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Introduction

The subject matter designated by the above title is very broad indeed. The present article aims at covering only a few pertinent aspects of the area. The main aim is that of identifying the circumstances under which real as opposed to formal transfers of technology from transnationals to Third World countries are possible. In addition to presenting an outline of the article, the present section offers some clarification as regards the concept of technology and types of possible transfers of technology.*

The following section addresses general development trends as regards transnationals and the transfer of technology to the Third World. It is noted that these trends are by no means uniform, but point to new possibilities as well as new limitations for the Third World.

* I am grateful for comments from John Kuada, Hans Gullestrup, Olav Jull Sørensen, Jørgen Kristiansen, Birgitte Munch, and, in an earlier phase, Jens Müller. I can safely say that each of them would have written a somewhat different article.

Against this background, I proceed to a short case study of transnationals and technology in Brazil. Firstly, Brazil's technology policies from the latter half of the sixties to the late seventies are introduced. Then three examples of attempts at technology transfer involving transnationals are discussed. This provides a basis for identifying the preconditions for real technology transfers. Additionally, I briefly valuate Brazil's technology policies during the last decade, and point out some of the flaws and contradictions it contains.

The final section discusses the possible general relevance of the Brazilian case and touches upon the problematic of "modern" versus "appropriate" technology.

The concept of technology employed her is the one developed by Jens Müller in his recent study.[1] However, the present discussion of technology transfer does not cover all four aspects of the concept of technology. The focus here is on the "hardware" and the "software" component of technology, i.e. technique (with machines and tools at the core) and knowledge (with know how at the core).

Formal (or partial) transfers of technology may then be said to cover merely transfers of techniques, while real (or total) transfers of technology imply transfer of not only techniques, but also of knowledge. This means that real transfers of technology enables the receiving country to gain effective control over the imported technology, not only being able to use and adapt it, but also to reproduce it and improve it in accordance with local development priorities.[2] This kind of control may cover the ability to change the organizational component of the technology in question, and perhaps also the product. In the present context, however, this is not so important. The

crucial distinction here is the one between real as opposed to formal transfers of technology.

For a real transfer of technology to take place, there has to be somebody at the receiving end. In the above, I talked about the "receiving country", but clearly, in most cases it is not the Third World country as such to which technology is transferred, but some organization in the country, most often a national enterprise, public or private. The problems pertaining to various social carriers of technology[3] are not dealt with in this context. In other words, at real transfer of technology, contributing to upgrading of the technological capability of the country in question, is understood to have taken place when techniques and knowledge pass from being controlled by a transnational to be controlled by a local (indigenous) "unit" in the Third World country.[4]

There is no implication that so-called sophisticated technology coming primarily from the industrialized West is "good"/desirable and "home-grown"so-called traditional technology is "bad"/undesirable. The starting point is that in a number of cases Third World countries want real transfers of so-called sophisticated technology to avoid situations of technological dependence. The issue is how such transfers are brought about. In addition, the debate on "modern" versus "traditional" technologies is briefly touched upon in the final section of the article.

To decide whether a real transfer of technology has taken place in the sense referred to by Dieter Ernst in the above (i. e. the receiver is able to use, adapt, reproduce and improve the technology) is often a quite difficult task. The Brazilian cases described below are not crystal clear on every single one of these dimensions. But taken together, they do demonstrate the complex set of issues involved real technology transfers.

Transnationals and the Transfer og Technology: General Trends.[5]

It has often been asserted that the most important contribution from transnationals to the economic development of the Third World is the transfer of modern technology.[6] There are signs of an intensified transfer of technology on the part of transnationals during recent years, one of the most important being an increased TNC-involvement in the producer goods industries in Third World societies, a process forming a part of a general increase in TNC-activities in manufacturing industry in the Third World.[7]

Sanjaya Lall has noted the tendency for a number of peripheral societies to commence exporting "manufacturing technology" and finds this to be only

> "...the tip of the iceberg of an enormous amount of technological progress under way there, (pointing) in the direction of an important reordering of the technology market in the future." 8

