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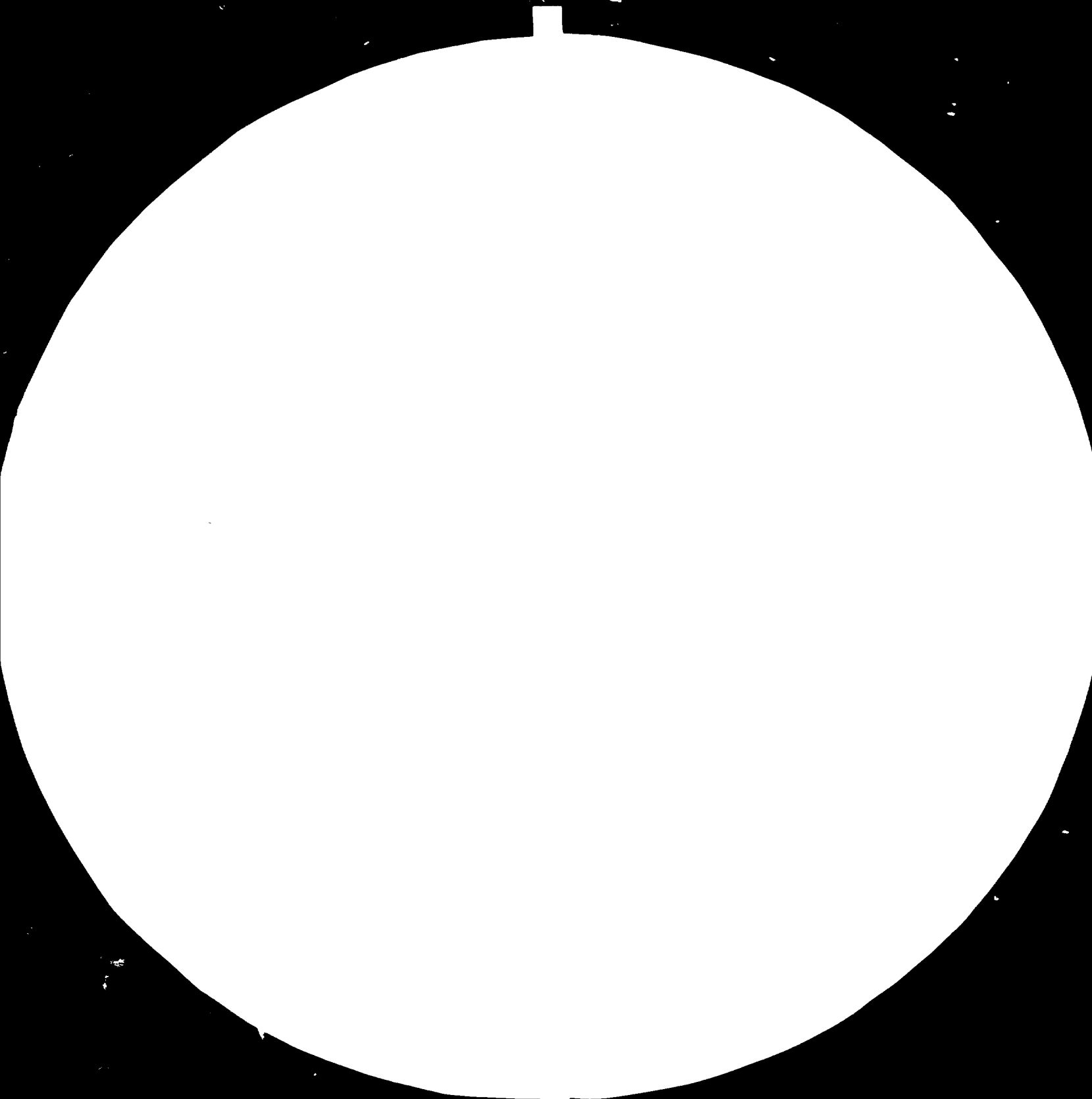

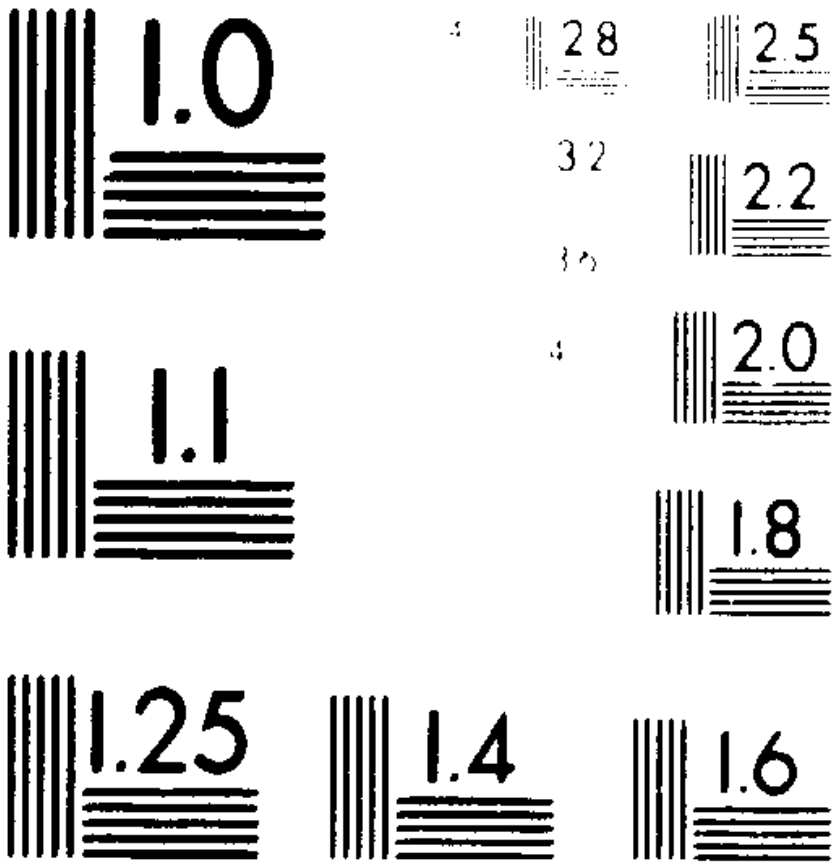

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Dieter ERNST

THE NEW INTERNATIONAL DIVISION OF LABOUR, TECHNOLOGY, AND UNDER-DEVELOPMENT

1984

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Chapter I

INTERNATIONAL TRANSFER OF TECHNOLOGY, TECHNOLOGICAL DEPENDENCE AND UNDERDEVELOPMENT: KEY ISSUES

by

Dieter Ernst

Introduction

This chapter reviews some key issues with regard to the international transfer of technology, technological dependence and underdevelopment. It is a kind of "synthetic" piece for the volume as a whole. It is thus meant to prepare the stage for the following chapters which will take up in more detail specific aspects of this global problem.

Obviously, identifying key issues depends to a considerable extent on value judgements and on personal experience (1). So I would like first to state explicitly my main premises and concerns, hoping thus to highlight the message I would like to get across:

- First, technology is obviously a strategic factor at all levels of economic and social development. Today, technology has become a major instrument of domination. This applies both to power relations within a society and to international relations, especially in the North-South context. Yet, by stressing the growing importance of technology for development, one should not fall into the trap of technological determinism. The motor of the system is not technology, but social and political change. But, because of the growing subordination of technology to the needs of all kinds of economic, social and political activities, it has become indeed a very powerful material force in social change.
- Second, I am concerned that the new proliferation of technologies into developing countries, discernable especially since 1974, might lead to new and qualitatively intensified forms of technological dependence, thus further increasing the economic and political hierarchization of North-South-relations, but also of South-South-relations, with all the

implications for underdevelopment, misery and global conflict potential.

- Third, the reform concepts prevailing with regard to the system of international transfer of technology do not tackle the causes of technological dependence, let alone underdevelopment in developing countries. They are primarily oriented towards crisis management and structural readjustment to the requirements of the "New International Division of Labour".
- Fourth, the international transfer of technology is a major aspect of the internationalization of capital. That is, if one wants to understand the driving forces behind the considerable penetration of foreign western technologies into the Third World, one needs a thorough analysis of some recent changes in the international division of labour and the causes underlying them (2).
- Fifth, there is an urgent need for a fresh approach to the conceptualization of technological dependence and of its dynamic relationship with underdevelopment and social inequality.
- Sixth, attempts to identify, in operational terms, conditions of success for alternative approaches towards a "Science and Technology Policy for Development" should be given utmost priority (3).

It is around these six points that this chapter and much of the overall contents of this book have been organized.

Chapter I starts with an inventory of the present system of the international transfer of technology. In the second part, some of the prevailing concepts of how to reform the present international scientific and technological order are more closely evaluated. It is concluded that, whatever the short term merits of the prevailing reform concepts, a new policy approach is needed and this would presuppose a fresh approach towards the conceptualization of technological dependence. Part 3 focuses on some basic issues relating technological dependence to underdevelopment. After challenging some myths surrounding the concept of technology, some essential elements of the dynamics of technological dependence in developing countries are presented. This is followed by a more in-depth discussion of the dialectics of technological dependence and technological dominance. It is specifically pointed out that any meaningful analysis of the technological dependence of developing countries presupposes a thorough analysis of the causes, effects and protective mechanisms of technological dominance.

Finally, the last part is dedicated to some new forms and mechanisms of technological dependence and dominance. It is

concluded that these new forms and mechanisms should be explicitly taken into account by strategies to overcome technological dependence in developing countries. Otherwise they may produce just another form of a partial strategy with all the inherent dangers of rising misery, frustration and conflict potential.

1. International Transfer of Technology: An Inventory

1.1. The Predominance of Private Transfer of Technology

The international transfer of technology is dominated by private capital. It is thus, by and large, subordinated to the requirements of profit-oriented decision making. If one wants to understand the prevailing system of international transfer of technology, it is essential to take into account this very basic fact.

Predominance of private transfer of technology does not mean that there would't be countries or whole regions, where the public transfer of technology prevails, at least quantitatively and for certain periods. Obviously, this is the case not only for some of the so called Least Developed Countries, but more or less for most of the vast and rapidly increasing "pauperization areas" around the globe. The notion of the predominance of private transfer of technology would secondly not preclude that the public transfer of technology might outrank or at least equal private transfers in certain sectors or at least with regard to certain functions. This is definitely the case for infrastructural development and the supply of public social services. Public transfer of technology is also prominent in the exploration of some natural resources and energy sources. And of course, one should not forget the vast and increasing public transfer of technology to the military and police forces of some developing countries.

There is in fact a clear-cut division of labour between public and private transfer of technology, where the public transfer clearly plays a secondary and complementary role. It helps to establish some of the preconditions for private transfer of technology and it is supposed to help secure a minimum stability of the overall system. It is in this sense that the notion of predominance applies.

But doesn't the picture change somewhat if it is a Third World public enterprise which is at the receiving end of a private firm's transfer of technology? Recent research undertaken as part of the Science and Technology Policy Instruments project and by Vaitsos clearly indicates that this is not necess-

arily so (4). The mere fact that the technology receiving company is a state firm is not in itself a sufficient condition for countering the predominance of profit-oriented decision making criteria.

Private firms, especially those huge, worldwidesourcing capital groups, the Multinational Corporations (MNCs), are by far the most important actors in this field and their part has significantly increased in the last decade. In fact, especially with regard to hard-core elements of the international transfer of technology, a tendency towards an increased concentration on fewer firms can be discerned. This applies especially to the so called "dynamic" industries, i.e. those branches, which are expected to display a significant future growth potential and rising profitability. Probably the most typical case in point is the electronics industry, especially the semiconductor industry, and those firms producing automatic devices, and/or package solutions for the "automated factory". (Note that some of the leading firms in this field were pioneers in the Vietnam-type military technology of the "automated battlefield", and are now looking for "new outlets" for this technology.)

Private transfer of technology can take place as direct transfer, i.e. as part of direct investment. Direct investment implies that, whether nominal capital majority prevails or not, effective control of investment and other strategic decisions can be secured. Direct investment thus includes wholly owned subsidiaries and "joint ventures" with the private or public sector of the host country. In the case of a 100 %-affiliate, there is a transfer of specific components of knowledge internal to the firm, which means that this transfer can be subordinated, more or less without external interference, to the success criteria of the firm's specific goals and strategy. Private transfer of technology can take place too as indirect transfer, for instance as part of a patent deal, or a licensing- or management-contract. But indirect transfer of technology can also take place as knowledge "embodied" into exported machinery or production facilities, or as part of a package deal, for instance the export of a "turnkey plant".

If we compare these two varieties of private transfer of technology, we have to conclude that, as far as policies to control and regulate technology imports are concerned, the direct transfer offers practically no targets for attack. Through direct transfer of technology, international capital has at its disposal a very efficient mechanism of de facto-technology protectionism, at least with regard to developing countries' governments, competitors from other OECD-coun-

tries, and potential competitors from some developing countries. Thus, direct transfer of technology guarantees a maximum of control over technology, and the surplus to be derived from it.

The indirect transfer, on the other hand, could offer at least some possibilities for inroads by the governments of receiver countries imposing a policy of "controlled" technology imports. Accordingly, some developing countries, like, for instance, Mexico, Algeria, and India, which have been prominent proponents of the concept of the "New International Economic Order", and some international organizations, such as the UNCTAD secretariat, have long since propagated a reform concept of technology policy, which aims mainly at a relative decline of the direct versus the indirect transfer. This should be done through a policy of "unbundling of technology packages", i.e. the utmost diversification of sources of supply. But contrary to such expectations, transfer of technology via direct investment still predominates private transfer of technology. And as Nadal (5) has shown, there are even indications of a new renaissance of the 100 %-affiliate approach.

Thus, decisions about time and allocation patterns of worldwide technology flows are mainly left to private capital. Public regulations for transfer of technology, mainly from major OECD-countries, define the rules ot the game, and public transfer of technology has some significant complementary functions to fulfill. Yet it is private commercialization of technology which is the crux of the matter. Finally, there has been a significant increase in effective control over technologies transferred, and this control has been increasingly concentrated on less and less firms.

1.2. International Transfer of Technology - a Major Aspect of the Internationalization of Capital

Since the beginning of the 1960s, an enormous geographic expansion of the commericalization of technologies has taken place, encompassing the remotest corners of the world market. This worldwide proliferation of technologies has been a major element in the internationalization of capital. Obviously, MNCs have played a predominant role in this process. But what have been the real motivations behind this tremendous increase in the export of technology? Five of them can be discerned:

a) Extending the product life cycle of technologies

Given the increased oligopolization of major world markets and the intensification of world market competition, the export of technology can be viewed as an attempt to extend the product

life cycle of technologies which are either at a high stage of "maturity" or are going to become obsolete in the very near future. In this sense the international transfer of technology performs the function of a substitute for innovation. Thus, it has been shown that a significant part of the transfer of technology to developing countries consists of mature or obsolete consumption technologies, which, furthermore, are sold at excessive prices (6).

However, this technological conservatism, inherent in the export of technology, should not be overdone. Obviously, it is not only mature or obsolete consumption technologies which are transferred to developing countries, as Vernon's product life cycle theory seemed to imply. In fact, modern or high technologies have recently been transferred to developing countries on an increasing scale. It is essential to understand that this transfer of "modern" technology is no less part of a global strategy of "planned obsolescence" as is the transfer of mature and obsolete technologies. I will show later in this chapter that the near complete control, by a handful of private firms, of the life cycles of most of the technologically relevant industrial products and processes is used by those firms as a major instrument of oligopolistic competition, i.e. by skillfully devising optimal time patterns for obsolescence.

b) Pentrating closed markets

The worldwide commercialization of technologies has turned out to be a very efficient instrument for the penetration of closed markets.

There is an obvious need for Western capital to penetrate new markets: world trade whose volume, during the period 1963 - 1973, had an average annual growth rate of 9%, since 1974 has grown by less than 4 % (7). This tremendous crippling of export possibilities applies especially to intra OECD trade, and, even more dramatically, to intra European trade and trade between Europe and Japan. Given the stagnation of East-West trade, the disclosure of "new frontiers" will have to take place mainly in some developing countries, especially the OPEC-countries and the socalled key countries. There are three types of "growth markets" available in these countries: private luxury consumption, government procurement mar- and world market factories. Given the high level of effective protection surrounding them, the export of technology might in fact be the only way to penetrate these markets. This point has been succinctly stated by Thomas A. Callaghan Jr., a U.S.-industrialist

and influential consultant for the technology export policy of the United States: "Markets closed to products are invariably open to technology. Even extremely closed markets will open to Western technology, providing the West gives them the credits to make the purchase! ... As long as the United States is the predominant technological power in the world, closed product markets will always be open to American technology" (8). Besides, market pentration through export of technology seems to be the most durable form of market penetration available. As Judet and Perrin have put it: " ... Si avec des crédits on lie pour un temps, avec de la technology, on lie pour longtemps" (9).

c) Shifting the cost burden of research, development and engineering (= r&d&e)

The international transfer of technology has been increasingly perceived by corporate headquarters as a necessary and efficient instrument for shifting the enormous cost burden of r&d&e-activities on to other shoulders, especially those of weaker bargaining partners. For this sake, a lot of very efficient instruments - most of them rather informal ones - have been devised by business intellectuals and management-think tanks: the great variety of transfer pricing-practices and some new techniques of global cash management are just two cases in point.

Two implications are essential in this context:

(1) This corporate policy of "burden sharing among unequals" is an important precondition for present global patterns of technological dominance/dependence, since it has helped to establish very efficient and flexible mechanisms for a significant and increasingly perverse transfer of financial means from developing to industrialized capitalist countries, through which developing countries are in fact actively funding metropolitan r&d-activities.

(2) Technology-exporting firms might not have much room for compromise, for instance with regard to the prices of transferred technology.

The corporate policy of "burden sharing among unequals" is in fact a very rational reaction to an objective dilemma. From corporate headquarters' point of view, this dilemma might be roughly described in the following way: How to finance that minimum of innovative activities essential for securing worldwide oligopolistic market positions, given the following constraints:

- the increasing strategic importance of r&d&e for capital accumulation;
- the excessive rates of inflation pertaining to r&d&e-costs;
- the very high risk inherent in r&d&e-expenditures?

R&d&e-activities today have in fact become a key factor in management strategies. This does not mean, as some would claim, that private appropriation of r&d-benefits would secure an optimal development of science and technology, at least with regard to social welfare. On the contrary! The increasing perversion of science and technology, especially in the capitalist societies of major OECD countries, has been exhaustively documented (10). What it does mean is that under conditions of intensified world market competition, r&d&e-activities have become a precondition for survial. This is obvious for markets with a rapid succession of innovations, such as the computer or the semiconductor industry. But it also applies for the more "traditional" industries, such as steel or textile production, where, at first glance, the innovative potential appears to be saturated, but where, as in-depth-analysis has shown, a lot of innovative activities do occur, although predominantly with the aim of obstructing or at least controlling the development of "alternative" technological production routes (11).

