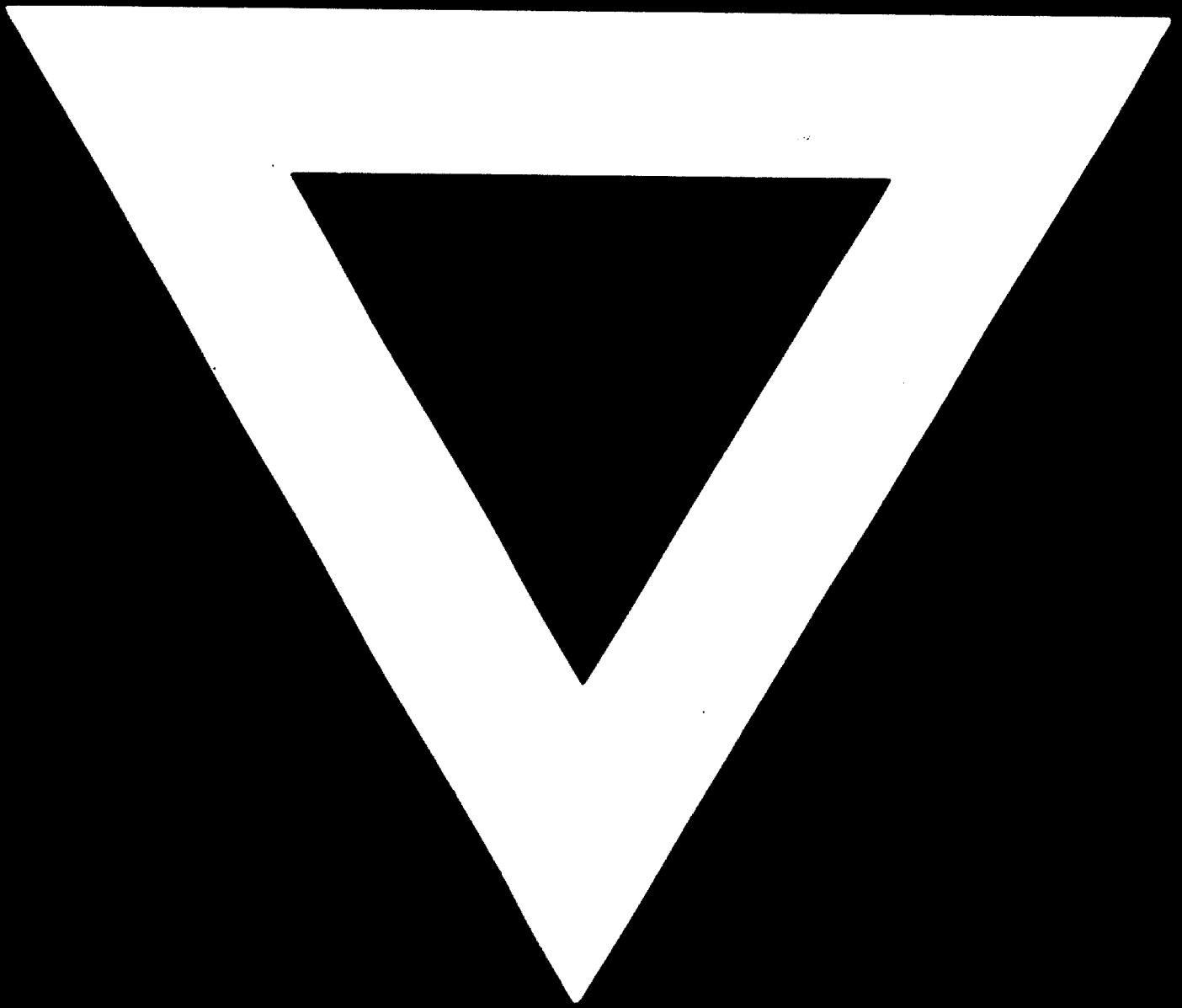
xv) Bilateral and multilateral aid agencies should really be forced to address alternative real world technological processes early on in their consideration of project lending to LDCs, rather than permitted to continue with the "best" engineering practice, while increasingly paying lip service to the need for more appropriate technology choices. Of course, resort to program lending and to flexible local cost financing rules would reduce the pressure for really forcing the consideration of technological alternatives within the cost/benefit analysis structure. This observer is skeptical on the number of projects whose approval has really been determined by rate of return analysis rather than political considerations. But he is less skeptical about the potential for changing the technology of an already agreed upon project in this fashion.

54) In sum, as we look at the real landscape in the contemporary developing world today, we often find a highly concentrated industrial structure along with a good deal of technological dualism. It is striking that the more successful or "deviant" countries, including the Japanese historical case, have experienced a much less concentrated, more decentralized industrialization pattern, with a strong rural industry orientation leading to good growth as well as distributional results. It seems evident that the ability to refrain from excessive concentration, i.e. beyond that dictated by the conditions of population density, topography, transportation costs, economies of scale etc.--along with the avoidance of an excess volume of technological dualism within urban industry--has been associated

with a highly successful pattern of industrialization and overall growth with equity. In the field of appropriate technology the search for simplistic or emotional solutions is likely to mislead us. Neither the solar cooking stove nor the big technology breakthrough are likely to prove to be "the" key. Rather, the answers lie with the response by millions of non-spectacular individual actors searching out the appropriate process and specification--and being helped to make modifications in these across a vast range of applications and landscapes. If government's direct actions assist this process, and its indirect actions refrain from creating barriers to it, we have reason to be optimistic. Enough evidence has been accumulating, at the country, and at region or time-specific levels within countries to give us confidence that we can do much better. That confidence is not based on either the notion that there exists a "quick fix" in economic policy or in technology; rather, it is based on our conviction that many of the problems are man-made and can thus be un-made by man--if he wants to.



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