These developments do not guarantee, however, that transnationals are increasingly performing real as opposed to formal transfers of technology to the Third World. Clearly,"transfer of technology" to a subsidiary within a transnational corporate network does not constitute any "real" technology transfer. The technology "transferred" is kept under corporate control.[9]

Transnationals are, not surprisingly, eager to keep advanced technologies and the related R&D-activities to themselves.[10] R&D efforts are kept in the home countries, the only parts transferred to the Third World being activities aimed at adapting processes and products to local conditions. Surveying R&D undertaken in the Third World by a sample of 56 transnationals based in the industrialized countries, Behrman & Fisher observe:

> "What did not exist, however, in the firms in our sample, were conscious, direct efforts by the firms to contribute to the technical capabilities of the host countries." 11

As far as "standard" technologies[12] are concerned, however, transnationals are not unwilling to perform real transfers to the Third World, the reason being, of course, that such technologies are fairly dispersed already, and do not hold possibilities for profitability based on oligopolistic control.

This corresponds to the stand taken by the industrialized countries in the UNCSTD-negotiations on transfer of technology to the Third World:

> "The capacity of local enterprises of small and medium size for absorbing modern, "standardized" technologies should be improved, by estabilishing complementary scientific-technical infrastructures in the developing countries...
> New possibilities for transfering standardized components and production moduls have to be established also for capital goods production." 13

This is not to imply that real transfers of advanced technologies to the Third World are never undertaken. When it happens, however, it seems to form part of a process of technological "upgrading", where transnationals maintain a decisive technological lead in vital areas, while simultaneously transferring some advanced technology to the Third World.

This is what happened in the case of Piper Aircraft's contract with Brazilian aircraft manufacturers EMBRAER in 1974. The contract was for seven Piper-models to be manufactured in Brazil by EMBRAER, going through three stages, where in the final stage about 70 per cent of production and assembly is undertaken in Brazil.

EMBRAER gets access to parts of the advanced technology involved in aircraft manufacturing; Piper on the other hand gets access to an attractive protected local market and, most importantly, Piper is able to "...maintain technological lead and competitiveness against future Brazilian export capabilities."[14]

A number of observers find this example of technological "upgrading" on both sides to form part of a more general trend where control over vital advanced technologies is increasingly concentrated while at the same time other parts of advanced technologies are increasingly transferred to (parts of) the Third World.[15] The general background to this trend is the tendency for technical conditions of production to change across a wide range of industries, particularly producer goods, giving increased importance to electrical and electronic technology. Daniel Malkin provides an example of these developments as far as machine tools are concerned:

> "The progressive introduction of numerical control devices has widely transformed the technico-economic performance of machine tools. First, it leads to increasing specialisation of machine tools allowing for greater series of production - enhancing capital productivity... Secondly, the development of modular elements allows a more flexible use of machine tools as well as increased efficiency in the production of smaller series. Finally, the development of controllable systems of machines og machine centres gives rise to completely automated production lines ... there is hardly any aspect of utilization of machine tools which cannot be revolutionized by the introduction of electronic systems and where the developers of such systems do not gain advantage over those who do not master them.."[16]

The point is that the conditions for mastering the production of a wide range of producer goods are undergoing significant change. Capability in the design, production and application of electronic systems are becoming of decisive importance.[17] In this process, substantial parts of the manufacturing of producer goods may be transferred to (parts of) the Third World,[18] while at the same time the new key sectors are controlled by institutions in the industrialized countries.[19]

There are signs then, of a process technological "upgrading" in a number of Third World countries, even assisted by transnational corporations, cf. also Lall's mentioning of technological progress underway in the Third World. The countermove on the part of the industrialized countries seems to be constant-

ly keeping one or two steps ahead by introducing ever more sophisticated technologies. Malkin mentions two kinds of "weapons" employed by the advanced countries:

> "The first one is the acceleration of technological evolution at the level of products. In the framework of the product cycle paradigm, advanced countries could recapture markets if they introduce new products that replace old ones for which they are outcompeted. The second is the fact that they can produce a technology which is "one generation in advance" once the developing countries master a certain production process. This is particularly the case in the electronics and specialized machinery industries, where the technological domination of the most advanced countries moves constantly upstream in the production route." 20

In this perspective, Third World countries seem to be caught in the dilemma of always being chasing behind the advanced countries, even in spite of the achievement of some technological progress.[21]

But this is of cause no exhaustive account of what is going on the technological field. I have restricted myself to the mentioning of some important development trends on a rather high level of abstraction. To come more to grips of what is going on, we need to be more specific, distinguishing between various types of countries.