In fact, decisions on r&d today are increasingly becoming top-level management decisions. That this is a rational reaction has been shown by a recent Commerzbank AG-report on "Research and Development in Industry" (12). According to this report, r&d-decisions are responsible for 70 % of the overall product life cycle costs of leading German Multinational Corporations.

It is thus essential to take into account not only the direct costs of r&d, but also the great variety of follow-on-costs. For instance, according to recent research on the US-electronics industry these follow-on-costs may exceed the direct r&d-costs by between 12 and 24 times (13). But even with regard to direct r&d-costs the increase of cost burdens is impressive. According to data supplied by the German chemical industry, its r&d-expenditures have increased by at least 100 % during the last 10 years. For West German industry in general, the direct cost of establishing one industrial r&d-job has increased from 140 000 DM in 1970 to nearly 220 000 DM in 1977 - nearly 60 % (14). This tendency towards significantly increased r&d-cost burdens becomes much more pronounced if one turns to "technological building blocks" (for example semiconductor-technology), military and avantgarde technologies (for instance seabed mining or large scale solar energy schemes) (15).

In any case it is safe to say that the need to export technologies, so that an essential part of the growing r&d-cost burden can be recuperated, will definitely increase over the years to come.

d) The global technological race

The international transfer of technology is rapidly becoming an essential element in a global "technological race". This new variety of international oligopolistic competition has gathered momentum especially since 1970 and is thus closely related to the growing crisis of capitalism (16). Its major battles are fought among companies based in OECD countries. Yet this does not mean that it has been restricted to the OECD region. Increasingly the transfer of technology into developing countries is of considerable importance for the outcome of this global technological race.

It is in this context that new strategies and tactics of "technological competition" have recently emerged. This applies both to new ways and means of penetrating and displacing dominant technology production routes and to those countervailing measures which strive to protect positions of technological dominance against "technological invasion" (17). Obviously, this new cluster of instruments and institutional set ups, available to international capital, will be of crucial importance for future developments of the international transfer of technology. Yet, up till now, they have only been marginally dealt with by research, let alone policy discussions, related to the possibilities of reforming the present system of international transfer of technology.

e) Preconditions for the internationalization of production

The international transfer of technology has been an essential precondition for the internationalization of production. In fact, the massive proliferation of production technologies abroad and strategies of worldwide sourcing would have been inconceivable without "transfer of technology". For the Multinational Corporation the main problem reads: How to coordinate highly complex flows of resources, capital, manpower, and technology on a global scale, i.e. the logistics of worldwide sourcing and production, in such a way that long-term profitability will be secured, and effective control maintained.

It is to these criteria of success that Multinational Corporations will have to subordinate their worldwide transfer of any kind of technology, be it development and engineering know-how, product and process technology, technologies for the exploration and exportation of natural resources and of energy sources. It is essential to understand this last point: For the donor firm transfer of technology not only makes possible but necessitates increasingly rigid mechanisms to control and protect its innovative capacities. In other words,

transfer of technology as part of the internationalization of capital is one of the main causes behind the increasingly hierarchical nature of worldwide production and distribution of scientific-technical knowledge. There is in fact a close interconnection between the predominance of private transfer of technology and global patterns of technological dominance and technological dependence, as will be shown in detail later in this chapter.

Thus, in contrast to textbook wisdom and the phraseology of international conferences, transfer of technology into developing countries is not the result of some kind of global welfare policy, striving towards an improved distribution of technologies needed for increasing global welfare. It is instead an important element in the strategies of private firms, essentially Multinational Corporations, which are forced to internationalize their overall cycle of capital reproduction on a growing scale. Consequently, transfer of technology into developing countries is pursued in such a way that the benefits to be derived form control over innovative capacities and new technologies can be optimized, both with regard to time horizons and geographical distribution (markets and production sites).

1.3. The Developing Countries' Dilemma: Uncontrolled Technology Imports and the Qualitative Intensification of Technological Dependence

Until recently, in most developing countries, policies concerning science and technology have been characterized by an extreme degree of "laissez-faire". In fact, policies to overcome what was then termed "technological backwardness" consisted first and foremost of an extreme variety of an "open door policy" applied to all technology imports, but especially to those via direct investment. Also, since the middle of the 1950s, in one developing country or another, there were some attempts to increase national university systems and scientific communities. But apart form a very few noteworthy exceptions, these apparently "inward-looking" science and technology policies merely helped to increase the consumptive capacity for imported technologies and thus only further increased the predominant de facto" outward-looking" orientation of science and technology policies.

Today, it is obvious that these policies had disastrous effects. There might have been, at least in some "growth poles" or for some sectors or products, some noteworthy

increase in the local capacity for absorbing technologies. The same might apply to some fragmentary "upgrading" of infrastructure and productive facilities to world market standards. But without doubt, there has been no significant reduction of the developing countries' "technological gap". In fact, the hierarchical nature of the international system of production and distribution of scientific-technical knowledge has been intensified. On the whole, the effects of imported technologies on social equality and political systems have been extremely negative. But even those who would deny these last two points, do agree that the unrestricted transfer of technology will definitely not be helpful in finding a solution to the most burning question of developing countries: how to prevent a further dramatic increase of the already very high marginalization and pauperization of the majority of the Third Wold population?

A lot of very useful research has been accumulated during the last fifteen odd years on the negative developmental effects of the transfer of technology, subordinated to the laws of oligopolistic competition. One is forced to conclude that, with very few exceptions, technologies transferred have been particularly unsuitable for the requirements (in social terms) of the developing countries, have been extensively overpriced and have been surrounded by a great variety of explicit and implicit restrictions. A strict definition of the term transfer of technology would imply that the receiver country would gain effective control over the imported technology. Effective control means that the developing country would not only be able to use and adapt the imported technologies, but also to reproduce and further develop them in accordance with social technology needs. Social technology needs result from the requirements of a developments strategy, which would aim at three main goals: greatest possible fulfilment of essential material and social needs; utmost use of local resources; and long term increase of accumulation potential. In this sense, most of the flows of technology towards developing countries are in fact non-transfers. As Michalet has shown, the present system of international transfer of technology is essentially characterized by "the MNEs' (Multinational Enterprises, D.E.) anxiety to stop as far as possible technological leaks forced upon them by the conditions of oligopolistic competition on a worldwide scale. ... They (= the MNEs, D.E.) have little room for technological components to escape except at the end of the chain in finished products" (18).

Another basic shortcoming of the present system of transfer of technology to developing countries is the almost complete

absence of a complementary transfer of r&d&e-activities integrated into local production requirements. Except for some standardization and test activities (which, if carried on in the laboratories of the Mother Company, would have been too costly or are barred by legislation), almost no engineering, development, or research activity has actually been transferred to developing countries by the main agents of the international commercialization of technology, the Multinational Corporations. In the capital goods sector, for instance, a research project on Mexico has shown, that MNC affiliates are used as experimental stations in the very restricted sense that experiments are extended to selling equipment that has not been fully tested by the parent company in order that it may be tested at the risk of the buyer (19). For the pharmaceutical industry it has been shown that in Mexico and some African countries foreign-owned enterprises test new drugs on local patients, while such experiments are prohibited in the mother countries of those companies (19).

Finally, a research project on India has shown that Multinational Corporations have at their disposal highly developed systems to register and absorb inventions and innovations produced in developing countries (be it by private or public labs), so that r&d&e-activities have been transferred from developing countries to the metropolitan countries rather than vice versa. The most obvious sign of this perverse transfer of innovative capacities is the very high and still increasing brain drain. The concept of brain drain is not only applicable in the international context, i.e. to the direct export of highly qualified labour into major OECD countries, but also refers to the national context of developing countries, i.e. to the absorption of highly qualified labour through foreign-controlled enterprises and infrastructural works conditioned by the needs of foreign investment (= the socalled internal brain drain).

Finally, the massive proliferation of "modern" technology imports during the last twenty odd years, in a majority of developing countries, has been essentially dedicated to three types of "advanced technology" - growth poles: private luxury consumption, government procurement markets and world market factories. The concentration of technology imports on these growth poles has considerably increased the structural deformation of developing countries. This applies in a dual sense. On the one hand, these growth poles, in terms of spin-offs and the diffusion of learning effects which are essential for adapting, reproducing and further developing the imported technologies, are only marginally linked to the host

countries' overall economic circuit (20). On the other hand, all of these three growth poles, even in the extreme case of a world market factory located in a "free production zone", are in fact displaying a variety of significant linkages both with the countries' capacity to accumulate and its capacity to fulfil basic needs. This applies to the use of scarce local resources, including the scarcest of all, qualified labour, and to the absorption of surpluses, including those derived form the socalled informal sector. All of these linkages are almost invariably characterized by a basic structural deformation: they are subordinated to the world-wide sourcing requirements of international capital and not to the requirements of local accumulation. This means that the key elements of a developing country's social and industrial development, such as its educational system, its r&d-capacities, its engieering activities, and its capacity to produce capital goods, are undergoing a process of progressive disintegration. This is in fact the essence of the qualitative intensification of technological dependence. It means that the developing country's capacity to control or reduce the gap between social technology needs and technology supply will be crippled for a long time to come (21).

Thus, to sum up the main effects of "open door" policies towards technology imports:

- uncontrolled technology imports have almost invariably led to a process of displacement, deformation or destruction of existing local innovative and adaptative capacities;
- innovative capacities have been transferred from the developing countries to highly industrialized countries rather than vice versa; and
- there has been a clear trend towards a qualitative intensification of technological dependence in developing countries.

From the viewpoint of the Third World there is an obvious need for a throrough-going change in the present system of international transfer of technology. This applies to the restructuring of North-South technology relations, the promotion of individual developing countries' national scientific-technological capabilities, and, last but not least, the increase of South-South scientific-technological relations. In part 2 of this chapter I will briefly discuss some of the reform concepts prevailing in this field.

2. A "New International Scientific and Technological Order" (NISTO) as Part of a "New International Economic Order" (NIEO) - the Distorted Nature of Prevailing Reform Concepts

International transfer of technology, left to the laws of oligopolistic competition, has led on a global scale to a further increase of the already very asymmetric distribution of control over both the inputs and outputs of research, development and engineering activities. It has thus been instrumental in perpetuating the hierarchization of North-South, but also of South-South-relations, with all the implications for underdevelopment, misery and global conflict potential.

A reform of the present system of international transfer of technology is overdue - at least on this point there seems to be an unusually far-reaching consensus. Yet this consensus is more apparent than real. In fact the contents and scope of such reforms are highly controversial. Some would claim that truly comprehensive change is needed: Reforms should facilitate, within a realistic time scale, the transition towards a NISTO which could then help to set the stage for a concerted attack on the technological dependence and underdevelopment of Third World countries (22).

Yet, the reality has been somewhat different, to say the least. Given the present international class structure and distribution of power, it is not surprising that those reform concepts, which have been cleared for international negotiations, are of an extremely piecemeal and fragmentary nature. Even if they could be realized (which is highly doubtful), they would be marginal if not dysfunctional to any real problem-solving. This is so because the prevailing reform concepts do not tackle causes of technological dependence, let alone underdevelopment in developing countries. They are primarily oriented towards crisis management and the structural readjustment to the requirements of the "New International Division of Labour".

In what follows, some of the major shortcomings of the prevailing reform concepts will be more closely evaluated. I will specifically focus on three points:

- the attempts to reform the international system of transfer of technology;
- some negative implications of the newly arising myths of "science and technology for development";
- and, finally, the possibilities and limitations inherent in the concepts of Collective Self-Reliance and Technical Cooperation among Developing Countries (TCDC).

2.1. Reforming the International System of Transfer of Technology - a Permanent Deadlock?

Background and major shortcomings

Since the end of the 1960s, discussions about a reform of the present system of the international transfer of technology have gathered momentum. These attempts have centered on the development of instruments and institutions for a technology policy which would enable governments of developing countries to neutralize the predominantly negative developmental effects of technology imports and, at the same time, to increase local innovative capacities. The main focus of these concepts are partial reforms of the transfer-aspect of technology, with regard to both the conditions of transfer and to some secondary characteristics of the transferred technologies. This reform of the transfer-aspect should be complemented by some structural readjustment policies and social engineering measures, which would have to be applied both by receiver- and donor-countries.

This position predominates in reform discussions today, and it is an essential component of the New Development Orthodoxy characteristic of the Second UN-Development Decade. It has many manifestations and ramifications and it is rather difficult to find a common denominator. There are variants which are still prey to development concepts à la Rostow. But the more intelligent versions at least would start from the presumption that the technological dependence of developing countries has been the result of some basic flaws in the present system of transfer of technology. In most cases, technological dependence will be defined in a static way. At best the growth of the "technological gap" with regard to Western industrialized countries will be given some attention, especially in the field of r&d-intensive branches. The historical dimension of the problem will not be denied. Yet, in general, it will be argued that to know this won't be of much use for problem-solving. Main emphasis will be laid on restrictions and loss of sovereignty for governments of Third World countries, resulting from tricky bargaining deals, restrictive business practices and from the increased technological gap, and these restrictions on government decision-making are perceived as essential elements of an increasing potential for North-South conflict.

The therapy derived from this diagnosis follows the logic of a problem-solving approach which is primarily orientated towards conflict reconciliation. Consequently, an attack on the underlying causes is tabooed. This applies to the status quo of an extremely asymmetric access to innovative capacities,

means of production and political and military power which is characteristic both for international relations and for class relations within a society. This basic cause of technological dependence will not be called into question - at least not in an operational form which could be translated into concrete institutions and politics. On the contrary! It is the balance of this status quo which most of the instruments and institutions inherent in this therapy are striving to maintain. Accordingly, this approach is primarily aiming at

- a removal and reduction of hindrances for the continuous expansion of the international flow of technology;
- a stigmatization of some "excessive abuses" which might endanger the stability of the present system;
- some minor corrections of secondary structural defects and
- the global standardization of the "legal and juridical environment" for the international transfer of technology.

Six issues for debate

There are six concrete issues which are up for discussion:

a. A "modernization" of the International Patent System (the Paris Convention, still binding today, dates back to 1883) should remove some rigidities of the present system which has become rather dysfunctional for the protection of technological monopolies. This modernization should help to avoid unnecessary conflicts and at the same time should pave the way for the codification of new and more subtle protective mechanisms.

b. A Code of Conduct for the Transfer of Technology should make it possible to devise some basic rules of the game for the international technology markets which up till now have been characterized by a rather high degree of anarchy. This would significantly facilitate long-term planning for the MNCs, the main actors in the international transfer of technology, and thus could help to reduce the very high risk presently involved. In addition, a code is supposed to serve as a normative pattern for the kind of political instruments necessary to control and regulate technologies, which would be available to donor and receiver countries. I have shown elsewhere (23) that codification in this context will mean an important set-back for the bargaining flexibility of those developing countries, which already had much better instruments available and whose experience has largely provided the empirical basis for draft provisions of the various instruments.

In fact, any code of conduct on transfer of technology, finally realized, would form part of a whole combination of codes which would have to cover various levels of the internationalization of capital (24). There are many reasons to fear that such codes will mainly be conceived to restrict host governments' room for manoeuvre in controlling foreign inve.tment (any reading of Business International will show this!) (25). In any case, UNCTAD negotiations on an international code of conduct for technology transfer have reached a deadlock on the key issues of its legal character and implementation machinery (26).

c. Existing factor cost disparities, which are viewed as an "essential hindrance" for the transfer of "appropriate" technology, should be tackled through manipulations of monetary and fiscal policy instruments and through improved engineering of business cycles, both on a national and on an international scale. These corrective measures should be put into action both in the technology receiver country and in the country from where the technology originates. Appropriateness of technology in this concept is primarily viewed in terms of the factor endowment currently prevailing in the receiver country. Consequently, priority is given to raw material-intensive technologies and especially to those process technologies with a high need for low-cost, low skilled, easily trained, and easily displaceable labour.

d. The local technological infrastructure, especially with regard to information networks, communications systems, standardization and test and adaptative activities, should be sufficiently increased, inter alia to improve bargaining positions for concrete technology deals. This should be achieved mainly through, on the one hand, a so called modernization of educational systems which essentially strives to imitate some features of the educational systems of major OECD-countries, whose doubtful effects on skills and social equality have already been exhaustively demonstrated (27), and, on the other hand, the establishment or increase of local Science and Technology institutions (an approach, which, as the experience of some Latin American countries since the 1950s shows, will at best help to increase the capacity to consume foreign technologies).

e. A planned, albeit limited dynamization of comparative costs should be attained mainly by two policy instruments:
   - new combinations of incentives together with control and selective measures, to be applied to international economic flows;

- increased use of science and technology policy as part of more general structural readjustment policies.

These policies should be applied both in highly industrialized countries and in developing countries. In Western industrialized countries structural readjustment is defined as meaning the subordination of branch-specific and regional structures to recent upheavals in the world economy and to technical change, so that it will be possible are candidates for offshore production in developing countries. On the other hand, it is on these products and processes that policies to strengthen local technological capacities in developing countries should focus. Thus, overdue structural change in the "International Division of Labour" could be channelled in such a way that the extent of such change could be reduced and kept under control.

f. To check the negative social "side effects" of the present system of international transfer of technology which might become dangerous for the status quo, corrective welfare policies and social engineering measures should be applied both in developing countries and in industrialized countries, as well as through international organizations (such as ILO, FAO etc.). The increasing unemployment and marginalization of a majority of the developing countries' population, which, amongst other things, is a result of the predominantly job-destructive character of "technological progress", should be mitigated through the planned development of labour-intensive technologies on a significant scale. Yet, the use of such "appropriate" technologies is meant to be restricted mainly to those economic activities which are not directly subordinated to the necessity of profit-making, i.e. to:
   - those parts of the agricultural sector, which have not yet become fully integrated into capitalist production;
   - subsistence activities and subcontracting activities of small firms in the urban slums;
   - the disposition of certain public social services and infrastructures.

The growing pauperization of a majority of the world population and especially the unimaginable increase of rural poverty should be countered by a so-called "basic human needs strategy of development". Such a strategy should focus on the development and diffusion of technologies, in the field of food production, housing, medical care and elementary education, which would be cheap, easily transferrable, easily learned,

not easily worn out and easily maintained. No one would deny the urgency of such emergency measures. Yet one essential problem remains controversial: who would have to fund the considerable costs of such programs?

Thus, the main aim of prevailing reform concepts of the international transfer of technology are limited changes of transfer conditions. What is really necessary would be to attack technological dominance, i.e. to break open the extremely asymmetric distribution of control over processes of production and innovative capacities. This necessity, which has been wordily articulated in countless resolutions at international conferences, has not yet been transformed into politically operational concepts let alone institutional settings. This is why up till now it is still the import of technology which is given the key position in policies to overcome technological dependence.

2.2. "Science and Technology for Development": UNCSTD and after (28)

Since UNCTAD III the reform of the international system of transfer of technology ranks high on the agenda of international conferences conferences concerned with the establishment of a NIEO. We have seen that politically relevant discussions were more or less dominated by the transfer aspect of technology, i.e. by problems such as how to reduce excessive costs and how to moderate certain restrictive business practices related to the commericalization of technology (the reform of the international patent system and a code of conduct on transfer of technology being the only potential albeit somewhat ambivalent 'success stories' in this field). The decisive problem of science and technology for development, i.e. how to overcome the technological dependence of Third World countries, was only marginally dealt with.

But hasn't there been a change of late? A host of international conferences will have taken place by 1980 which, at least according to their proclaimed agenda, will give prominence to the establishment of necessary p. conditions for the effective application of "science and technology for development". This applies, to the Buenos Aires conference on TCDC, UNCTAD V, UNIDO III and, most specifically, to the United Nations Conference on Science and Technology for Development (UNCSTD, Vienna, August 1979).

Take for instance UNCSTD. Doesn't it for the first time ever open up some chances to approach the issue of overcoming technological dependence? According to the 7th Special Session of the UN General Assembly, the establishment and

promotion of local technological capabilities in developing countries should be the main subject of this conference (Res. 3362/S-VII). The same resolution states: "Developed and developing countries should cooperate in the establishment, strengthening and development of the scientific and technological infrastructure of developing countries."

Obviously, the issue of "science and technology for development" has become a highly "politicized" issue for North-South bargaining. And obviously, too, the very fact that politically relevant discussions are no longer completely restricted to the transfer aspect of technology might of itself be called a considerable step forward. But what are the next steps to be? How does one evaluate the dynamics and the chances of implementation let alone success inherent in these reform concepts? Will they really enable governments of developing countries to neutralize the predominantly negative development effects of technology imports and, at the same time, to increase local innovative capacities? Will they facilitate, within a realistic time horizon, the transition towards a NISTO which could then help to set the stage for a concerted attack on the technological dependence of Third World countries?

I tend to be rather sceptical about this. In fact, it might very easily turn out that the balance to be drawn after UNCSTD and similar conferences will be much more gloomy than the high expectations, prevailing at the moment especially in some organizations of the UN-family.

One basic leitmotif: increased proliferation of technologies into developing countries

There is on basic leitmotif underlying all these recent reform moves: to increase the proliferation of technologies into the Third World, both with regard to new applications and with regard to new countries. The overwhelming concern of a majority of developing countries is with "access to modern technology" originating in the OECD region, and issues related to the "strengthening of scientific and technological capabilities of developing countries" are clearly subordinated to it.

This preoccupation on the part of developing countries with an increase of international technology flows coincides with the new interest of western industrialized countries, especially articulated in the U.S., the FRG and Japan, in opening up new markets for technology exports on an unprecedented scale. I am concerned that this new proliferation of technologies into developing countries might become instrumental in producing new and qualitatively intensified forms of techno-

logical dependence, thus further increasing the economic and political hierarchization of North-South, but also of South-South-relations.

Evaluating UNCSTD: interests involved and main trends

In this context, UNCSTD might serve simply as another pretext for legitimizing a New International Division of Labour with regard to the Production, Application and Distribution of Scientific-Technical Knowledge. This, to say the least, will only be marginally compatible with the effective application of science and technology to the fulfilment of essentail needs of a majority of the world population. In fact, elements of this "New International Division of Labour" are already with us.

Expectations concerning UNCSTD do vary considerably. Besides discussions on basic principles and (future) possibilities of applying science and technology for development, UNCSTD, like any international megaconference, will serve as a clearing-house for conflicts of interest, inherent in the conference subjet. This dual function of UNCSTD has been lucidly described by Jack Baranson in his contract study for the U.S.-Department of State, entitled "North-South Transfer of Technology: What Realistic Alternatives are Available to the U.S.?":

"Agenda items associated with scientific communities can deal with opportunities and horizons; technology topics should be orientated towards necessary adjustments in the terms of trade between buyers and sellers of technology. (my emphasis) (29)"

In other words, whereas scientists would be engaged in devising scenarios and futurology-type glass bead games, bureaucrats and businessmen could turn without further ado to the real conference subject, i.e. how to establish a workable frame for the international technology trade. What are the interests at stake? The Secretary-General of the conference, the Brazilian da Costa, defines his main expectations concerning UNCSTD in the following way: "One of the most positive benefits will be derived ..., if we ... have promoted the understanding that an integrated world is to everyone's benefit. ... Developed countries should renounce their monopolistic attitudes towards high technology and developing countries could ensure supplies of raw materials." (30)

A barter deal is proposed: Western industrialized countries reduce the degree of their almost monopolistic control over high technologies, while developing countries, and especially main exporters of strategic raw materials, would guarantee the longterm supply of these resources. It might not be un-

fair to call Da Costa's position typical for a majority of urban elites and bureaucrats in developing countries, especially the economically "dynamic" ones, like Brazil, India, South Korea and pre-revolutionary Iran etc..

For major OECD countries, six main positions regarding the transfer of technology to developing countries may be distinguished:

- Hindrances for the worldwide proliferation of technology, taking place predominantly as transfer internal to the firm, should be removed or at least reduced and a worldwide standardization of the legal and juridical framework for these transfers should be achieved in order to reduce uncertainties and risks.
- Government Procurement Markets for infrastructure, basic industries and arms production should be significantly expanded, especially in some so-called key countries of the Third World.
- The capacity of local enterprises of small and medium size for absorbing modern, "standardized" technologies should be improved, by establishing complementary scientific-technical infrastructures in developing countries. Longterm control of these infrastructures has to be secured, if only to make the optimum use of them for worldwide screening and tapping of new scientific-technical developments and innovations.
- New possibilities for transfering standardized components and production moduls have to be established also for capital goods production.
- The potential of cheap, disciplined, easily displacable and highly qualified labour - especially scientific-technical professionals, laboratory teams, engineering consultancy teams, and business lawyers - should be increasingly integrated into strategies of worldwide sourcing. Such woldwide sourcing for low-cost brain implies, inter alia, new forms of international subcontracting with regard to engineering consultancy.
- The control of innovative capacities, key and avantgarde technologies has to be increasingly centralized in some private firms and public institutions of major OECD-countries. Accordingly, new institutions and instruments to protect this technological dominance are to be devised and established.

It is safe to assume that OECD countries, and especially the United States, the Federal Republic of Germany and Japan, who, particularly with regard to technology, do have a very strong bargaining position, will use it to push through their notions of a new proliferation of technologies into developing countries.

I suspect that this new proliferation of technologies may very easily become instrumental in producing a "new industrialization scenario", first in some key countries of the Third World, later on a much broader scale. This "new industrialization scenario" which, superficially, may fulfil some of the expectations prevailing, for instance, in some recent declarations of the 'Group of 77', may in fact turn out to fulfil nearly all the preconditions to significantly increase the technological dependence of these countries. I am referring to three new types of industrialization of Third World countries:

a. the expansion of certain basic industries (iron & steel; aluminium; petrochemicals), which has been given an enormous push by the new drive of major OECD countries to export turn key-projects in this field;
b. the new pattern of world market subcontracting with regard to certain branches of capital goods production (e.g., low cost NC machine tools) and engineering consultancy (worldwide sourcing of low-cost, locally subsidized r&d-teams);
c. the attempts prevailing in a growing number of developing countries to induce the growth of local capital goods and basic industries via the establishment of local arms industries.

As far as arms production is concerned, its doubtful effects on technological development let alone economic and social development have been amply documented (31). The first two industrialization patterns have one thing in common, namely that, at first sight at least, they might seem to be priority candidates for strategies to overcome technological dependence. Yet they also have in common the very disconnected and fragmentary nature of their integration into the overall industrial and socioeconomic systems of the "receiver" countries. In fact, they may lead to a qualitative intensification of global patterns of technological dominance and dependence, thus further reducing the room for manoeuvre for development strategies in Third World countries.

An extreme case: the subordination of "industrializing industries" to the requirements of the New International Division of Labour

Let us take as an extreme example a country which persistently strives to give utmost priority to the promotion of the so-called industrializing industries (a term which was first coined by Gérard Destanne de Bernis for Algeria's development strategy). Such a strategy includes, among others, the machine tool industry, the production of textile and agricultural

machinery, and a reorientation of basic industries, processing locally available resources in order to increase the share of down-stream activities and to push ahead its integration with regard to both the country's industrial and agricultural production. This stratey would include attempts to strengthen local engineering capacities, especially with regard to pre-investment studies, chemical engineering and equipment design.

As long as our country tries to realize this strategy indiscriminately on the basis of a significant proliferation of technology imports, this strategy may in fact fulfil nearly all preconditions to significantly increase its technological dependence. True, some segments of industrializing industries will now be located within the national frontiers, such as, some first stage down-stream activities in the steel. aluminium and petrochemical industries. The same may apply to highly standardized machine tool production and even to low-cost NC machine tools. But it would be shortsighted to conclude that this country now had access to the elements of an industrial system, the so-called technical coefficients of interindustry linkages. On the contrary! My research forces me to conclude that these key elements almost invariably remain under the strict control of a handful of private firms and public r&d-centres, predominantly located in major OECD-countries. In fact it is possible to discern strong tendencies to exacerbate this hierarchy of control. This relates specifically to basic research, innovation capacities, avantgarde technologies, means to devise technological building blocks, systems for world-wide screening and tapping of scientific-technological developments and feedback information concerning production experience. The same applies to process engineering and equipment design and techniques with regard to information and communication systems, production logistics and marketing.

This is in fact the essential manifestation of what I would call a "qualitative intensification of technological dominance". Growing technological dominance increases the capacity of those few private firms and public institutions to exercise cumulative hierarchical control. The concept of "cumulative hierarchical control" intends to highlight the growing capacity of Multinational Corporations, some major OECD-countries' governments and certain international organizations, such as, for instance, the IMF, both separately and in various combinations, to react towards the loss or reduction of nominal control on relatively low levels of the

overall productive system of a branch or a product, by increasingly monopolizing the decisive elements of r&d, engineering, finance, maintenance and logistics and strategy and organizational structure.

Although in a growing number of developing countries a proliferation of "modern" industrial technologies can be discerned, including in some cases even potentially industrializing industries, there is a de facto reduction of access to and control over these technologies with regard to developing countries' firms and public institutions. Nevertheless, illusions that national technology policies have an increasing room for manoeuvre still abound - countries like Brazil or Iran are cases in point.

UNCSTD and the vitalization of a new development myth

Unfortunately, there are indications that much of the recent reform moves and especially UNCSTD might become instrumental in further refining this new development myth. This myth might be useful in fulfilling three functions:

- the process of qualitative intensification of technological dependence, prevailing most developing countries, might be given a convenient disguise;
- the progressive neutralization and obstruction of those very few existing attempts by developing countries to control technology imports and direct investment, such as, the Andean-pact regulations, might be concealed;
- strategies of "global planned obsolescence" and "technological dominance", pursued by a handful of Multinational Corporations and the governments of some major OECD countries, might be effectively legitimized.

2.3. Collective Self-Reliance of Developing Countries (CSR) and Technical Cooperation among Developing Countries (TCDC) - Some Sceptical Comments (32)

But what about Collective Self-Reliance? And, more specifically, what about that variety of Collective Self-Reliance which is up for negotiations, i.e. TCDC? What are the implications of the presently evolving New International Division of Labour for TCDC? Under what conditions will TCDC effectively "... promote and strengthen collective self-reliance among developing countries through exchanges of experiences, the pooling, sharing and utilization of their technical resources, and the development of complementary capacities." (33)?

I will not repeat definitions and expectations. This has been done extensively elsewhere (34). (In fact, the terms "Self-Reliance" and "Collective Self-Reliance" have recently experienced a wide circulation. They have thus become an easy prey for cooption and misuse.)

Instead, I will focus on five specific questions:

- What is the background of these concepts?
- What is the "reformist potential" inherent in the concept of TCDC?
- What is the role of Industrialized Countries?
- How to evaluate the outcome of the Buenos Aires Conference on TCDC?
- And, finally, what are the issues we should look at much more closely if we want to break through the stalemate prevailing after the Buenos Aires Conference?

TCDC - an element of the NIEO program, but still of marginal importance

The strengthening of South-South cooperation is one of the three basic elements in a strategy to transform present international economic relations into a New International Economic Order (NIEO).

Within this concept, collective self-reliance is the necessary complement to the restructuring of North-South relations and the promotion of individual developing countries' development potentials, including their scientific-technological capabilities.

In this sense, the concepts of collective self-reliance and of TCDC are basically sound. Yet all depends, as usual, on the concrete realization of these concepts, i.e. on the institutions and policy instruments into which they are translated.

Up till now, South-South cooperation, on whatever level one might refer to it, is still a very marginal element in international relations. Nor do viable institutional set-ups exist which could promote and protect intra Third World cooperation.

This applies especially to international economic relations and even more so to the international division of scientific and innovative capacities. Take, for instance, the case of exports of industrial products: less than one third of the Third World's exports of industrial products are dedicated to other developing countries, and this share is declining still further. Or take the case of transfer of technology which still nearly exclusively consists of North-South arrangements. Only recently, a few private and state firms from socalled Newly Industrializing Countries (NICs) like

India, South Korea, Brazil, Argentina and Mexico have become involved as suppliers, but mainly as subcontractors within socalled triangular arrangements (35). Obviously, there is an urgent need for an increase of South-South cooperation. And, obviously too, the scope for such South-South cooperation is tremendous, as are the inherent conflict potentials, both with regard to South-South and with regard to North-South relations. Thus, any serious move towards increased South-South cooperation requires a concerted and hig level policy approach.

TCDC - a position of withdrawal rather than of progress

TCDC, the latest attempt to institutionalize South-South cooperation, is in my opinion a position of withdrawal rather than of progress. It is basically a defensive position which tries to consolidate some minimum requirements of global South-South cooperation and the countervailing (and still predominant) interests, especially of some major OECD-countries. Thus its potential for bringing about the necessary breakthrough to global South-South cooperation seems to be rather limited.

A brief look at post-war attempts to institutionalize South-South cooperation may clarify this point. Until the beginning of the Seventies, institutional set-ups of South-South cooperation were mainly restricted to regional free trade or common market schemes, accompanied by regional financing institutions. These schemes have been effectively subordinated, especially by Multinational Corporations, to their own worldwide and regional sourcing requirements and thus have only marginally increased the developing countries' cooperative potential (36).

After 1973, tendencies towards a global OPECization of countries exporting natural resources seemed to abound. Yet after the stalemate of the 1976 Paris North-South conference, there was definitely a retreat by most developing countries, even the most active proponents of the NIEO concept, to much softer and accommodating positions. It is as part of this withdrawal from NIEO related positions that the concept of TCDC was created, at the conferences of the Non-Aligned States at Colombo, 1976, and at the 1977 conference of the Group of 77 at Mexico City.

So, in contrast to conventional wisdom and the high expectations wordily articulated in countless resolutions of international conferences, I tend to be rather sceptical about the real potential of TCDC. This applies even more to the possibilities of realizing collective self-reliance.

Identifying the reformist potential of TCDC

In spite of its shortcomings and basic structural defects, TCDC could have a potential for certain "reformist" activities, which might help to mitigate some of the very negative effects of the present system of international transfer of technology.

One could argue that, given the present international set-up of economic, political and military power, TCDC is probably one of the few areas left where at least some isolated reformist changes might occur. The reform of the international patent system and attempts to establish a legally binding code of conduct on transfer of technology are hopelessly deadlocked. National policies to select and control technology imports have recently experienced significant drawbacks. In fact, on the "reformist front", there is not much choice left for most developing countries but to participate in TCDC. My personal position would be that any strategy to increase the collective self-reliance of developing countries should make use of trends prevailing in the political landscape anyway, trying to steer them in the "right" direction. So it should be asked under what conditions, for a period of transition at least and for certain restricted problem areas, TCDC, if carefully handled, could significantly increase South-South cooperation.

But let us first identify some essential elements of such a reformist approach to TCDC. These might include:

a) The etablishment of alternative networks of communication, whether institutionalized or informal. A selective delinking from the predominant networks of communication based in industrialized countries would in fact be a basic precondition for building up collective self-reliance-capabilities. Some activities have recently occurred in this field. Yet, viable alternative Third World networks of communication are still missing (37).

b) Cooperation with regard to the redirecting of the international brain drain to at least some South-South cooperative schemes.

   Much lip service has been recently paid to this point. But next to nothing has changed. Most parts of the Third World still even lack reliable subregional and regional "skilled manpower inventories". Viable bilateral of multilateral schemes for scientific and technological cooperation among developing countries do hardly exist. Furthermore, no effective provisions exist, which would guarantee that at least with regard to devising and implementing TCDC projets, Third World brain would be

given high priority. Instead, projects promoted for instance by the World Bank and the UNDP still require to use primarily engineering consultancy services from developed countries, be it for pre-investment studies, in the preparation of "tender bids", and for technical design (38).

c) Cooperation with regard to the strenghening of national and regional basic engineering capacities.

For instance, the establishment of highly specialized engineering capacities for certain priority areas presupposes that the relevant engineering teams will have a minimum size and will be able to work together for a long period. TCDC could help to secure economies of scale and the necessary continuity of orders.

d) Selective and planned cooperation with regard to pushing through alternative technology production routes, at least for some priority areas.

Examples abound: planned scaling-down, especially of resource-oriented industries; reduction in the degree of automation; increase of decentralization and changes in the organization of the labor process; and substitution of synthetics by locally available natural resources.

Furthermore, TCDC could be especially useful for the rediscovery and selective upgrading of traditonal technology.

e) Cooperation with regard to studies and preventive policy measures concerning the effects of major technological break-throughs realized in the OECD-region on the economic and social development and particularly on the scientific and technological self-reliance of developing countries (39).

f) Cooperation with regard to the conceptualization and implementation of alternative educational patterns and systems.

Presently, education systems are not only completely inadapted to development needs, but constitute in fact a major factor of dependence. Education should instead become a training place for self-reliance (40) TCDC could help to pool resources, draw together diverse experience, and facilitate some first attempts of selective delinking from prevailing "Western" educational systems.

Role of Industrialized Countries

According to the Kuwait Declaration on Technical Cooperation among Developing Countries, "TCDC should not relieve industrialized countries from discharging their

responsibilities towards the development of developing countries. On the contrary, industrialized countries should substantially increase their contribution to development and to the implementation of structural changes of the international system ... " (41).