What we may note, is the tendency for technological development to contain new possibilities as well as new limitations for Third World countries: the former because of intensified transfers of technology to the Third World, even advanced technology; the latter because of the fact that vital advanced technologies are still retained in the center countries, who also control related R&D-activities.

Against this background, a more precise valuation of the role of transnational corporations as far as technology transfer to the Third World is concerned, cannot be made on this general level. Specific case studies are required. In the following sections, we turn our attention to the Brazilian case.

Transnationals and Technology in Brazil: Brazil's Technology Policies

The development priorities laid down by the military regime of 1964 did not contain any specific reference to the technology issue. The intention was that of basing economic development on imports of advanced technologies from the center countries, to a significant extent via direct foreign investment.[22]

The great expectations regarding foreign investors' contribution of technology did not come true. As is generally the case, transnationals operating in Brazil kept their R&D-efforts at home,[23] and did not contribute substantially to the increase of Brazil's technological capabilities.[24] The reverse side of this picture is the flow of payments from subsidiaries to the transnational parent for all kinds of technological "services". In the Brazilian case, there is little doubt that these payments constituted channels for additional profit transfers.[25]

Against this background, the military regime changed signals in the late sixties, turning research and technological development into a special policy area.[26] Three main kinds of measures were taken. Firstly, funds were devoted to the strengthening of Brazilian firms' technological capabilities on the one hand, and developing the country's scientific and technological infrastructure (basic research and education of scientists) in the other.[27]

Secondly, the Institute for Industrial Property (INPI) was formed in 1971. All contracts regarding foreign technology are subject to INPI's approval, the main aim being that of reducing the costs of imported technologies, and cancelling restrictions preventing real transfers of technology.[28]

Finally, if the measures mentioned above amount to the "stick" used on foreign investors, the "carrot" consisted of new econo-

mic incentives for inducing transnationals to increase their R&D-efforts in Brazil. Tax exemptions and access to favourable financing of R&D are the main elements in this regard.[29]

A number of other measures taken in the seventies (financial support to local firms manufacturing producer goods, the purchase policy of state enterprises giving priority to Brazilian firms etc.) are also of importance for the development of local technological capabilities, but the above measures constitute the technology policy in a narrow sense. Before turning to a valuation of this policy, we shall take a closer look at a few concrete examples of technology transfer, allowing us to come more to grips with the problems involved in the creation of local technological capabilities.

Transnationals and the Transfer of Technology: Three Examples

1. Technip-KTI and Petroquisa[30]

The following example of technology transfer concerns the building of a new petrochemical complex in Rio Grande do Sul. Petroquisa (a subsidiary of Petrobras, the state-owned oil company) opened negotiations on the project in 1976. The aim was not only that of expanding Brazilian capacity in petrochemicals, but also to secure a real transfer of petrochemical technology to Brazil.

Two U.S., one German, and one French firm entered the bidding for the complex. The French firm Technip (in co-operation with a Dutch firm, KTI) was awarded the contract, due to the fact that Technip was the only bidder willing to release petrochemical frontier technology to the Brazilians.[31]

The contract with Technip-KTI meant that Brazilian technicians were involved in the project right from the drawing board. Sercovich summarizes the Brazilian's benefits from the contract as follows:

"- massive training and retraining at the supplier's R&D and other facilities;
- acquisition of rights to build, sell, and install ethylene plants in Brazil and any foreign country after 10 years;
- technical assistance (including that concerning future plant exports by PETROBRAS and adaptation of Technip's computer programs to Petrobras' computer system);
- complete access to all details concering engineering and scientific data, including methodologies, computer memories, process correlations, simulation models, manual of use and application, etc; althogether some 60 volumes with 20,000 pages;
- design of experimental units and technical assistance for R&D activities, and
- access to all improvements that the licensor may develop during the next 10 years." 32

The project is one further phase in the development of the basic petrochemical industry in Brazil which is characterized by increasing Brazilian participation. The first petrochemical complex in Sao Paulo (production start: 1972) held a negligible local share of producer goods and other materials. In the second complex in the Northeast (production start: 1978) the Brazilian share of engineering was 54 per cent and the share of producer goods etc. 65 per cent. Finally, in the Rio grande do Sul Complex mentioned above (production start: 1982), the Brazilian shares have increased to 70 and 61 per cent respectively.[33]

Most important, however, is not the quantitative increase of the Brazilian participation but the fact that the latter project involves a transfer of technology that is likely to take Brazil to the technological frontier in the petrochemical field.[34] The inbuilt risk is of course that the technology provided by Technip-KTI may not remain at the technological frontier. But even in that case, the contract means that Petroquisa will be much better equipped to absorb further technological developments in the petrochemical field.

Why was Technip[35] willing to make a real transfer of advanced petrochemical technology to Petroquisa? The main reason seems

to lie in the fact that when the contract was signed, Technip was undergoing a process of diversification meaning that in a longer perspective, petrochemical technology would not be a "core" activity of the firm. Against this background, future Brazilian competition in the field was not considered a serious threat.[36] Conversely, one should not expect more specialized transnationals, whose oligopolistic advantages are in the field of petrochemical technology, to be involved in that kind of real technology transfer.[37]

2. Nippon Steel and Usiminas.[38]

Usiminas is a steel rolling mill, founded in 1956 as a joint venture between a state enterprise (60 percent equity) and Nippon Steel (40 per cent). The company commenced production in 1962 under Japanese supervision and using Japanese technology. When full capacity was reached in 1966, Brazilians trained by the Japanese took over responsability for production.[39]

From the beginning, the Brazilian management put a high priority on developing the firm's technological capabilities. Each link in the chain of production was scrutinized, and improvements attempted comparing with the most efficient processes employed in foreign mills. In this manner, from 1966 to 1972, Usiminas was able to more than double the output from the initial plant.[40]

In a following phase, Usiminas established R&D facilities in 1970. Six years later, annual R&D spending amounted to roughly 50 million dollars. Technical assistance and know how was still purchased abroad, but on an increasingly selective basis, drawing on a large number of suppliers. The larger part of expenditure was on training of personnel at home and abroad with the aim of solving specific problems in the process of production.[41]

Dahlman Summarizes the technological developments of Usiminas as follows:

> "Overall the Usiminas experience suggests that successful local technological development depends on a relative long term strategy of building systematically on experience as it is acquired. The first phase of this process involved accepting the practices and advice given by the Japanese in the initial operation of the plant. However, as a clearer idea of the technological package was obtained through this initial experience and the firm passed to the stage of analyzing the contents of the package it passed from the know how stage to the know why stage. As it learned by doing, it entered into the more difficult phase of studying and understanding its technology in order to pinpoint its deficiencies and correct them. This involved the creation of the research oenter and the purchase of a more specific and more focused technological assistance. Usiminas absorbed the technology it purchased at each step so that it progressively moved the type and nature of the assistance which it bought to a higher and more specific level." 42.