What does this mean in concreto? Obviously, developing countries need a clear-cut conception of the role of industrialized countries, and especially of major OECD-countries, if TCDC is to become a viable instrument for increasing collective self-reliance capabilities of the Third World.

For instance, instead of asking for an indiscriminate proliferation of Western technology imports, developing countries should emphasize highly selective acquisition of strategic technologies with significant multiplier effects for increasing the developing countries' technological autonomy. One way of doing this consists of focusing on technologies for capital goods production related to the fulfilment of basic needs. In addition, one should emphasize that this implies the necessity to develop basic needs-oriented national engineering capacities and fundamental research. Without them, the local production of basic needs-oriented capital goods will easily be coopted and reintegrated into worldwide sourcing strategies of international capital.

To make this point more specific, I assume that the economically stronger OECD countries, and especially some of the socalled like-minded countries, will in the near future present new catalogues of incentives and pilot projects for TCDC. Governments of developing countries, before taking part in such projects, should, with due scepticism and care, identify those conditions under which they would not be roped into new forms of dependence.

For those of us living in the OECD-region, I personally think that it would be politically advisable to campaign for the expansion of such TCDC-assistance programs. Yet, we should always demand that it would be the developing country concerned which should have a direct say in their conceptualization and implementation. Furthermore, provisions should be included that new forms of democratic participation of the peasants and workers effected by these programs should be established and that identifying social needs must and can be done as a social learning process.

Another equally important point would be to reverse the prevailing trend towards new and more indirect forms of tied-in clauses of technical aid, prevailing for nearly all major OECD countries. We have already pointed out that

the World Bank and the UNDP have been especially keen to include such indirect forms of tying into most of their projects, including the socalled TCDC-related ones. To the best of my knowledge, TCDC programs sponsored by OECD-countries make use of these very same informal mechanisms of tying (42). Obviously, TCDC projects based on implicit tied-in clauses are nothing but a new instrument of market penetration. Yet, it is hard to see how developing countries could succed in reducing their importance, given the increasing competition among major OECD-countries for world markets.

Evaluating the outcome of the Buenos Aires conference on TCDC

To enable developing countries to reap some of the benefits of TCDC's reformist potential, there is one basic precondition: the financial arrangements and the institutions established for TCDC should be effectively controlled by the developing country concerned.

Much of the controversy of the recent Buenos Aires conference (September 1978) revolved around who should control the "new intergovernmental machinery for reviewing TCDC activities" and the "new financial arrangements for TCDC activities" (43).

The conference was "successful" in the sense that it adopted, what is now called the Buenos Aires Plan of Action for promoting and implementing technical cooperation among developing countries, which recommends a number of reforms at national, regional and international levels, all aimed at improving the possibilities for technical cooperation - but only on a voluntary basis. The conference did avoid earmaking special funds for TCDC, and it did not set up a special TCDC agency. Instead, it left effective control of all TCDC-related activities in the hands of the United Nations Development Programme (UNDP) secretariat and to regular high level meetings of all states participating in the UNDP. This procedure means that voting powers will be determined by the financial contributions to the UNDP budget. Thus, despite the seemingly accommodating provision that all decisions should be made "in close consultation with the developing countries concerned", major OECD countries will effectively control most of the TCDC-related activities.

To sum up, TCDC within the institutional set-up, decided for it at the Buenos Aires conference, will not be very helpful for the strengthening of the collective self-reliance of developing countries. This conclusion applies,

even if one uses a very much watered down reformist concept of collective self-reliance. Thus, although TCDC is in itself a position of withdrawal from earlier concepts of how to bring about a new international economic order, even this minimum position of South-South cooperation will be effectively controlled by some major OECD-countries, and, to a lesser extent, by some OPEC- and by some so-called key countries of the Third World.

In fact TCDC in its presently adopted form may turn out to increase rather than decrease the hierarchization of North-South and South-South relations:

- New markets for technology exports and new worldwide and regional sourcing potentials, especially concerning lowcost brain available in the Third World, will be opened up to private capital located in the OECD-region (including now an increasing number of medium-size firms).
- Private capital, located in some OPEC and some key countries of the Third World, can expect to participate in this appropriation of new frontiers and global sourcing possibilities, albeit in a position of junior partners.
- Reform concepts in the national and regional context of developing countries, aimed at the selection and control of technology imports, and the strengthening of national and regional technological self-reliance, can be more easily coopted and controlled by the metropolitan countries.
- And, finally, the hierarchical nature of economic, political and military South-South relations will be further increased. At the same time, those few countries of the Third World, which are of economic and/or geopolitical importance to the "Atlantic Community" can be most effectively upgraded to and integrated into the currently evolving new international division of labor.

2.4. Reform Concepts at Crossroads: the Need for an Alternative Approach

Attempts to reform the "International Scientific and Technological Order" are clearly at the crossroads. I have indicated that the prospects of prevailing reform concepts are rather bleak, to say the least. None of the real issues of underdevelopment and domination have been touched by any of these concepts. This applies especially to the limitations imposed by the way in which science and technology are inserted into an increasingly hierarchical world order. Whatever well-meaning intentions may have

been behind the prevailing reform moves - at the level of implementation results are either dead-locked or turn out to be counterproductive (44).

This is not to deny that the "reformist front" has seen some advances, that some of these moves have been translated into institutions and funds and that new legitimization possibilities have been made available for using these very institutions and funds in a somewhat different way than before. Nor is it to deny that as part of these reformist moves an enormous amount of new information has been dug up concerning the mechanisms and effects of the present international scientific and technological order; and that bureaucrats and politicians from the Third World engaged in the international reform process could improve their bargaining techniques considerably.

But these are minor points compared to the real issues at stake:

- First, the tremendous and accelerating increase of underdevelopment, misery and exploitation of a majority of the world population urgently necessitates a concerted effort to apply science and technology effectively to development. Development must be understood as a process of radical economic, social and political transformation which would make possible significant improvements to the material and social welfare of the underprivileged. If solutions cannot be found rapidly, global conflict potentials might get out of control.
- Second, reform through international conferences might not be the appropriate method of action. In fact, evidence abounds that there has been a tacit consensus among power elites from North and South to use international conference technique as a device for coopting, diluting, diverting and ultimately denying movements for change. This is so because large international conferences, however "progressive" their agenda might be, still leave ultimate decision power in the hands of governments which, in most cases, are unlikely to give priority to the interests of the underprivileged. Furthermore, such meetings tend to exclude many of the people who could best identify problems and have the richest experience in confronting them.
- Third, the logic underlying the NIEO program has to be thoroughly reviewed. Obviously its effectiveness as a bargaining instrument has significantly declined, as a result of the increased crisis in the world economic system. Furthermore, the NIEO concept turned out to be insufficient to secure a minimum amount of "Third

World Solidarity" vis-à-vis the North. In fact, power elites in the Third World are increasingly becoming aware of this growing "dysfunctional nature" of the NIEO-program. The recent intensification of Third World countries' competition for privileged access to bilateral "industrial cooperation" with the US, the EEC and Japan is a case in point.

But more fundamentally, it must be asked whether the NIEO was ever conceived as an instrument to change in any substantial way the present international economic and political power relations. In fact, as some insiders to the NIEO bargaining process would argue, it might very well be counter-productive in that it seeks to straightjacket potential liberating forces (45).

- Fourth, the strengthening of scientific and technological self-reliance in developing countries and the effective application of science and technology for development require major socioeconomic and political transformations in the Third World. Furthermore, substantial changes are required in the structure of international power relations.

  This argument which is obviously true, but has been mostly neglected in prevailing reform discussions, should not be taken as an alibi for political apathy. Historical experience shows that what was once perceived as unlikely or even utopian, sometimes after only an extremely short period turns out to be everyday routine. So any attempt to devise an analytical framework for reformist policy action in the field of science and technology should not exclude "concrete utopia", such as, substantial changes in the international power structure. (Take, f.i., the recent events in Iran and their tremendous effects on international geopolitics and economic circuits!)

To conclude, it is obvious that Third World countries do not have much choice but to participate in the "international reformist game", with much concerted effort and aggressiveness. But such policies should be based on a much sounder analytical framework. There is an urgent need for a fresh approach to the conceptualization of such an analytical framework. This applies especially to the notion of technological dependence. This is what we are now turning to.

3. The Need for a Fresh Approach to the Conceptualization of Technological Dependence

There is obviously an urgent need for a fresh approach to the conceptualization of technological dependence and its dynamic relationship with underdevelopment and poverty. If we want to define realistic conditions of success for the effective application of "science and technology for development", we need to know much more about the motive forces behind technological dependence and their effects on development, accumulation and innovative capacities in the Third World.

More specifically, we need to identify those new global patterns of technological dominance dependence inherent in the internationalization of capital. This issue is of vital importance! From Chile to Mozambique, from Cuba to Vietnam (let alone the prospective future of Iran) it has always been the same sad story: After a political revolution, a developing country strives to get a strategy of transition towards a mode of economic and social development off the ground which stresses autonomy and the needs of the underprivileged. Sooner or later, the fact that science-based technology has to be imported on a significant scale, will have negative consequences for the scope of such "alternative" strategies. Clearly, technological dependence per se would not be that critical. The real issue is rather the effects of technological dependence, most of them indirect and long term, on the overall dependency and structural deformation of the Third World.

3.1. The Concept of Technology

Technology, as a product of science, fulfils a twofold function: it is a force of production, and an instrument of social control. In fact, technologies are in a sense the crystallization of specific historical modes to organize social relations. In short, I would define technology as the specific way in which labour and means of production are combined, to use knowledge for the appropriation of and change in one's material and social environment. In a class society, for instance, technology will be used to perpetuate power and privileges. The ruling elite, besides controlling and appropriating the economic surplus, cannot but exercise the strictest control over science-based technology.

Three levels of the application of technologies should be distinguished:

a. the process of production in a narrow sense, including all manufacturing activities from the exploitation of raw materials to the production of final consumption goods;
b. the process of production in a broad sense, including all phases from r&d, via the procurement of essential inputs and infrastructural preconditions for production, to marketing, finance and management decision-making;
c. all those social activities, which preserve the structure of a given society, i.e. namely political, economic, and military ones, including, for instance, preventive counter-insurgency.

Most contributions to the discussion on transfer of technology and technological dependence are restricted to a., though some might take up some aspects of b.. Yet to really understand the dynamics of technological dependence and their social effects, it is essential to take into account all three levels.

Basically, a technology is determined by the material conditions of the object which has to be processed, the final product, and the process of production which makes possible this metabolism. But this is only one aspect. Equally important are the nontechnical determinants of technology, i.e. its economic and social determinants:

- the strategy and organizational structure of the individual production entity, for instance a capitalist firm;
- the economic determinants of the social process of production, for instance profit-orientated allocation and use of the social surplus;
- the needs to protect and develop a hierarchical social system, for instance the preservation of unequal access to economic surplus.

Surely technological progress means first and foremost: improvement of the means of controlling one's material environment. Through this, technological progress allows for the growth of productivity of a society's productive forces. This is one very important side of the coin. But there is still a second function of technological progress. The history of sciences shows that, the well-meaning intentions of inventors and scientists notwithstanding, technological development has been mostly used for establishing new and more efficient forms of dominance, the safeguarding of hierarchical structures and the deployment of more intensive forms of social control. This begins in the very process of production itself by segregating the labour force from the productive means and by the parallel separation of manual and mental labour. One does

not have to quote Frederick Taylor to illustrate this aspect of technological development, any reading of magazines like Business Week will show the same. Technological development aims at increasing labour productivity and labour intensity and at improving the possibilities of "scientific management". This aspect of technological development is even further stressed by modern management techniques. Indeed one of the main preconditions of the worldwide commercialization of goods, means of production and technologies has been the fact that through this kind of technological development new methods and organizational techniques have been developed in the highly developed capitalist states, which enables them to control the surplus resulting form these worldwide transfers.

The development of technologies doesn't take place in a vacuum. It is the result of a specific historical mode of accumulation. In other words, each historical mode of accumulation requires a specific mode to produce and supply technologies, its dominant technology system. A technology system will be dominant, if it fits some basic material characteristics of the mode of accumulation and the class structure and patterns of state intervention underlying it. On the other hand, those technology systems which happen to be ineffectual or even counter-productive to the development of a historical mode of accumulation, will be displaced and suppressed. This is exactly what is happening today in developing countries to the socalled "traditional" or "pre-capitalistic" technologies.

The dominant technology systems of today are the result of a specific historical mode of accumulation, as it has developed since 1945, first in the U.S., then, during the 1960s, in Western Europe and Japan.

Basically, this mode of accumulation displays four major "material" characteristics:

a) The growing importance of the "Petroeconomy", defined in a broad sense, with regard to overall productive activities.
b) The progressive separation of manual and mental labour in the very process of production itself. This separation of manual and mental labour strongly affects the way in which science and technology are produced and used for accumulation and social development. In fact, it has two highly interrelated effects. On the one hand it leads to a progressive deskilling of a majority of the labour force. On the other, it leads to a growing centralization of control over knowledge ("software") by "think tanks", engineering firms, and central management headquarters.

c) A progressive computerization and automation, not only of manufacturing techniques (the proliferation of continuous production processes), but including distribution, services, r&d, and "social engineering technologies".
d) Excessive consumption of energy and highly capital-intensive and centralized modes of energy provision.

Simultaneously, this mode of accumulation is based on a certain way of organizing social relations, which boils down to the fact that the economic surplus is controlled and appropriated by a small minority. Furthermore, it presupposes a certain class structure and certain ways of organizing the state.

Thus, "modern" science-based technologies, like any other technology, are the product of a social process of production. At the same time they are a product of the social relations within which they are developed and utilized. These limitations should be taken into account by governments and planning institutions of developing countries when they are talking about access to "modern" technologies. Some of the far-reaching expectations concerning the import of Western technology may turn out to be just a new variety of a "development myth". Technologies, which, in the context of Western industrialized countries, might be rightfully termed "modern" or "key" technologies, may not be the best choice for a developing country's policy to optimize national accumulative potential and the fulfilment of basic needs. Worse still, evidence abounds that the import of Western "modern" technologies can have extremely retrogressive effects on both these aims.

To sum up, technology is more than the sum of techniques applied in the process of production. Technology is obviously a strategic factor at all levels of economic and social development. Especially today, technology has become a major instrument of domination. This applies both to power relations within a society and to international relations, especially to the North-South context (46).

3.2. The Dynamics of Technological Dependence

Technological dependence (TD) today, in a majority of developing countries, constitutes a major element of their deformed economic and social development. The key to understanding TD is to analyse it as part of the overall dependency characterizing Third World societies. There is a certain ambivalence in using concepts like technological dependence or technological dominance. It should be clear that this does

not imply that other levels of the dependence/dominance relationship do not exist. On the contrary! The decline of some classical instruments of domination notwithstanding, there is no doubt that a great and increasing variety of very efficient instruments for global and regional domination does exist, especially vis-à-vis developing countries. This applies, to finance, marketing and control of prices, production logistics, strategy and organizational structure and consumption patterns - and also to certain social techniques and institutions dedicated to the legitimization and reproduction of political systems and class structure, including preventive counterinsurgency, political destabilization and, if need be, modern-style "gunboat diplomacy".

What it does imply is that there might be some sense in singling out that specific variety of the dependence/dominance relationship, related to technology, if only because, of late, technology has gained considerable ground as an instrument of control and domination, in relation, for instance, to trade and monetary pressures or military intervention. In this sense, TD may rightfully be termed a crucial determinant of the scope of development strategies.

Let us now take a closer look at some specific characteristics of TD. A country, or more generally, any economic entity (be it a region, commune or an industrial plant) may be called technologically dependent under three conditions:

- it needs to import technology;
- it needs to import the capacity to utilize and apply the imported technology, and, finally,
- it is incapable of adapting, reproducing and improving the technologies received in an autonomous way.

Yet it is important not to rely exclusively on descriptive definitions of TD, but to uncover some of the roots underlying this phenomenon. In fact, TD means there exists a structural gap between social technology needs and technology supply. Social technology needs are to be derived from the requirements of a development strategy which aims at the optimization of three goals: utmost fulfilment of needs for a majority of the population; utmost use of local resources and long-term increase of accumulation potential.

But this is only one aspect of the problem. What has to be explained, is: Why does a country not mobilize without delay all its resources and social energies to overcome this very gap, and why would it not be able to count on really helpful external assistance?

When the obvious solution is not applied, there must be some basic reason, or, in other words, some structural

constraints. I would propose to look at three of them.

First, developing countries are in fact confronted with a situation which could only be adequately described as one of an overwhelming technological dominance. That is, the knowledge which is needed to overcome the aforementioned gap, to develop new technologies, to disseminate them and to make productive use of them is concentrated within a few private and public r&d-centres, which are predomiantly located in major OECD-countries. Thus, any serious attempt on the part of a developing country to increase "national technological capacities" will, almost invariably, be confronted with significant external constraints.

Second, TD reflects some basic structural deformations pertaining to a developing country's forces of production. This applies specifically to its scientific, innovative and learning capacities and to their integration into the overall process of the country's social and economic development. In other words, the key elements of a developing country's capacity to gett off the ground an increasingly endogenous industrial sector, such as r&d-capacities, engineering activities, educational systems and its capacity to produce capital goods, are undergoing a process of progressive disintegration. Developing countries are in fact what Sagasti has aptly called societies with an exogenous scientific and technological base (47), i.e. societies in which knowledge-generating activity is not related in any significant way to productive activities. This basic structural deficiency in the production forces of developing countries has by now received extensive empirical documentation (48).

Some progress has also been recently made in operationalizing these concepts (49). For instance, we now know that we have to specify the criterion of "structural incapacity to produce capital goods" and that we should pay specific attention to three product groups: capital goods for the production of capital goods, especially machine tools; machinery for producing agricultural implements and textile machinery; and capital goods used in the production of basic materials and intermediates. We also know now that, with regard to linking local r&d-potential to productive use, the simple proliferation of esoteric scientific and research communities is insufficient. Much more important are, for instance:

- Well integrated and experienced laboratory teams;
- scientific and technical management cadres trained to apply social cost-benefit criteria;
- an "appropriately" qualified labour force, i.e. workers who would be neither overskilled in the sense of being

highly specialized watchdogs of "automated factories" nor deskilled in the sense of having been deprived of certain general-purpose skills, such as welding;
- clear priorities concerning the allocation of scarce skills (priority candidates would be the aforementioned capital goods branches);
- and finally, the selective recovery and upgrading of "traditional" innovative capacities, if these have not already been destroyed by the pentration of foreign technology.

Third, TD is an outcome of certain basic deformations in the class structure and the political systems prevailing in developing countries. This applies not only as a description of a historical relationship. It also applies to the fact that social and political constraints internal to developing countries have very significant obstructive effects on present policies to overcome technological dependence. It is this internal constraint which has been given the least attention in attempts to analyse the dynamics of technological dependence.

So we have four essential elements of a definition of technological dependence: the gap between social technology needs and technological supply; external constraints for policies to overcome technological dependence; basic structural deformations of productive forces and innovative capacities; and internal social and political constraints. In what follows, I shall focus mainly on the second point (50).

Before I do, let me add three essential requirements for any attempt to identify in an operational manner a developing country's TD:

a) It is not insufficient scientific-technological capacity per se which is the real problem, but the almost complete lack of autonomy about even very basic decisions concerning technologies which are employed as part of a "national" development plan. This applies both to decisions on what kind of technologies will be needed for development, and to decisions on what sources of supply should be tapped to fulfil these technology requirements.

b) It is within a society that the technological needs for development have to be defined, with regard to both the optimum use of local resources and the utmost fulfilment of basic needs. The identification of all the manifestations of a society's technological dependence has to take place as a social learning process, giving adequate

participation to those directly affected by technological dependence. Only then can effective control of technological dependence become a realistic aim.

This involves some very harsh decisions about priorities and the establishment of institutions and political instruments to fight for that long and painful internal social transformation, which is the only reliable basis for achieving technological self-reliance. The concept of "Technological Self-Reliance" should cover two aspects:

- the ability to generate, adapt and use technological systems relevant for meeting social technology needs;
- the ability to choose and control the areas of partial technological dependence, which, in any country, will remain unavoidable for many years to come.

c) Attempts to diagnose TD and policies to overcome it should be based on a systematic review of branch- and product-specific patterns of TD, especially in priority sectors. Forms, mechanisms, and growth patterns of TD should be differentiated accordingly. This may help to neutralize to some extent a major dilemma for technology policies in developing countries: wether to opt for maximum growth of industrial output, nearly always accompanied by large-scale imports of foreign technology and "upgrading" of local means of production and class structure to the "needs" of these foreign technologies; or whether to focus on decision autonomy in the sense defined above, which, as long as applied indiscriminately to all or most sectors of the economy, would be bound to fail. Thus, the differentiation of branch and product specific criteria for TD enables a developing country to identify the priority sectors for selective technological delinking form the world market, which, under the given conditions, may be the only realistic approach to overcome TD (51).

3.3. The Dialectics of Technological Dependence and Technological Dominance

Technological Dependence in developing countries is the result of the very asymmetric distribution of control over both inputs and outputs of research, development & engineering activities on a global scale. Developing countries are in fact confronted with a situation which can only be adequately described as one of overwhelming technological dominance.

That is, the major elements necessary to generate, distribute and make productive use of technologies are highly concentrated within a few private and governmental r&d-centres, located predominantly in the major OECD-countries. This relates to:

- Basic research and innovative capacities. Especially in this field, public "think tanks" such as the Rand Corporation, the MIT, the Stanford Research Institute, the Denver Research Institute, the Battelle Institute, or the Fraunhofergesellschaft, play a major role. In this context, the term "public" is rather misleading. One should talk of institutions, which are financed out of tax funds, but whose results are available only to certain specific segments of the "public".
- The avantgarde technologies. It is noteworthy that especially in this field there is a clear predominance of firms which have gained their technological lead mostly out of militarily orientated r&d, for instance: the Lockheed Missiles and Space Co. in Sunnyvale/ California, a daughter of the Lockheed Corporation, in the field of new technologies for seabed mining, especially with regard to manganese nodules; or the Industrieal Products Division of the Hughes Aircraft Co. involved in developing laser-directed industrial automation systems; or, finally, the MBB Ottobrunn of the Federal Republic of Germany in new technologies of public transport.
- The socalled "technological building blocks", especially semiconductor-technology. Although, in terms of value and weight, such technological building blocks are usually only a minor part of the technology systems into which they are integrated, they are in fact the really decisive elements. Consequently, there can be no effective control of process and product technologies, as long as one does not control these technological building blocks.
- The information systems for worldwide screening and tapping of scientific-technological developments and for feedbacks concerning production experience. Besides the relevant information systems of Multinational Corporations, Banks, and Engineering Consultancy Firms (see, for instance, Control Data Worldtech Inc., known as a "technology exchange service" of the Control Data Corporation), it is again public information systems and data banks which play an important role. A case in point would be the U.S. Air Force Systems Command,

which, according to its own statements, maintains probably the most complete information system on innovations and innovative potentials in the field of electronics. Compared, for instance, with the contents of such an information system, it is hard to see how the Industrial Information System, presently prepared within UNIDO's Industrial Documentation Unit, will be able to play more than a marginal role.

- Basic engineering activities, especially process engineering and equipment design. The rapidly expanding world markets for these activities are increasingly under the tight control of a handful of private firms. US-firms are dominant, such as A.D. Little, J. Diebold Assoc., Fluor Co., Stone and Webster, Bechtel, Austin, Kaiser, to name but the most important ones.
- Finally, the manifold techniques to solve problems of worldwide logistics, maintenance, and marketing.

Research and development expenditures

To give some very rough illustrations of the overall pattern of technological dominance, let me start with the global distribution of r&d expenditures. Recent figures (socialist countries excluded) indicate that a certain multipolarization of technological dominance has taken place since the middle of the 1960s. Yet this relates almost exclusively to some effects of redistribution among highly industrialized capitalist countries. The developing countries' share of world r&d-spending, which was 2 % in 1963/64, has only increased to 2.8 %. It is thus safe to say that, for developing countries as a whole, the very asymmetric distribution of innovative capacities has not significantly changed during the last 10 years (52).

Indeed these statistical indicators may significantly overestimate the innovative capacities available to governments of developing countries. Figures relating to the distribution of r&d-spending, impressive as they may be, only give a partial picture of the prevailing pattern of overall technological dominance. Thus, one should ask: What are the functions of those local r&d-activities which are being financed out of the 2.8 %-share of overall r&d-expenditures? And, if there is in fact some socially valuable output of r&d-expenditures, under what conditions could one talk of innovative capacities as being "accessible" to governments of developing countries?

In this context, three points need consideration:

- A great part of developing countries' r&d takes place without any significant link to productive activities

located there. That is, a great part of what, according to statistics, are r&d-expenditures, are in fact consumptive expenditures.

- Those of the developing countries' r&d-activities, which are in one way or another related to productive purposes, have been, in most cases, effectively screened and absorbed by the worldwide networks for tracking profitable innovations mentioned above.
- In many developing countries up to 50 % of officially documented r&d-expenditures are related to military and police purposes, i.e., to a very high degree they are nothing but marketing subsidies for some Western armaments firms.

Any meaningful interpretation of the distribution of r&d-spending should be combined with an analysis of the significant and increasingly perverse transfer of financial means from developing to industrialized capitalist countries, which is embodied in growing debt payments and deterioriating terms of trade. These payments are closely linked to the developing countries' increased imports of technology. Thus not only do developing countries have extremely limited access to overall innovative capacities, but they are actively funding r&d-activities of the metropolitan countries, thus increasing technological dominance.

Capital goods production (53)

In 1970, around 61 % of the world production of capital goods accrued to industrialized capitalist countries, around 36 % to the socialist countries of Eastern Europe. In the same year, developing countries produced 3.18 %, roughly the same part of world production as in 1963 (2.89 %). The bulk of this very low volume of developing countries' capital goods production is concentrated in a small number of countries: India, Brazil, Argentina, Mexico, South Korea - Algeria and Iran are examples of recent newcomers to this group. In 1970, only 3 countries (India, Brazil and Argentina) were more than 80 % self-sufficient with regard to engineering products (54). With regard to machine tools, a key element of any capital goods production, only 4 countries (Argentina, Brazil, India and Mexico) have significant levels of production. The world market for machine tools is dominated by West German and US firms. The growing submarket for NC (= numerical control) machine tools, or, more generally, for 'automated factories' is first and foremost controlled by US firms, followed by Japanese and West German firms (55).

The growing automatization of industrial production has one Achilles heal, i.e. the production of electronic components, and, more specifically, the semi conductor-technology. In 1976, US firms controlled around 75 % of the market for integrated circuits, whereas some 10 years ago their part was only around 55 %. Thus, one might even discern a tendency towards increased technological dominance of US firms, at least in this strategic sector. The US-trade balance on technology-intensive products may be another case in point. Since 1956, it has never been negative. The lowest surplus was 6.6. bio $; in 1973 the surplus was 10.7 bio $, 1974 19.2 bio $ and, finally in 1975 it reached 24 bio $ (56).

The control of these 'technological building blocks' enables those firms to force restrictions upon developing countries which are embodied in the transferred technologies themselves and which prevent the technology-receiver form reproducing, let alone further developing these technologies by means of 'prototype copying', 'reverse engineering' and 'selective technical upgrading'.

Technology-embodied restrictions

Four categories of these technology-embodied restrictions can be distinguished:

a) adaptation to Multinational Corporations' global industrial standards restricts the possibilities of adaptation to local conditions;
b) planned diversification and obsolescence of all products transferred, including turnkey plants, subsystems, machinery, intermediates and spare parts;
c) maintenance and repair techniques that make an overhaul of the imported machinery impossible or at least extremely costly withouth using the company's maintenance and repair manuals or computerized maintenance information systems; and
d) planned technological indivisibility as a result of the transfer of technologies within a package.

This last point is of increasing importance. Packages consist of main components (to take the example of the Green Revolution, miracle grains) and of complementary inputs (for instance, fertilizers, insecticides, pesticides, irrigation systems, pumps, etc.). Without these inputs, the package cannot function. A package consists of a combination of mutually dependent innovations and improvements that are, for all practical purposes, indivisible or could be divided only at a very high cost. Thus, sellers of a package are in a very favorable position to make themselves irreplaceable for a long time.

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Control of technology life cycles

Another essential element of technological dominance is the almost complete control, by a handful of private firms, of the life cycles of most of the technologically relevant industrial products and processes. This control is used by these firms as a major instrument of oligopolistic competition, by skillfully devising optimum time pattern for obsolescence. This makes any attempt on the part of a developing country to reach technological autonomy by importing such oligopolistically controlled technology a truly Herculean task. For the developing country may try its best to acquire operational capacity, then to proceed to reproductive capacity, and, finally, to reach improvement capacity. Once it tries to enter the world market with its "own new technology", it will immediately find out that it has already been surpassed by the original technology-exporter's new technology.

Control over basic engineering

Finally, technological dominance is decisively determined by the strict control of process engineering and equipment design, access to information systems and control of technical standards. Again, US firms and public institutions dominate these fields. For instance, even the French firm Technicatome, for the formulation of a feasibility study on the commercial export of nuclear power stations, preferred with good reasons to call for the assistance of the US engineering firm Bechtel.

Concerning avantgarde technologies (nuclear energy and alternative energy resources; exploitation of low grade ores; oceanography; public transport etc.) it seems as if the die is already cast for an even further intensification of technological dominance. The same applies to one field of avantgarde technology which is in fact taboo in most of the discussions on science and technology for development: the military technologies.

Thus, the technological dependence of developing countries corresponds to the technological dominance of a handful of highly developed market economies. Technological dependence and technological dominance are in fact closely interrelated processes. Any meaningful analysis of the technological dependence of developing countries, especially with regard to strategies to overcome technological dependence, presupposes a thorough analysis of the causes, effects and protective mechanisms of technological dominance.

3.4. Identifying New Forms of Technological Dependence and Dominance

New forms of the internationalization of capital, such as offshore sourcing or worldmarket-subcontracting in components, certain basic industries and even engineering consultancy and equipment production have led to new forms of technological dependence and new forms of technological dominance. Both have considerable negative consequences for the room to manoeuvre of strategies to overcome technological dependence in developing countries.

To take but one example: the progressive computerization and automation of the machine tools industry, which applies not only to manufacturing techniques in a narrow sense, but also to r&d-activities, engineering, maintenance and marketing. This progressive computerization and automation has already produced significant changes on three levels:

- The contents of the technical coefficients of intraindustry-linkages is changing considerably, i.e. industries or subgroups of industries, which until now might have played a strategic role in progressive industrialization, are now loosing this specific quality.
- The preconditions for and elements of effective control over technology are also changing considerably. For instance, in an increasing number of cases, control of the "technological building blocks", i.e. some tiny electronic devices, will secure effective control over both process and product technology. This opens up new possibilities for worldwide schemes of "planned obsolescence" as the most subtle instruments of effective control over innovation and accumulation capacities.
- The forms and contents of the working process, not only in manufacturing itself, but also in laboratories, engineering departments and marketing divisions, are already undergoing significant changes. This applies, for instance, to the division and contents of tasks and job specifications, and specifically to skill requirements.

Or conside the growing importance of maintenance for TD. According to one expert in this field (57), maintenance services related to package transfers (for instance, turnkey or product-in-hand plants) are rapidly becoming the key element in devising new patterns of planned obsolescence. To be more precise: We are not talking primarily of repair of accidential breakdowns nor of preventive maintenance, required at regular intervals in the life cycle of a piece of equipment. The real issue is corrective

maintenance. Corrective maintenance is defined as including all measures to counteract abrasion and wear of components. Abrasion is a normal part of a component's life cycle, the extent of it depends on its age and the way it is used. During the first years the variations are minor, but increase later on. The wear of a single component usually has little influence on the proper functioning of the equipment, but if a number of components showing wear are combined, they may cause technical changes in the plant as a whole, resulting, inter alia, in:

- variations in the product qualitiy;
- increased consumption of energy or raw materials;
- increased refuse;
- reduced security of the working place.

Corrective maintenance is a highly complicated matter and demands perfect knowledge of the process used. For instance, it may be necessary to reprogram a process computer, or work out new rules for the regulation of cycle. Now, as Bennaceur and others (58) have shown, maintenance contracts concluded with suppliers of turnkey plants usually cover only one or two years of operation. When the training and maintenance personnel is provided, contracts invariably exclude corrective maintenance. Another aspect of this same phenomenon is that a growing number of MNCs now have at their disposal globally mobile "trouble shooting" flying squads which can be called to any industrial site around the globe at extremely short notice (59). Such developments have already produced new and qualitatively intensified forms of technological dependence. However, there is still almost complete lack of perception of these new forms of technological dependence and their very negative economic and social consequences, especially for the majority of the developing countries' population.

The ever growing proliferation of technologies into the Third World during the last 20 odd years has in fact led to a qualitative intensification of the gap between social technological requirements and technological supply. Worse still, the local capacity to control or reduce this gap may have even significantly declined. Let us take an example of complex mechanical engineering, the development and production of aircraft. Even if a country can produce locally 70 and more percent of the overall value added, the decisive bottleneck for technological self-reliance would still exist: the inability to produce (develop/test/repair & maintain) the main parts of the system, i.e. engines, high quality steel and alloys and avionics. So even such

a country which may be able to produce all of the frame (which in itself requires a lot of precise metal working and machinery building skills) may still find itself completely dependent on external decisions with regard to the concrete forms and conditions of aircraft production and sale. It is this kind of technological dependence which I would call technological dependence on a qualitatively higher level. It is qualitatively higher, first because to build up the facilities for airframe production and related complementary production facilities (including, for instance, aluminium smelting and milling facilities) and infrastructure cost the country a lot in terms of scarce resources being absorbed into it. And secondly, because this establishing of highly complex production facilities, far from widening the room of manoeuvre for economic decision-making, may increase vulnerability to external decisions. Any interruption of imports of some strategic components would leave the existing production capacities idle and would dramatically add to the waste of scarce resources. Let us even assume that after some years the country can run this production line on its own (an assumption which even in the case of India and Brazil did not materialize!). Still this country would definitely be unable to maintain, let alone reproduce this plant without "external aid". Cum grano salis, the results won't be different for other branches of mechanical engineering.

The most obvious manifestation of this qualitative intensification of TD is the increasing perfection of the "system character" of technology exports. All major technology elements necessary for the realization of a given project, are increasingly tied up into one package deal, from the pre-investment study to the final acceptance of the production unit, including in many cases long term contracts regarding maintenance and repair, supply of essential inputs and "technological building blocks", and marketing. The main effect for the technology-importing country is that the network of technology dependence relationships, induced by these package imports, gets more and more complex and obscure. In many cases the foreign main contractor deliberately maintains a monopoly of understanding and control of the complicated agreements between the various firms involved and the complex channels and mechanisms necessary to realize them. Recently, new types of contracts for the procurement of ready made production units - from "turnkey production units" to "product-in-hand" or to "turnkey market" contracts - have further

obscured the technological dependence-relations induced by the technology package transfer. A very good example has been Abtellatif Benachenhou's case study on turnkey and product in hand contracts in Algeria (60).

Worldwide sourcing and the concomitant tendency towards increased global intrafirm transfers not only make possible but simultaneously make necessary an ever increasing intensity of control. I have already stressed this tendency towards increased cumulative hierarchical control. The close relationship between the internationalization of capital and the growing need for MNCs and some national and international public institutions mainly controlled by OECD countries to conceive ever more far-reaching global control mechanisms, especially with regard to strategic sectors, such as innovative capacities, etc. is in fact one of the more salient aspects of the presently evolving new international division of labour.

Strategies to overcome technological dependence in developing countries should explicitly take into account the new forms of technological dependence and technological dominance described above. Unfortunately, most of the concepts presently available about strategies to overcome technological dependence fail to do exactly this. Thus, they may produce just another form of partial strategy with all the inherent dangers of rising misery, frustration and conflict potential (61).

3.5. Technological Dependence and Capacity to Accumulate

TD has significant negative effects, at least during a certain period of transition, on policies to increase the long-term accumulation potential and to improve social equity. I will focus here only on the accumulation issue and will deal with the social equity issue in chapter V. However let me first add one qualification: TD per se is clearly not the essential impediment to such policies. But it definitely opens up new inroads for an increase of overall dependency, thus considerably decreasing the room to manoeuvre for autonomous development strategies.

TD has very negative consequences for the capacity to accumulate of developing countries. Obviously, as long as a country has to import most of the means of producing goods, including whole plants, any attempt to substitute imports, especially capital goods and intermediates, will, of necessity, lead to large-scale follow-on imports,

i.e. negative import substitution. But that is only the tip of the iceberg. There are more fundamental, yet "low-profile" built-in mechanisms for draining off scarce foreign exchange, such as:

(1) The nearly complete dependence on basic engineering activities, especially on design engineering and equipment design. One example is Algeria, a country which, at least according to its own pretensions, has been following a consistent policy to strengthen national technological capacities. There, in the period 1970-73, Algerian firms carried out the engineering activities in only 4 % of all industrial projects (62). With the accelerated rate of plant procurement since 1974, it is safe to assume that this 4 % mark might have fallen still further.