In the late seventies, Usiminas has entered the "final" stage of this process. The firm is itself developing new processes and products, and has become one of Brazil's most important exporters of technology.[43]

The Usiminas experience examplifies a process by which the firm has so to speak "upgraded" itself technologically, from a starting point of almost exclusive dependence on foreing technology. The fact that other Brazilian steel mills of similar size have not had the same kind of succes in this field testifies to the assertion that such developments are only workable when the firm in question places a very high priority on developing technological capabilities.[44]

On the other hand, the process also requires transnationals willing to offer the kind of technical assistance that Usiminas required. In this case, mainly Japanese partners have been involved. There is evidence, though, that the Japanese are unwilling to go all the way in this regard. When the Brazilians announced in 1981 the desire to "move into the sophisticated steel market",[45] Japanese backing was not forthcoming. "Purpo-

seless adoption of the most advanced techniques should be avoided"[46] a leading spokesman of Nippon Steel argued in 1981, valuating the future position of Third World countries in the field of steel manufacture. The question is then, whether Usiminas has already gained capabilities that may allow for disregarding the Japanese "opposition", or alternatively, will be able to obtain further technical assistance from other sources.

3. SYCOR, IBM and COBRA

COBRA (Computadores e Sistemas Brasileiros), founded in 1971, is the only state-owned computer manufacturer in Brazil. Together with three private Brazilian producers, COBRA was in 1977 put in charge of Brazil's manufacture of minicomputers. The responsible authority, CAPRE,[47] wanted to reserve the minicomputer field to Brazilian producers. Consequently, the big leading computer firms already very active in Brazil were barred from the Brazilian minicomputer market.[48]

A significant part of the military government wished to establish a Brazilian capability in the computer field, for reasons of "national security".[49] The head of CAPRE saw the 1977-decision as "...the first important defeat that the transnationals have suffered in Brazil for the last 20 years."[50]

None of the leading computer firms were willing to undertake real transfers of technology to the Brazilians. However, COBRA got a contract with the comparatively small U.S.-firm SYCOR.[51] SYCOR was no threat to the leading firms, at home or abroad. Without the contract with COBRA, it was unlikely that SYCOR would have got a foothold in the Brazilian market. Against this background, the company has less to lose by joining forces with a Brazilian firm.[52]

The contract gave way to two kinds of criticism.[53] Firstly, it was doubted whether Brazil had the technological capacity

to produce its "own" computers. Secondly, the technology contracted from SYCOR was claimed to be substantially less advanced compared with that of the leading firms.[54]

Meanwhile, IBM's Brazilian subsidiary turned the screws on the government, complaining to be a victim of discrimination. And IBM also claimed that it would be able to manufacture a computer with ten times the capacity of COBRA's at a price of no more than 50 per cent over the COBRA product.

IBM's pressure bore fruit in late 1978, when the company was allowed to market a computer of medium size, capable of competing with COBRA's minicomputer.[55]

In late 1980 COBRA was able to present its Model 530, the first medium sized computer designed and built in Brazil. At the same time, however, the company ran into financial difficulties. Just to keep abreast with technological developments in the field, COBRA has to spend considerable amounts on R&D. 8 per cent of the 1980 turnover was devoted to this task. the corresopnding figure for IBM is 5.9 per cent. But the actual difference is of course enormous: COBRA spent 5.9 million dollars on R&D in 1980; IBM spent 1.4 billion dollars.[56]

The course of events illustrate the difficulties in establishing local technological capabilities in a field heavily dominated by transnational corporate giants, unwilling to transfer "their" technologies. In addition, it is a field where the Brazilian point of departure was relatively weak, technologically as well as economically.

Real transfers of technology from transnationals: When are they possible?

What have we learned from these examples of technology transfers? Real transfers of technology contributing the the estab-

lishment of locally controlled technological capabilities require three preconditions, all of them seemingly commonplace, but worth a closer look anyhow: 1. The existence of locally controlled firms capable of demanding real technology transfers; 2. a high local priority on real technology transfer relative to other aspects of business activities; and 3. the existence of transnationals who are willing to undertake real transfers of technology.