(2) The far-reaching dependence on maintenance and repair of imported machinery and "turnkey" plants. This applies especially to "corrective maintenance" and "trouble shooting", i.e. the capacity to react quickly and at lowest cost to unforeseen disturbances in the production process.

(3) The nearly complete dependence on access to information systems storing the bulk of new technological knowledge and feedbacks on production experience.

Add to this the rich opportunities, available to suppliers of technology, for transfer pricing, which, for the receiver country, means a significant overpricing of technologies supplied. Thus, TD may not only be instrumental in reducing import capacity and in worsening the receiver country's terms of trade, but, in addition, may cause high monetary instability and depreciation of local resources, as a result of the price inflation embodied in imported technology inputs. There is an obvious circularity here: to expand technology imports (which are deemed essential for "upgrading" the economy towards world market conditions), developing countries must increase their exports; to expand their exports, developing countries must further increase their technology imports, and so on ... .

Of much greater importance are those deformations of a developing country's accumulative potential, resulting from TD, which may in fact prevail for a very long time. True, countries with sufficient 'political stability' and 'resource endowment' (including natural resources, infrastructure and humanware) may nowadays experience an oversupply of technologies. To some extent this may even include technologies of a very high complexity, which may

superficially be conceived as an indicator that the country has access to key technologies. In a growing number of developing countries there are also first signs of expanding 'localized' r&d-capacities, i.e. test-, standardization- and engineering-activities transferred over from MNCs' central or regional headquaters. Yet, one crucial problem remains: the control of the strategic elements of the overall economic circuit and especially of the industrial sector, the socalled technical coefficients of interindustrial relations. Dependence on imports of, inter alia, machine tools, machinery to produce agricultural implements, equipment for the basic goods industry and core engineering-activities means that decisions with regard to investment allocation and the organization of the production processes will be subordinated to external control. That is, even the most basic precondition for national control over capital accumulation will be absent as a result of TD. To give but one example: Suppliers of machine tools have been pursuing for some time now a policy of worldwide proliferation of computerized manufacturing techniques, which from their point of view, i.e. with regard to the optimization of their product life cycles, might be called functional. However in view of the already extremely alarming levels of unemployment and 'marginalization' prevailing in developing countries, this policy might indeed have disastrous consequences.

But how would a country which nearly completely depends on machine tool imports and which sticks to the predominant world market orientation of its productive activities, be able to resist such a policy? True, there exists an option of bringing in 'outsider' firms, thus trying to diversify dependence. Candidates for such alternative procurement sources could be found in socialist countries or even in some of the socalled Newly Industrialzing Countries, like, for example, India. These firms produce predominantly non-computerized machine tools and have a significant surplus available for export. It might be safe to assume that at least a certain number of such firms have not already been integrated into worldwide sourcing and cooperation schemes of MNCs. Nevertheless, developing countries have only marginally made use of this option, probably out of fear to loose potential benefits in terms of worldmarket competitiveness, expected from using NC-machine tools. Under such conditions, attempts to reform technology policies will, of necessity, be reduced to the mere adaptation of local productive forces and class structure to the requirements of imported technology. Thus, developing

countries may have chosen in fact the worst of all worlds: growing misery and exploitation of their population without any real chance to improve accumulative capacities.

References

Introduction

1 I am drawing heavily on experience as a consultant for international organizations and on research done for the German Society of Peace and Conflict Research (DGFK).

2 In fact, the main focus of this volume is on the international context, i.e. on the effects of some recent changes in the international division of labour on the mode of application of science and technology in developing countries.

3 This aspect will be specifically taken up in chapter V which focuses on the search for new approaches.

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20 Note that I am not talking about linkage potentials defined in the strict Hirschmanian sense, see A. O. Hirschmann - "The Strategy of Economic Development", Yale University Press, New Haven, 1958. My point is somewhat more specific and relates to the non-existence of durable learning effects and spin-offs. Take, for instance, the case of infrastructural investment. Clearly, this type of growth pole is supposed to have a relatively high linkage potential to the developing country's overall production system. Yet there is no doubt that as long as most of the machines, know-how and organizational techniques are imported, learning effects and spin-offs to be derived from these imported technologies will remain low. See, for instance, evidence presented on the experience of OPEC-countries in: Anton Gälli - "Die sozioökonomische Entwicklung der OPEC-Staaten", Ifo-Studien zur Entwicklungsforschung, München, 1979, Chapter I.

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51 For attempts to operationalize the concepts of "Technological Self-Reliance" and "Selective Technological Delinking", see chapter V

52 The exact figures and further details are given in Jan Annerstedt's contribution to chapter II

53 For further details, see the contributions of Bennaçeur, Gèze, Malkin, and Tiberghien in this volume

54 Self-sufficiency being defined as consumption/output plus imports minus exports

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CONSEQUENCES FOR NATIONAL POLICIES TO STRENGTHEN TECHNOLOGICAL SELF-RELIANCE: RESEARCH PRIORITIES AND ISSUES FOR DEBATE

by

Dieter Ernst

Let us now draw together the different threads of an alternative research and policy approach to the issue of science and technology for development.

In this book we have gone a long way in identifying the main problems and areas of conflict. We have also highlighted the most urgent research deficits. Furthermore, a lot of evidence has been compiled which might help to challenge and dismantle some of the new development myths inherent in the concept of "Science and Technology for Development". This applies especially to the concept of "Appropriate Technology", to some myths surrounding the concept of "Strengthening National Scientific and Technological Capabilities", and to some of the very high expectations concerning "Access to High Technologies", and "Policies to Strengthen the Self-Reliance of National Capital Goods Production and Engineering Capacities".

The sector- and country-specific case studies and the papers attempting a synthesis have thus set the stage for a fresh approach towards a systematic screening and operationalization of new approaches. But this is only a beginning. For instance, the concepts of "Technological Self-Reliance" and "Selective Technological Delinking", which are essential to such an alternative concept, still lack sufficient clarity. The same applies, to operational criteria for identifying and redefining

- a basic matrix of goals and instruments;
- criteria of success for self-reliant industrialization strategies;
- branch- and product-specific patterns of technological dominance/technological dependence, which is an essential precondition for identifying and pushing through alternative "technology production routes", and
- the concepts of TCDC and Collective Self-Reliance.

Finally, and most importantly, these shortcomings apply to the attempts, presented in this book, to identify conditions of success for the application of science and technology for development, especially regarding strategies and tactics for the period of transition.

By way of concluding this collective endeavour on the new international division of labour, technology and underdevelopment, I will focus on three points:

- self-reliance requires selective technological delinking;
- key development objectives and priority areas for science and technology should be closely interlinked;
- conditions of success, especially with regard to identifying carriers of the strategy and timing, should be clearly spelled out.

Finally I will present a catalogue of concrete research proposals and issues for debate which will, I hope, contribute to a new appreciation of the real problem areas for follow-on activities after UNCSTD and similar conferences.

1. No Self-Reliance without Selective Technological Delinking

We have seen that international transfer of technology, left to the laws of oligopolistic competition, has led on a global scale to a further increase of the already very asymmetric distribution of control over research, development and engineering. The hierarchization of North-South, but also of South-South relations has thus been further increased, with all the negative implications for underdevelopment, misery and global conflict potential.

Technological dependence is a dynamic process which has recently gained increasing weight as an obstacle to strategies of transition towards self-reliance. In other words, without a comprehensive and coherent national science and technology policy, designed as an integral part of the national plan, there will be no self-reliant development. Obviously, research and policy activities related to the identification of priorities for the application of science and technology to development are of utmost importance. But what kind of development is meant and how to identify socially relevant scientific and technological priority areas? (1)

Before talking about priorities we should keep in mind one basic precondition for the application of science and technology to development, i.e. the effective control by developing countries' governments or other public institutions of science

and technology, especially with regard to identifying and pushing through urgently needed "alternative technology systems".
As a result of centuries of externally-geared underdevelopment, most developing countries today need technology imports if they want to increase output, productivity and their long-term development potential. The crucial problem is how to prevent the process of importing foreign technology on a significant scale leading to a qualitative intensification of dependence. This clearly implies the necessity to internalize the technology issue as part of an autonomous decision-making process by means of selective technological delinking and by defining priority areas for technological self-reliance.

In addition to what has been said before, five points need to be specifically stressed:

a) Instead of asking for an indiscriminate proliferation of Western technology imports, emphasis should be placed on selective acquisition of strategic technologies with significant multiplier effects for increasing self-reliance. This is in fact the essence of what I would call "selective technological delinking". One way of doing this is by focussing on technologies for capital goods production related to the fulfilment of basic needs. This implies a priority for technologies needed for capital goods producing basic needs products and for capital goods needed in downstream activities on local resources. In fact, selective acquisition of technologies necessary for an increasing integration of national resource use and the fulfilment of basic needs constitutes an essential element of policies to strengthen national technological self-reliance. Take for instance a developing country which is well endowed with natural gas and iron ore but does not have coking coal. In such a country, a policy basing the development of its steel industry on the technology system: "Automatic classic blast furnace based on coke" might rightfully be called an extreme form of resource waste. Instead, the best approach would be to combine the technique of "direct reduction" with miniaturization of plant size. The negative consequences for self-reliance and development of an indiscriminate proliferation of Western technology imports are most obvious when we look at recent attempts of a growing number of developing countries, to give nuclear power an increasing share in their future energy systems - an approach which has been rightfully termed the "nuclear trap" (2).

Strengthening technological self-reliance implies furthermore the necessity to develop basic needs-oriented national engineering capacities and Fundamental Research. Without them, the local production of basic-needs-oriented capital

goods will easily be co-opted and reintegrated into world-wide sourcing strategies of international capital.

(b) For a policy aimed at strengthing technological self-reliance, the focus on technologies for basic needs-related capital goods production is a necessary, but not a sufficient condition. It is a necessary condition, because it implies decision autonomy about the products needed for the fulfilment of basic needs and the conditions under which they are produced. It may thus be called a necessary first step towards an effective participation by those directly involved, i.e. the majority of the developing countries' populations. Yet, this is only one side of the coin, and if one does not want to evoke a new set of "development illusions", one should hasten to add the other side. That is, policies to strengthen technological self-reliance need to identify those industries and their optimal modes of interlinkages, which, under given geographic, historical, social and economic conditions, will increase the long-term national accumulation potential.

(c) Identifying conditions of success should not be perceived in a narrow sense. Questions like: What institutions and what social and political coalitions are necessary to realize these new approaches? - will play a prominent role.

(d) Delinking is definitely not an "easy" solution. Without social transformation, i.e. without political and economic revolutions, delinking is not only unfeasible but a chimera. Delinking might only have significant chances of success in periods which do not leave much choice anyway with regard to economic, political and military self-protection. But these "worst cases" are in fact "very normal cases" for a great many developing countries! Thus, it will be very difficult to achive and maintain delinking. Invariably, delinking will be accompanied by very high social costs, it will have to be of a partial nature and will be full of contradictions. Still, there is no real alternative to selective technological delinking - at least if the development strategy is aiming at increasing self-reliance. But to make delinking a viable approach, we have to explicitly identify and translate into policy variables the social costs involved and the trade-offs in comparison to strategies of increasing world-market integration.

(e) Strategies to increase technological self-reliance are bound to be long-term strategies. Consequently the path towards the realization of higher degress of technological self-reliance will be full of contradictions and set backs. Any attempt by a developing country's government to identify successfully the prevailing forms and mechanisms of technological dominance and dependence, and to implement

efficient countervailing policies will be, for a long time to come, confronted with new forms and mechanisms of technological dominance and dependence, and so on ... That is why delinking strategies have to be both selective and flexibly handled.

2. Interlinking Key Development Objectives and Priority Areas for Science and Development

For any strategy of self-reliance, it is essential to identify and push through a complex set of alternative technology systems which would allow for the maximum mobilization of domestic resources and the extension of national development capacities. The solution is not to make "one across-the-board dogmatic technology choice".(3) A variety of technology levels may coexist at a given moment according to sectors, subsectors, products or even individual plants, ranging from advanced and sophisticated technologies to socalled traditional ones. The choice of a social optimum for such a technology mix presupposes the systematic identification of sector- and product-specific alternative technology production routes and their main preconditions of success. This is in fact one of the most urgent research requirements for development research.

If we want to identify such priority areas for science and technology, we have to have a clear conception of the key development objectives to which these science and technology priorities should be subordinated. I would propose to focus on five key development objectives: (4)

- Effective control of key sectors;
- Converging needs with effective demand;
- Support of agriculture, especially to achieve self-sufficiency in food;
- Creating the optimum social benefits by using and processing natural resources;
- Identifying and strengthening of "industrializing industries".

Effective control of key sectors

Today, in a majority of developing countries, key sectors of the economy are controlled by private capital, mostly originating from the OECD-region. This means that, by and large, the development of these sectors has been subordinated to the requirements of worldwide sourcing strategies of international capital.

Without effective public control of key sectors of the economy there will be no control over accumulation let alone development. This is a basic precondition for the establishment of dynamic inter-industry linkages and for the realization of strategies for transition towards an alternative development pattern. Nationalization per se is just one first step. By no means should it be confused with effective control. The latter must include: control of the market, of the essential inputs, of forward and backward linkages and, last, but most importantly, control over relevant basic research and technologies.

Converging needs with effective demand

In most developing countries, the gap between the needs of society, or more specifically, the needs of its underprivileged majority, and the effective demand, i.e. the demand which can enter monetary exchange relations, is dramatically increasing. Decreasing fulfilment of basic needs and overconsumption in some urban growth poles are the familiar symptoms of this trend. Without doubt, a deliberate and comprehensive policy to bring needs in line with effective demand is of utmost importance. This would imply three interrelated priority activities:

- identifying social needs;
- defining criteria for the adjustment of effective demand to social needs;
- restructuring the supply side.

a) Identifying social needs

Doing this as a technocratic exercise would be useless and it must and can be done as a social learning process (5). It is in this context that some of the national and regional papers prepared for UNCSTD have collected valuable information (6) which could be used as a staring point for indepth participative field research.

b) Defining criteria for the adjustment of effective demand to social needs

In this area, detailed research has been almost completely lacking. On a very general level some criteria are rather obvious such as:

- fulfilment of basic needs of the underprivileged;
- productive integration of the labour force;
- use of local natural resources;
- integration with local scientific and technological capabilities and (upgraded) traditional skills;

- traditional consumption and living habits will be preserved, at least insofar as they won't lead to discrimination or exploitation (see the recent debate on women's rights in postrevolutionary Iran).

What we do need is a rich body of field research and case studies on a much more disaggregated level which could then help developing countries' governments to orient policies to establish a genuine new consumption model.

c) Restructuring the supply side

Much lip service has been paid to this. But without knowing social needs and without having converged them with effective demand, the most well-intentioned policies to "restructure the supply of goods and services for national development" will lead nowhere. It is this kind of "choice of product"-problem which still needs a lot of case studies and questioning of those directly involved, i.e. especially the agricultural poor.

d) Implications for choice of product and technology: a hypothetical example

Let us take as an example a country that has undergone a political revolution. The new government, we assume, tries to initiate a process of economic and social transformation which would lead to a development policy based on self-reliance and the needs of the underprivileged. Such a self-reliant strategy would clearly affect choice of product and technology.

Table 1 might help to delineate priority candidates for choice of product.

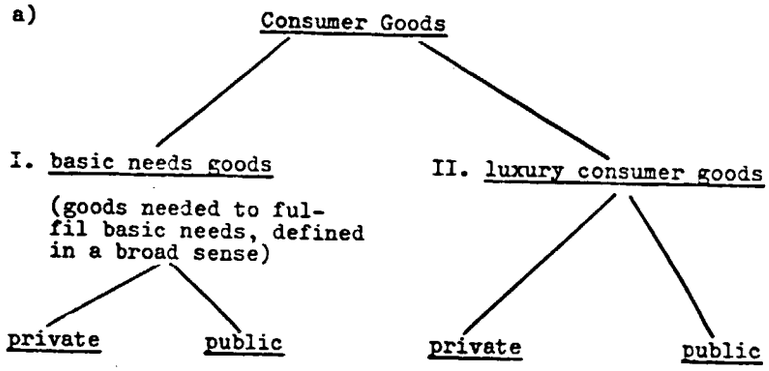
With regard to consumer goods, product choice will have to rely almost exclusively on basic needs goods, preferably on public ones. With regard to capital goods, product choice will have to be, ceteris paribus, restricted to I and II. (7)

Now, let us assume that the economic, social and political constraints on "appropriate" choice of product, as defined in Tab. 1, can be overcome. Indeed, these constraints would be formidable - nothing less than a complete reversal of the dominant mode of accumulation would be at stake. But even this would only be part of the story. Because a second level of constraints now has to be taken care of. This is exactly where the problem of technological dependence comes in. The issue at stake is: How to acquire those basic research, development and engineering capacities which would enable the country to produce those priority basic needs goods and the capital goods of categories I and II?

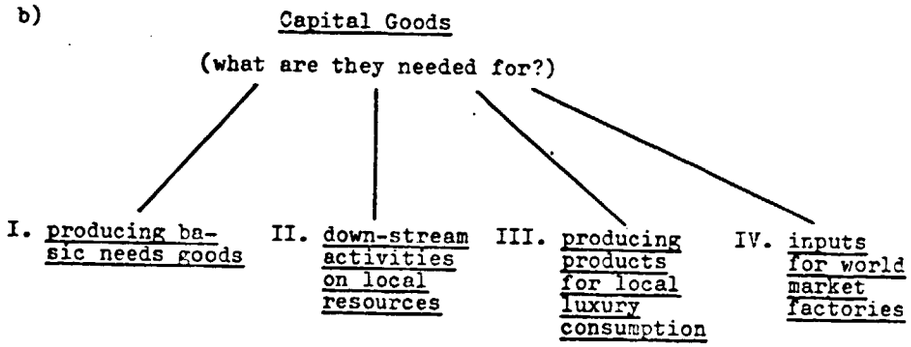
But again this is not the whole story because, in fact, these priority products can be produced with different systems of technology and based on different modes of organizing the labour process. Indeed, the primary aim of those technology systems and forms of labour organization which are the dominant ones today on a worldwide scale, is to reduce the labour costs,

Tab. 1: Implications of Self-Reliance Strategy: Choice of Product

a)



b)



II.1.
as inputs for local agriculture & industry

II.2.
producing products for sale on the world market, in case they will be able to reap monopoly rents

i.e. the price of the labour force. There are two options available to realize this goal: to increase unemployment and/or to deskill a growing part of the labour force. This structural bias in dominant technology systems and modes of labour organization has as its logical corollary a significant decline in the living conditions of a majority of the world population.

So our country, in relating its choice of technology to its self-reliance strategy, would have to take into account two other criteria:

- Technology systems and organization of the labour process should be so chosen that the country would be capable of reintegrating its active population into the process of social production. (In fact, developing countries have been experiencing a long-term decline in their labour absorptive capacities which, as growing empirical evidence has shown, is essentially a result of the type of technology imported. (8) That is, choice of technology and labour process should enable our country to increase its capacity for absorbing socially useful labour.
- Dominant technology systems and local means of production should be tailored to suit the level of qualification of its labour force. Criteria for qualification should encompass much more than the mere capacity of the labour force to subordinate itself under the necessities of the production processes and should include the capacity to comprehend, control and reproduce these very processes. The growing deskilling of the developing countries' labour force, as a result of the present international system of transfer of technology, may in fact be the key to developing countries' technological dependence - systematic research on this topic almost hardly exists.

Support of agriculture, especially to achieve self-sufficiency in food

Today, most developing countries, even those with an abundant potential for agricultural production, are becoming increasingly dependent on food imports. The achievement of self-sufficiency in food is a major objective of a self-reliant strategy. (9) Consequently, support for an agriculture which would guarantee self-sufficiency in food is one of the main priorities for development strategies and especially for industrialization strategies. This applies to sectors producing agricultural inputs (implements, fertilizers, pesticides, irrigation equipment etc.), to sectors serving transport and distribution requirements and

to those processing agricultural goods. Possibilities abound for the application of science and technology to increase agricultural productivity, to improve post-harvest technology and to introduce innovations into plantation industries, fisheries and forestries.

It should be noted that agro-allied industries are sectors where international capital (the socalled "agri-business", especially originating from the United States) has recently gained a particularly strong position. In other words, any policy which wants to use agriculture and agro-allied industries as an instrument to achieve self-sufficiency in food must surround these sectors with effective protective mechanisms against penetration and denationalization. This is a necessary precondition for the effective utilization of some of the very useful knowledge recently accumulated in some international and national institutions, such as the United Nations Research Institute for Social Development (UNRISD), the IPRA Food Policy Study Group, the Institute for Food and Development Policy at San Francisco, and the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) at Hyderabad, India.

Social optimization of using and processing natural resources, including energy resources

Mineral, water, agriculture, fisheries, forests, wildlife and renewable and non-renewable energy resources are among the basic elements for national industrialization and development. National control over the prospecting, exploitation, production and marketing of these natural resources is thus an essential precondition for self-reliant development.

Yet, most of these resources, at least if they have a significant profit potential, have been systematically screened and tapped by international capital which takes great care to preserve this monopoly of knowledge. In fact, to carry out rapid and detailed surveys of geological, mineral, agricultural, forest, fishery and other resources in developing countries requires the use of highly sophisticated technologies such as remote sensing using satellite imagery, airborne surveys and aerial photography. These technologies are dominated by a few private and public firms mainly located in the US, and to a lesser degree in Japan, Great Britain, France and the Federal Republic of Germany. They are also extremely costly. (10) The same is true, by and large, of technologies needed for the exploitation and processing of these natural resources.

In other words, most developing countries still have to develop the basic preconditions for effective control over the natural resources located within their frontiers, i.e. national capacities to detect, exploit and process them. Research in this field should therefore be a top priority. This should include a systematic search for areas in which co-operation between developing countries would be feasible.

On the other hand, availability of natural and energy resources should have a determining effect on the contents of the industrialization strategy with regard to the choice of sectors, process and techniques. Here again, we know little about the kind of linkages that should prevail between resource endowment defined in the sense above and industrialization patterns. Such knowledge is urgently needed to prevent industrialization from misusing those natural resources which are scarce and non-renewable, to give priority to sectors linked with processing renewable ones and to develop the production of inputs and equipments for sectors exploiting local natural resources. In other words, developing countries need systematic research which would enable them to subordinate industrialization to the requirements of ecodevelopment, i.e. to the protection and development of the resources of the biosphere.

Identifying and strengthening "industrializing industries"

Industrialization is potentially the centrepiece of socio-economic development. It has an enormous potential for accelerating the development of other sectors, such as agriculture, transport and communications, energy, drugs and pharmaceuticals, health and social services etc.. That is, industrialization can be the most effective instrument for a progressive integration of the key elements of the developing country's social and economic development.

Yet, in reality, industrialization in the Third World has nearly invariably meant the progressive disintegration of these economic and social circuits with all the inherent consequences for structural deformation, underdevelopment and misery.

A concerted effort is needed to redefine industrialization patterns conducive to development and to give an operational content to industrialization as an integral part of a strategy of transition towards self-reliant development.

Utmost priority should be given to the identification and promotion of the socalled "industrializing industries" (11), i.e. industries which would allow for the optimum use of local natural resources, guarantee the fulfilment of basic needs and

facilitate the long-term optimization of accumulation and scientific-technological capacities. Such a strategy includes, inter alia, the development of the machine tool industry, the production of textile and agricultural machinery, and a reorientation of basic industries, processing locally available resources which would aim at increasing the share of downstream activities and to push ahead its integration both with regard to the country's industrial and agricultural production. This strategy would include attempts at strengthening local engineering capacities, especially pre-investment studies, chemical engineering and equipment design, and attempts to control technological building blocks and technology life cycles.

The general principles of such a strategy have been established by now. What we now need is a whole series of concrete sector-and product-specific case studies which would help to clarify in detail the scientific and technological requirements of such a strategy.(12)

Recently, a new generation of "industrializing industries" is increasingly taking over the place of the traditional key industries, such as steel, electro-mechanical engineering and chemical industries. (13) It is to this dynamic change of industrializing industries and to its consequences for industrial priorities in the Third World that the aforementioned case studies should be mainly dedicated. This might help to identify the options available to developing countries, both individually and as Collective Self-Reliance - groupings, with regard to a selective delinking from this new type of OECD-based technology race. (14)

3. Conditions of Success

Three basic conditions of success for national policies designed to strengthen national technological capacities can be discerned:

- a restructuring of the international context;
- a thorough change of the educational system;
- identifying carriers of the strategy and optimal timing.

Restructuring the international context

To apply science and technology effectively to the aforementioned key development objectives, developing countries would obviously have to restructure quite considerably their present international economic, political and military relations. This

would have to include concerted attempts to increase the potential for international cooperation, especially the economic and technical cooperation among developing countries. (15)

We still lack systematic research undertaken from a Third World perspective on how the crisis of the international economic and political relations is going to effect the positions of industrialized countries with regard to international cooperation, and especially with regard to new forms of national and collective self-reliance in the Third World.

Clearly, the prevailing trends point to much more rigid and uncompromising positions. (16) But this is only a global picture and reality is much more complex. No doubt will there be differences with regard to countries and industrial sectors involved. This will be even more so with regard to political groupings and social classes.

Take, for instance, the case of the OECD-region. Notwithstanding the recent successfull moves to increase the homogenity of OECD-countries' bargaining position vis-à-vis an increasingly fragmentated Third World, there is no doubt that the world economic crisis is permanently generating new conflicts and political frictions between different fractions within this region. The same would apply to the global scene, whether one talks of an increasing multipolarization or not. (17)

It would be even more important to analyse these conflict dynamics on the level of specific industrial sectors and branches. From the viewpoint of OECD-countries this has been extensively analysed, for instance by the OECD's Interfuture project, by the OECD Directorate for Science, Technology and Industry, and by the French think tank GRESI (Groupe de Reflexion pour les Strategies Industrielles). (18) Finally, it is no secret that trade unions, by and large, do have somewhat different ideas than, say, employers' associations, on how to integrate developing countries into a restructured world economy.

Third World countries should be able to draw on research on such diverging positions and conflicts of interests among industrialized countries. Only then could areas of conflict and areas where conciliation of interests is possible, established in an operational manner, and only then could realistic options be identified for national and collective Third World strategies to diversify dependence.

Another education system is needed

Furthermore, the education systems prevailing in developing countries would have to be thoroughly changed. Presently,

they are not only completely inadapted to development needs, but constitute in fact a major factor of dependence. (19) Education should instead become a training place for self-reliance. (20) Only such an alternative education system could guarantee

- an "appropriately" qualified labour force, i.e. workers who would neither be overskilled in the sense of being highly specialized watchdogs of "automated factories" nor deskilled in the sense of being deprived of certain general-purpose skills, such as, for instance, welding;
- scientific and technical management cadres devoted to social cost-benefit criteria, and
- that "tradional" innovative capacities will be selectively recovered and upgraded.

Carriers of the strategy and timing

In order to make self-reliance a viable strategy one has to know not only what it should aim at, and why. One also has to know who shall do it, i.e. the carriers of this strategy, and how they are going to do it. This obviously presupposes a critical inventory of the prevailing class structure, especially with regard to who controls the generation and use of the social surplus and thus can decide which technology system will become dominant and which ones will be displaced.

The explicit inclusion of domestic distributional effects is a necessary precondition for understanding the social conflicts underlying the introduction, diffusion, adaptation and further development of technology in a given society. In other words, a research approach is required which would allow us to separate those social groups and/or regions which are going to benefit from the application of a certain technology system from those which are going to pay and suffer. Only then could one hope to identify in an operational manner the socially and politically relevant forces attached to or opposing self-reliance, the areas of conflict and the areas where conciliation of interests is possible, the necessary institutional set-ups, and finally, the social and political coalitions necessary to realize this strategy.

This type of analysis focussing on the internal class basis for choice of technology should of course be linked back to the analysis of the prevailing international order, referred to above. Otherwise we would loose track of some major factors and mechanisms underlying the political, economic and scientific-technological systems prevailing in the Third World.

Identifying carriers of self-reliance and their conflicting interests is a highly complex and multi-dimensional task. Yet we still lack systematic research on this essential issue.

Another crucial problem is the question of timing. Galtung has recently pointed out that it has two dimensions: the prinicple of ripe time, and the principle of correct time order. (21) If developing countries would base their strategies and tactics on a careful scrutinizing of the timing question, they would not anymore simply have to react towards the dominant activities of the North. Rather, they might be for the first time able to use the inherent imbalances and contradictions of the world economic crisis as a driving force to increase their room of manoeuvre for national and collective self-reliance. Yet, the time factor has been nearly completely ignored in discussions on how to proceed with self-reliance.

To conclude, without thorough going political and economic change, that is without a complete restructuring of the prevailing class structure and state functions for the benefit of the underprivileged, the application of science and technology to self-reliant development will not only be unfeasible but a myth.

Such change must occur as much in the Industrialized Countries as in the Third World. Otherwise, misuse of science and technology will not end.

4. A Tentative Catalogue of Research Proposals and Issues for Debate

This paper in no way could claim to present more than piecemeal answers to the question of how national policies to strengthen technological capacities should be designed and implemented. This reflects the present state of research in this field. Yet, a beginning has to be made.

The following tentative catalogue of research proposals and issues for debate will hopefully stimulate some further thoughts and systematic research in this field.

A. Focus on the operationalization of new approaches

Research should focus on operationalizing new approaches which might be useful for the formulation of some basic guidelines for self-reliance strategies, both in the specific field of science and technology, and with regard to overall social development.

This implies, inter alia:

- A review of branch- and product-specific patterns of technological dominance and dependence, confronting developing countries, with the specific aim of identifying priority sectors for selective technological delinking;
- an evaluation of major types of science and technology policy, prevailing in or proposed to developing countries;
- an identification of the economic, social and political changes needed to achieve more technological self-reliance in developing countries.

B. Alternative approaches to energy and resource-oriented industries (22)

(1) More attention should be given to research into the energy and resource-oriented sectors:

a) Of a country-case study nature, looking at the successes and failures of individual countries in making autonomous technological decisions:

b) on ownership and control over particular processes or technologies and on their diffusion; (23)

c) on the feasibility of technical cooperation among developing countries, including sharing of know-how and experience, joint procurement of critical equipment, materials and components and joint production;

d) on technology transactions involving particular supplying firms, utilizing data from both supplying and receiving countries, with particular attention to the pricing of technology, materials and equipment flows;

e) on technology transactions, comparing terms and conditions among different recipient countries;

f) on forward and backward linkages resulting from the application of technology in the energy and resource-based sectors, including long-term economic and social effects;

g) on the developing countries' experience concerning joint ventures with COMECON countries.

(2) Developing countries need to carry out their own well-conceived r&d programs on energy technologies utilizing renewable resources. Furthermore, research is also desirable on technology options for energy consumption.

(3) With respect to both energy and resource-based industries, there is a need to search for, upgrade and diffuse existing indigenous technologies.

(4) By gaining the maximum advantage from their natural resource endowments and by controlling the technology for their exploitation, developing countries must strengthen and develop their own independent capacity in the fields of surveying, exploration and prospecting.

(5) Concerning the aforementioned case studies, the influence of class structure and the political system on the achievement of greater technological self-reliance should be specifically taken care of. More attention needs to be paid to the nature of social, political and economic measures required for creating and strengthening the capacity to perceive, adapt and apply appropriate technological innovations as well as the capacity to make one's own innovations.

(6) Selective technological delinking, though it may be uneconomic in static comparative advantage terms, obviously can have significant long-term benefits for increasing the country's development potential. This may apply specifically to some sectors of the energy and resource-based industries (for instance, agro-allied industries catered to food production). To be able to identify conditions of success and strategic and tactical guidelines, a lot of detailed branch- and product-specific case studies concerning "selective technological delinking"-potential is needed. It is in this context that much of the recent discussions, especially within UNIDO, on appropriate industrial technologies and, more specifically, on appropriate plant size may be of some help in formulating a catalogue of detailed research priorities. (24)

C. Strengthening the self-reliance of national capital goods production and engineering capacities and preconditions for identifying and pushing through alternative "technology production routes" (25)

(1) Research is urgently needed which could identify, both on an aggregate and on a sector-and product-specific level, the role of capital goods industries and engineering consultancy in the process of accumulation.

(2) Research is urgently needed which would identify those segments of the capital goods industries and engineering consultancy which have recently been transferred on a significant scale to developing countries or are candidates for such a transfer. We need detailed research into the involvement of specific firms and the strategic functions and tactical procedures underlying these new forms of industrial deployment, i.e. what are the determinants of these new

varieties of worldwide sourcing strategies? In-depth surveys of the types of agreements and joint ventures prevailing in this field are needed. Research done at the International Centre on Industrial Studies of UNIDO, the International Development Research Centre and the OECD Development Centre (26) has already produced some valuable information. On this basis, a catalogue of detailed research projects should be formulated now which should be pursued as a high priority.

(3) Research is needed on the scope left to technology-importing developing countries for adapting the organization of the labour process in the case of a given production technique. This requires a lot of (comparative) sector and firm specific case studies. Also comparative studies should be undertaken of similar production units in the OECD region, in the COMECON region, and in developing countries, in terms of the contents of particular jobs, job specifications, hierarchization of the labour process and other social effects of technology.

(4) Research is very urgently needed on the role and consequences of automation. The increasing computerization of production, development, maintenance and distribution activities is significantly changing the overall structure of the capital goods industry and its role in the process of accumulation. This applies especially to the international context (see the case studies by Bennaceur and Gèze and Malkin in Chapter III). For instance, what are the effects on the developing countries' room of manoeuvre to build up and strengthen national capital goods industries and local engineering capacities? Will automation not lead to a significant increase in dependence, for instance in terms of imports of automated equipment, technological building blocks, which are so complex that autonomous reproduction (for instance, via reverse engineering etc.) in developing countries may be precluded for a long time to come? Will increasing reliance on automation not reduce the possiblities of building up integrated national engineering (particularly basic engineering) capacities? And, finally, will automation not lead to a decrease in the scope for adapting the organization of the labour process?

Little knowledge exists about the technology options available to developing countries with regard to both increased automation and their scope for adaptation! That is, we need systematic research which would help us to establish the room of manoeuvre for countervailing technology policies on automation which must be pursued by developing countries.

(5) We need comparative research on the level of complexity of equipment goods delivered to developing countries by OECD countries, COMECON countries, and Third World suppliers like Brazil and India. This would help to clarify th scope for strategies to diversify sources of supply and to identify areas for economic and technical cooperation among developing countries.

(6) With regard to identifying alternative technology production routes, historical case studies should be undertaken on "alternative" or "minority" technology systems of equipment goods production (see, for instance, the case of the Soviet Union during the interwar period).

(7) Research is needed on the effects of automation on the kind of "small-scale industrial technologies" available on world-markets. Given the fact that most of these commercialized scaled-down industrial technologies are highly automized (automatic mini-steel mills; automatic mini-cement plants), will this not lead to a qualitative intensification of technological dependence?

(8) The maintenance function is clearly emerging as a key factor of technological dominance in the field of equipment goods. (27) Research on this subject is urgently needed. This applies especially to "corrective maintenance". Establishing "maintenance pools" and programmes for increasing "corrective maintenance capabilities" should be high priority areas. Research and policy action concerning maintenance should also be priority candidates for TCDC.

D. How to operationalize the concept of "Appropriate Technology"? (28)

(1) It has recently become fashionable, within ILO, UNIDO, and some national development agencies, to see the solution to social, political and economic problems in the development of new, socalled appropriate technologies. In particular, there is a tendency to assume that problems of unemployment in developing countries might be solved by labour-intensive technologies, without accompanying social and political changes.

(2) Used in this way, the concept of appropriate technology can serve to breed new myths about the omnipotent role of technology. It can also lead to new forms of technological dominance, by which appropriate technologies are researched, and developed in some major OECD countries, produced and marketed by multinational corporations and international organizations, in what can only be seen an "unholy alliance".

(3) The choice of technology can only be a subsidiary aspect in the formation of "sound" or "suitable" development strategies. A technology can only be considered appropriate in relation to political goals. For a certain period of time, developing countries, trying to dissociate themselves from the prevailing international division of labour, will have to make use of certain technologies that are, in many ways, inappropriate.

(4) Since, however, technologies emanating from the industrialized countries carry with them the hierarchical division of labour characteristic of capitalist production, the development of alternative technologies will be essential in the long term, if developing countries are to proceed along an alternative development path. Technologies will have to be developed that encourage a broader participation and mobilization of the majority of the population. New methods for evaluating technology that take into account the social and environmental costs and benefits, will have to be devised.

(5) The development of alternative technologies will thus also be important for today's industrialized countries. In these countries the only long-term solution to problems of structural unemployment and deskilling of labour involve new political strategies including the struggle for new forms of work organization and new participatory technologies.

(6) There is a need for research linking the development of self-reliant political strategies with the development of appropriate technologies. In what political context is a technology to be defined as appropriate? And by which social group is an appropriate technology to be developed? Who are the potential social bearers of appropriate technologies? These are the questions that are usually avoided in the international discussions of appropriate technology but are the questions that are most in need of answers.