Re. 1. The establishment of a locally controlled basic petrochemical industry and computer manufacturing has only been possible due to conscious measures taken by the state. Left to themselves, these areas would have been dominated by transnationals (or simply non-existent in Brazil). Such dominance would impede the building of locally controlled technological capabilities in these fields. Koopmann sees this as a more general dilemma of the Brazilian economy:

> "Thus, economic planners in Brazil find themselves in a precarious position: a weak domestic scientific and technological base is calling forth foreign direct investment as the main source of technology, if the self-imposed ambitious growth and productivity targets are to be fulfilled. Foreign capital, however, by its very nature is tending to further frustrate domestic R&D efforts." 57

The automobile industry in Brazil, dominated by transnationals, carries a recent example of the difficulties referred to by Koopmann. After the first rise in oil prices in the early seventies, the Centro Technológico da Aeronáutica (CTA) (run by the air force) started constructing an alcohol engine for automobiles. Due to these efforts, CTA was able to establich technical norms for the manufacture of alcohol engines.[58] The plan was that the construction of the engine should lead to a locally controlled production of trucks and busses, in cooperation with private Brazilian firms.[59]

However, transnationals in the automobile industry turned against these developments. When in 1979 the TNC's made an agreement with the government to commence production of alco-

hol engines, they were allowed to use modified versions of their own engines, for which royalties were paid to the parent companies. And the transnationals were also able to induce the government to close down CTA's alcohol engine project.[60]

These developments illustrate some of the difficulties involved in establishing a locally controlled technological capability in a field dominated by transnational corporations.

Re. 2. The local firm involved has to place a high priority on developing technological capabilities relative to other aspects of business activities. If the technology aspect had not carried top priority, Petroquisa "ought to" have chosen one of the U.S. firms for constructing the petrochemical complex. The U.S. firms were offering more attractive terms in other aspects than technology.[61] A high priority on technology was also the reason for Usiminas' success in the field, as compared to other local steel rolling mills.

Other circumstances may, however, impede a high priority on technological capabilities. There is evidence that in recent years, Brazil has accepted some "unnecessary" technology imports in order to achieve satisfactory results in renegotiating its heavy foreign debt.[62] One may also note that international lending institutions seem to put a priority on imported technology: for example, only 15 per cent of the World Bank's project loans are set aside for local suppliers; the rest is submitted to international tender, a procedure that does not help to promote local technological capabilities.[63]

Re. 3. Real transfers of technology must of course imply transnationals willing to go along with such transfers. The transnationals involved in the previous examples were all "otusiders" in a Brazilian context when the contracts were made. In addition, Technip and SYCOR were relatively small firms in an international context, able to gain foothold in Brazil through the contracts.

There is hardly any straightforward answer to the question whether other industries have similar firms, being at the same time "outsiders" and capable of offering relatively sophisticated technologies. In my opinion, there are many industries with this type of firm. If this is true, the question whether they are employed or not depends primarily on the points discussed above.

It should also be noted that contracts with "outsiders" tend to influence relations to the big, dominant transnationals in the respective industries. For example, COBRA's deal with SYCOR caused Olivetti to take local majority partners in its Brazilian subsidiary, and "... Control Data is considering making the same move for its computer service activities in Brazil".[64]

The Outcomes of Brazil's Technology Policies and the Role of Transnationals.

The launching of conscious Brazilian policies in the field of technology has to a large extent taken place during the seventies. Consequently, comprehensive analyses of the effects of these policies are not yet available. What follows are some preliminary comments, mostly based on interviews taken in Brazil in mid-1982.[65]

Focusing firstly on the economic aspect. i.e. the payments for foreign technology, we noted the formation of INPI in 1971, aimed at reducing costs for imported technologies. INPI seems to have been fairly successful in this regard. In a number of cases, the institute has been able to bring about price reductions in the contracts subjected to its approval. INPI has also been able to support local firms in their negotiations for foreign technology supply.[66]

The problem is, however, that INPI's control applies only to payments for technology. Other possible channels for transfer-

ring funds (profit repatriations, intra-firm loans, etc.) are not subject to similar forms of detailed scrutiny. This being the case, it is still possible to divert payments for technology to these channels. For example, the value of imported technology may be entered as a direct investment, with payment for the technology provided in the form of profit repatriation on the investment, a field with much "looser" regulations than those applied to technology payments proper. A similar procedure may be applied to the supply of technology to Brazilian firms: the transnational supplier becomes a minority shareholder in the Brazilian company.[67]

Against this background, INPI's "isolated" succes in the field of technology payments proper is not necessarily a succes in a broader perspective, involving other forms of payments to technology suppliers. This points to the inherent contradiction in Brazilian regulations, between strict control of technology payments on the one hand, and less restrictive rules for alternative channels of economic transfer on the other.[68]

Let us turn to the technological policy element proper. One main aspect in this regard was the attempt to induce transnationals to conduct more R&D in Brazil. The incentives provided in this field have not had much effect: with the exception of R&D aimed at adaptation of products and processes to Brazilian conditions, the transnationals still keep their R&D at home.[69] Transnational subsidiaries do not contribute substantially to industrial R&D in Brazil, and even less to the establishment of locally controlled technological capabilities.[70]

The dilemma is there: giving priority to rapid industrial growth via direct foreign investment tend to impair the main aim of the technology policy: expanding locally controlled technological capabilities.[71]

Maybe this dilemma is less pronounced after 1974, where general policies have aimed at strengthening local capital in the

Brazilian economy. But transnationals are still in heavy presence, tending to impede the establishment of locally controlled technological capabilities in industries dominated by foreign investment.

There are of course other problems involved in expanding locally controlled technological capabilities. One of the most important is probably the lack of a sufficiently qualified labourforce:

> "Although the Brazilian government has launched ambitious training and ecucational programs, a high percentage of the nation's business executives maintain that a shortage (perhaps even a growing shortage) of competent administrative and technical personnel will exist in the future because government program efforts have been limited to date, new technological innovatiosn require the utilization of a progressively more highly trained staff, and the expanding Brazilian economy will demand more capable personnel than are being prepared by the Brazilian system." 72

In spite of these problems, the technology policies have also had some success: it has in fact proved possible to start developing locally controlled technological capabilities in certain fields,[73] and it has also proved possible to implement real transfers of technology - even rather advanced technology - from some transnationals.

The measures taken in the technology field have, however, not yet basically changed the fact that Brazil is still to a substantial extent dependent on foreign technology, the latter being the most important source of technology supply.[74] But one should hardly expect such dramatic changes over a relative short span of years.

In sum, Brazil is still technologically dependent, but has also taken a step forward in building of a locally controlled technological capability.[75]

Which aspect, continued dependence or increasing technological "self reliance", will be the dominant one in coming years?

To a significant extent, that depends on the priorities given to the technological field relative to other considerations. Most recently, priorities have imposed themselves in the way that Brazil has been forced to deal with its spiralling foreign debt. Measures taken in this regard have meant negative industrial growth and a cutback in funds devoted to the development of an indigenous technological capability. On the other hand, this has not meant that the technology issue has been completely forgotten. For example, in 1981 one additional activity - the manufacture of microprocessors - was reserved for Brazilian producers,[76] and there is little doubt that the technological field will not again be disregarded to the extent that was the case in the early and mid-sixties.

Comments on the possible general relevance of the Brazilian case and the possible general relevance of obtaining advanced technology from transnationals

The most important lesson to be learnt from the Brazilian case is about the importance of strong local enterprises, when it comes to effectuation of real technology transfers from transnational corporations. Local capital (in the form of public or private enterprises) giving sufficient priority to the goal of real transfer of technology relative to other business aspects, are the most important precondition for such transfers to be undertaken. A strong local capital relative to foreign capital in the economy is also of importance in a wider perspective: the capitals' position in the economy form the power base from which state policies can be influenced. (On the other hand, state measures affect the relative power positions of local and foreign capital).

The stronger local capital interested in local technological capabilities, the better possibilities of promoting policies further enhancing this process. In this context, there seems to be a "good" and a "vicious" circle as far as the regulation of transnationals and technology transfers are concerned.

In the "good" circle, measures strengthening local capital's technological capabilities provide a basis for further measures in the same direction, towards an increasingly efficient regulation of technology transfers.

In the "vicious" circle, foreign capital holds strong positions in the economy, tending to prohibit efficient regulations. When such regulations are not forthcoming, technological dependence is enhanced, and the possibilities for arriving at efficient regulations decreases even more.