(7) Today's technological situation has to be analyzed with a historical perspective. For instance, we need systematic research on why certain technology systems became predominant and why others, some of them with an equal productivity potential, have been displaced and have disappeared. That is, a critical history of the historical dialectics of "technological progress" is urgently needed. One focus should be a critical history of the penetration of Third World societies by dominant Western technology systems. Another approach might be to reconstruct the history of resistance against "modern" or "new" technology. Understanding the historical reasons for the dominance of certain technology systems might help to get a clearer view of their main characteristics and thus pave the way for identifying and pushing through alternative technology systems.

E. Science and technology policies, social structure and the state: identifying the room of manoeuvre for strategies of transition towards self-reliant development (29)

(1) The application of science and technology for development implies the establishment of coherent internal socio-economic structures in developing countries compatible with meeting basic needs and the principles of sound ecodevelopment. Only then will science and technology policy lead to self-reliant development. The capacity for autonomous decision-making requires building up a complex of institutions, laws, educational systems and research facilities and, in general, an integrated scientific and technological infrastructure capable of making appropriate decisions regarding the importation of foreign technology, choice of alternative technology systems and adaptation and development of technologies. There is no recipe for science and technology policy or technological development applicable across the board to all developing countries. Each country must devise its own principles of technology assessment, its own ways of integrating science and technology into development planning according to its own unique conditions and development objectives.

(2) The internationalization of capital and its forms of insertion into the dependent economies of the Third World have been determined by and have multiple effects on socio-political structures, both in the home and host countries of multinational corporations and on the relationship between them. This reality poses various theoretical, empirical and methological questions, and confirms the need to approach these problems within the framework of a truly multidisciplinary analysis.

(3) Research is urgently needed into the various forms in which the internationalization of capital and the concomitant "transfer" of technology has effected the political behaviour of the classes or class-fractions traditionally linked to international capital; that of those which control nationally-owned (or mainly national) enterprises; and the behaviour of the working classes, particularly labour organizations (including rural ones). For instance, it will be of utmost importance to have highly disaggregated empirical research on the role of public enterprises and para-statals within the framework of national science and technology policies. Can they be used as a major instrument for national science and technology policies or are they instead playing the role of a "Trojan Horse" for the progressive denationalization of

productive forces and of options for development strategies? Research is also urgently needed into questions like: What are the links between the dependent state and its hegemonic centre? What are the effects of the increased penetration by international capital on the organization and behavior of state bureaucracies and the bargaining capacity of dependent countries?

(4) On the other hand, research is urgently needed into the state in transition pursuing alternative development strategies. We need research, for instance, on what have been the reactions of international capital in specific cases of structural transformation attempted by dependent states, to enable us to define the areas of confrontation as well as those where conciliation of interests is possible.

(5) On a more technical level, research is urgently needed into the following topics:

a) Contradictions between an explicit and implicit science and technology policy and their relationship to the logic of social and economic agents. (Sectorial approach).

b) State Enterprises' purchasing policies and their effect on the r&d of their suppliers and connected industries.

c) Possible State action to develop and use new knowledge for solving society's problems. (Sectorial approach).

d) Possible State action to strengthen the technical and scientific capacity of the educational system and of the technical and scientific system and to establish links with the productive system.

e) State intervention to develop knowledge for problems for which there are no solutions available in the present industrialized countries' stock of knowledge, especially where the market forces do not lead to this solution (e.g. tropical diseases).

f) Appraisal of the state as a regulating agency in the imports of technology.

g) State support to Trade Union involvement in the educational system.

(6) There is an urgent need for research to evaluate recent attempts, especially those of some socalled key countries of the Third World, to "upgrade" and strengthen national scientific and technological capabilities via the establishment of local arms industries.

Major research questions would include, inter alia:

a) How to evaluate intersectoral spin-offs and complementary forward and backward linkages, especi-

ally concerning the socalled "industrializing industries"?

b) How to evaluate effects on the degree of technological self-reliance? That is, how to evaluate the effects on the capacity to choose and control patterns of technological demand and supply and on the capacity to devise systems of technology diffusion and adaptation?

It would be extremely important to develop some methodological guidelines for empirical case studies, especially concerning key sectors, such as electronics and telecommunications, optronics and laser technology, the aluminium industry; high quality alloys and refined steel, down-stream activities with regard to strategic raw materials, and high precision machinery.

F. Establishing new forms of international cooperation, especially among developing countries (30)

(1) We need detailed research into the implications of the NIEO programme. (31) According to the regional paper for Latin America, prepared by the secretariat of the UN-Economic Commission on Latin America for UNCSTD, (32) the NIEO programme " ... entails the restructuring of international relations in order to bring about changes in the present division of labour and in the relations existing in the present international order so as to transform its most outstanding characteristic, its assymetrical nature, into one of negotiated symmetry by means of greater participation of the developing countries in world industrial activities; the achievement of their self-reliance in the production of food; an increased share in the external trade through an appreciable increase in exports; the strengthening of their local scientific and technological capacity; and greater access of these countries to the stock of financing and scientific technological know-how available in the world."

According to the same source, this would, in the international sphere, require the following principal structural changes:

" ... a) Redistribution of the world's productive potential;
b) Access of the developing countries to the sources of international financing and of generation of scientific and technological knowledge;
and c) The development of new forms of international cooperation that will tend to strengthen internal efforts to achieve development processes defined within the countries themselves."

How to proceed? The present state of knowledge on the options available to Third World countries is nearly zero. We still need a lot of detailed case studies.

(2) This urgent need to bridge existing research deficits applies even more to options for collective self-reliance, and, more specifically, to options available for TCDC. (33)

If we want to identify realistic options for collective self-reliance among developing countries, especially with regard to TCDC, and if we want to identify institutions and social and political coalitions which are necessary to realize these concepts, we need further in-depth analysis of the following three issues:

a) Decision-making procedures and implementation criteria of TCDC programmes and projects

We need a rich body of case studies on decision making procedures and implementation criteria of TCDC programmes and projects, especially of those managed by the UNDP. This should include country and sector case studies, and case studies dealing with specific TCDC institutions.

Furthermore, we would need case studies on the involvement of specific firms. Such research should help to establish differences of motivation, strategies and organizational structure with regard to firms from the OECD-region, those from COMECON-countries and those based in the so-called Newly Industrializing Countries (NICs). It should also help to identify the patterns of division of labour recently evolving between them. For instance, the growing involvement of private and state firms from India, mainly from the engineering consultancy, construction and heavy machinery trades, as technology suppliers, in the Near East, Africa, and some South-East-Asian countries (34) should be systematically scrutinized. This should help to find out what is "business as usual", what are simply new forms of international subcontracting, and what, after all, are at least first steps towards an increasing South-South cooperation on mutual beneficial terms. The same would apply to companies from Yugoslavia, Spain, Rumania South Korea, Mexico, Brazil and Argentina.

c)

b) Administrative inefficiency and bureaucratization as short-term impediments to TCDC

For most of the public administrations of developing countries it is still a no-one's job to search

out potential areas of cooperation among developing countries and to coordinate systematic follow-on activities including policy formulation. This is so in spite (or maybe because?) the recent proliferation of science and technology institutions. On high policy decision making levels, questions like "What can we do among ourselves, for ourselves?" are still basically dealt with as rethoric devices.

Projects like the International Development Research Centre's Science and Technology Policy Instruments (STPI) Project (35) have amply documented the manifold inconsistencies and contradictions of national science and technology policies. A similar research approach would be urgently needed on TCDC related policy instruments and institutions.

Furthermore, the considerable conservative influence of the international bureaucracy of the various special agencies should be thoroughly investigated. In fact, agencies and their employees tend to be mainly concerned with preventing either an invasion of their sectoral fields or a loss of the prerogatives and power of their executives and governing bodies. The division of labour recently agreed upon between UNDP and UNCTAD with regard to TCDC and ECDC would be a case in point. Furthermore, international organizations are inclined to assume that countries and governments are there to service them rather than the other way around.

c) The distribution of costs and benefits of TCDC

To paraphrase Vaitsos (36), we have to ask: "Who cooperates and with whom, how and for whose benefit?" This presupposes the identification of the main actors with regard to countries, international organizations, governments (respectively fractions of the public administration), firms, classes, and segments of the labour force. Furthermore, the crucial issue of effective control and democratic participation has to be closely scrutinized. TCDC would clearly make no sens if it would not help to alleviate international inequality.

Some first attempts of research in this field already exist. Examples would be the ongoing UNITAR project on "Technology, domestic distribution and North-South relations", research projects undertaken at ILET/Mexico City, and studies undertaken

within the framework of IFDA's "Third System" project. (37) But this is only a beginning and a clear TCDC oriented focus is still lacking.

(3) There is an urgent need for case studies identifying the "reformist potential" of scientific and technological cooperation between North and South. Areas of conflict and areas where conciliation of interest is possible have yet to be established on a much broader scale. The same applies to research on "success stories" and failures of such cooperation between groups of developing countries and OECD- or COMECON-countries.

(4) We still lack in-depth case studies on the effects of major technological break-throughs achieved in the OECD region on the economic and social development and particularly on the scientific and technological self-reliance of developing countries.

This applies especially to the following areas:

a) Development of new energy technologies, especially with regard to solar thermal technology and photovoltaic energy conversion. It would be unrealistic not to recognize that OECD-based MNCs, above all from the U.S., are once again in this field those which are most advanced, and that the substantial investment resources allocated in the last three years to research into new energy alternatives other than nuclear will only increase this lead in the next few years. So the crucial issue is: Under what conditions could developing countries prevent being trapped into new forms of technological dependence in the field of new energy technologies?

Consequently, research should focus on conditions of market entry, on built-in technological restrictions for building the equipment and on the degree of complexity of the operating process. It should start from a re-evaluation of social energy needs (38), thus trying to interlink supply and demand conditions as part of a systems approach to development.

b) Development of synthetics and other forms of substitutive research induced by price increases of raw materials. This preventive synthetization of raw materials is in fact a very powerful countervailing instrument available to OECD countries against further OPECization attempts by Third World raw material producers. Test cases would be, for instance: cobalt; chromite; sugar and sweetener produced from corn derivates; guayule as a new source of natural rubber; chocolate produced from soja.

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c) New technologies concerning the miniaturization and decentralization of automation systems.

d) Technological innovations related to seabed mining, offshore drilling, offshore prospecting etc..

e) New military technologies and their potential "civilian spin-offs", for instance: laser technology; optronics; weather modifications; bioweapons.

f) New technologies concerning material testing and production in the space.

g) Technologies to increase the worldwide mobility of capital, for instance: factories on board ships; low cost or zero cost maintenance and repair; mobile building techniques.

h) The tremendous technological potential of genetic engineering and bio industries.

i) New technologies for the increased computerization of society.

j) New technologies available for the (partial) humanization of the labour process.

G. Establishing informal networks of multidisciplinary and multilateral research cooperation

The very tight compartmentalization of different approaches to the dynamics of technology and society, prevailing until now, must definitely be overcome. New multidisciplinary research approaches must be devised, and truly multilateral channels for research cooperation between concerned research groups in developing countries and developed countries should be established. Multidisciplinarity here implies not only permanent exchange of information and research cooperation between social scientists, development practitioners, engineers and natural scientists. It implies also a planned and well conceived policy to promote research contacts and interlinkages between "research specialities" within one profession. For instance, during the Bonn workshop on "Technological Dependence - a Major Hindrance for Autonomous Development", (39) it turned out to be of considerable value that research groups had been brought together who work on rather different research subjects, such as, for instance, development planning, North-South-relations, problems of production and transfer of civilian and military technologies within the OECD-region, East-West-cooperation etc.. Multilaterality implies first and foremost that the choice of research programmes takes into account social interests which up till now have been clearly marginalized. It implies further that control mechanisms and

success criteria for joint research will be established on a mutually agreed basis.

For obvious reasons, most of the established institutional arrangements in this field will only be able to fulfil these funtions to a limited extent. Thus, alternative institutional channels for research cooperation have to be established. For instance, one immediate solution might be to broaden the impact of already existing informal networks of self-reliance information centers. A pragmatic approach would be to use the recently updated UNDP Directory of Institutions for TCDC in Developing Countries, UNIDO's preliminary compilation of "Technologies from Developing Countries", and the forthcoming OECD-Development Centre Directory of Development Research Institutes in Developing Countries. This might be supplemented by other already existing information networks, such as those established by the African Regional Centre of Technology, the Third World Forum, the Association of Third World Economists, the International Foundation for Development Alternatives, the International Center for Public Enterprises in Developing Countries, the UN-ECAFE Regional Centre for Technology Transfer, the International Peace Research Association and the Research Policy Institute in Lund.

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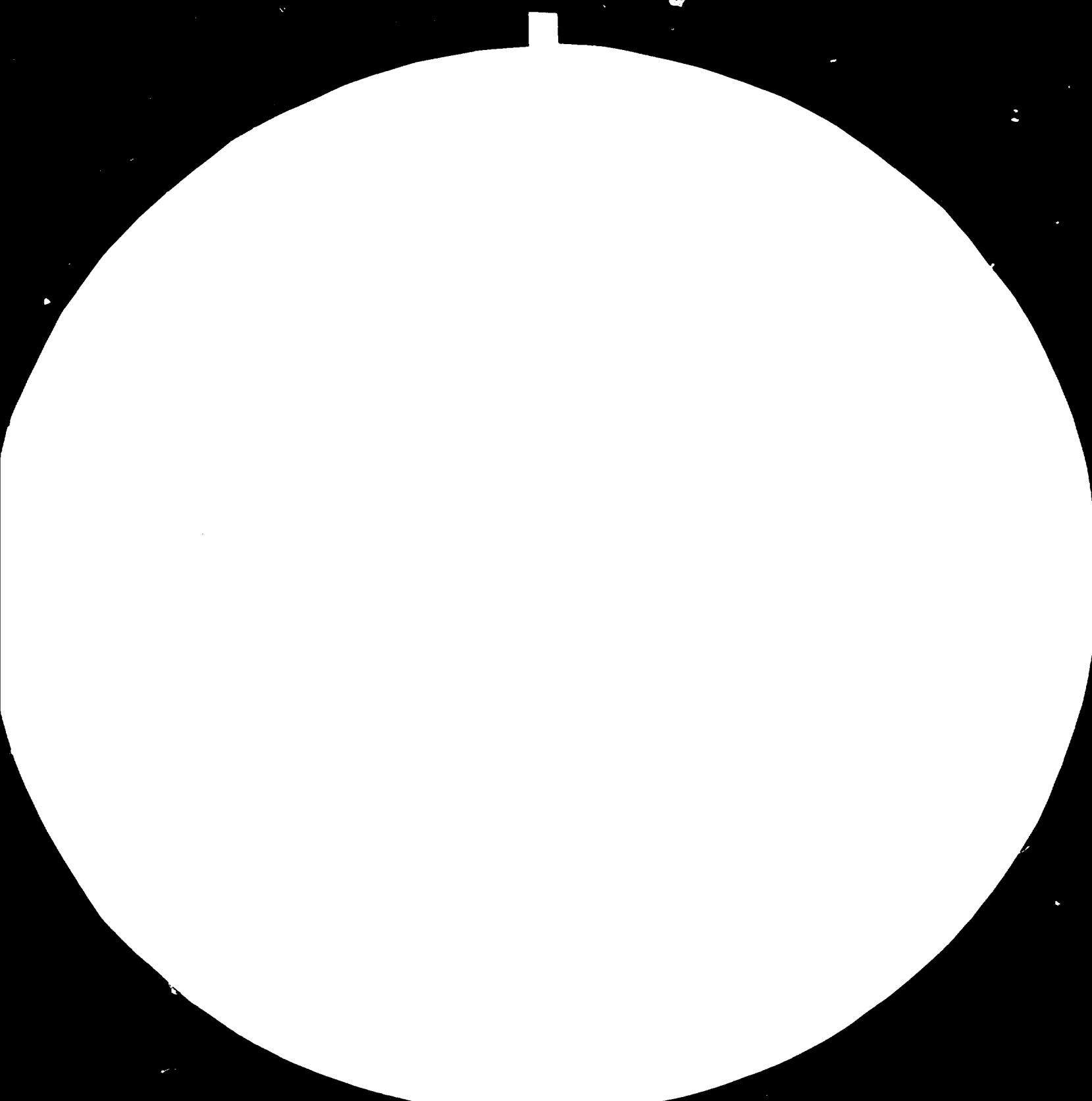

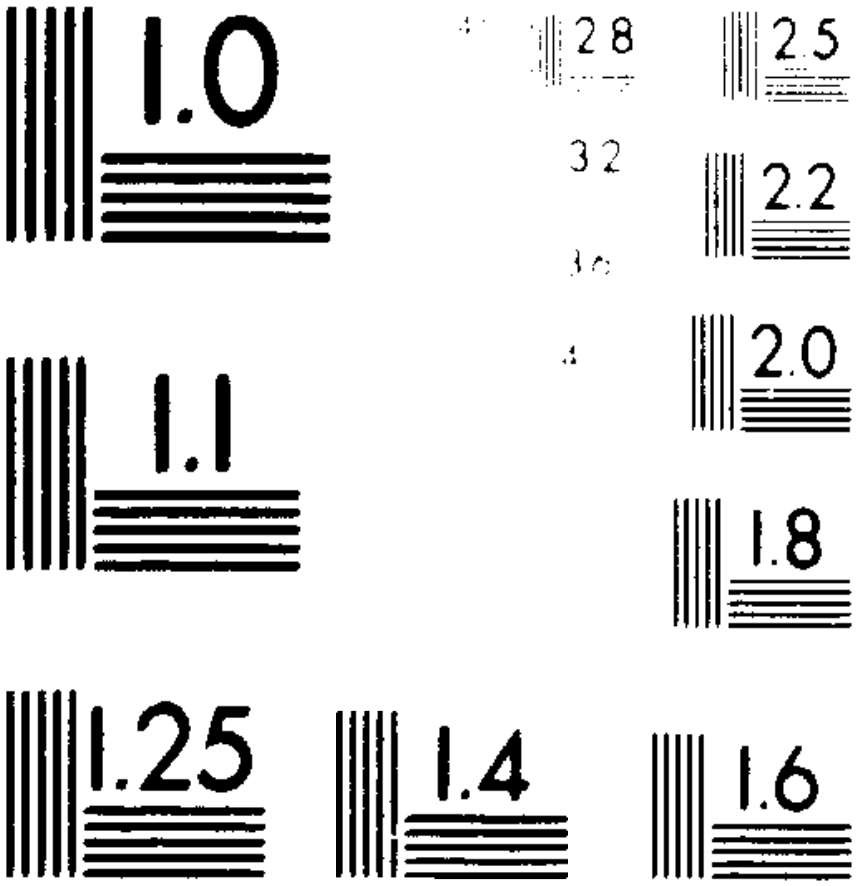

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