There is little reason to believe that the lesson learnt from Brazil has to do with factors unique to the Brazilian case. I contend, in other words, that the result is applicable to Third World Countries in general: the strength of local capital is of prime importance when it comes to ensure real technology transfers from transnationals. Considering the fact that the local capitals of most Third World countries are much weaker than is the case in Brazil, we must expect these other countries to be up against even harsher odds when it comes to reaping real technology transfers from transnationals.

This only serves to underline the strategic implication stemming from the previous analysis: the development of a strong, locally controlled technological base in Third World countries is not possible by relying on transnational corporations undertaking direct investments. On the contrary: in order to reap the technological benefits from transnationals, there has to be a strong local economic basis. There is, in other words, no easy way out: the gradual, perhaps even slow way of learning by doing is the only way to develop a strong technological base. Technology has it somewhat like love: you cannot buy the real thing.[77]

Having come this far, we must touch upon one last issue; it is, of course, the debate over "modern" or "advanced" versus

"appropriate" or perhaps "home-grown" technologies.[78] Having stressed in the above, the circumstances under which real transfers of advanced technologies are feasible, an 'appropriate-tech-freak' will undoubtedly mistake me for a 'modern-tech-freak', and this is precisely what is wrong with this debate: the contenders see each other occupying extreme positions that are distortions of reality. Those advocating transfers of advanced technologies to the Third World seldom go to the extreme of envisioning a complete obliteration of 'home-grown' (usually labour-intensive) technologies. Conversely, those favouring appropriate technology would hardly stand up for a development strategy in which advanced, capital-intensive technologies played no role whatsoever.

The real front lines of the debate are, in other words, not as sharply drawn as some contenders will have us believe. This could not be taken to mean, however, that there are no front lines at all. To my mind, the nitty gritty thing of this both academic and real world controversy is a piece of oversight on both sides: adherents of 'appropriate technology' tend to forget that there are only a very exclusive few countries in this world capable of autharky; consequently, (almost) all countries have a measure of integration in the world market. To participate in this world market on a basis of equality requires a measure of self-centred economic development. This in turn cannot be realized without controlling some measure of what we call advanced technologies, often only to be had from certain TNC-sources.

On the other hand, adherents of 'modern technology' tend to forget that what these technologies often do is to substitute one kind of development problems for another. If, for example, modern technology gives you maximum otuput with high productivity and quality, it often also gives you ecological problems (pollution) and it more often than not involves new hierarchisation in the organization of work (new forms of exploi-

tation). In short, a number of advanced technologies tend to substitute one kind of maldevelopment for another. Moreover, these problems of advanced technologies are often aggravated in a developing environment, which does not have time, opportunity and/or resources to correct them.

When these two oversights are let aside, I contend that there is not too much left of the 'modern' versus 'home-grown' technology controversy. What we need is a debate with new frontlines: when realizing that each and every piece of technology contains its "own" particular mix of advantages and drawbacks, the debate should focus on what type of technology mix that is feasible and desirable for particular Third World countries, (generalizations of 'standard strategies' are hardly feasible in this area). That would bring the debate much closer to reality without totally depriving it of a measure of positive vision towards a better society.

1) Jens Müller: Liquidation or Consolidation of Indigenous Technology, Aalborg 1980.

2) Cf. Dieter Ernst: International Transfer of Technology, Technological Dependence and Underdevelopment: Key Issues, in same (Ed.): The New International Division of Labour, Technology and Underdevelopment. Consequences for the Third World, Frankfurt am Main/New York 1980, p. 25.

3) Cf. Charles Edquist & Olle Edquist: Social Carriers of Technology for Development, Discussion paper series 123, Lund University 1978.

4) Comparing with the broad view taken by Jens Müller, it will be readily understood that this perspective does not exhaust the issue of technology transfer. In other words: my focus here is on reaping control of techniques and knowledge from the hands of transnationals, and not on the issue of who the new controllers actually are: national entrepreneurs, the working class, the masses etc.

5) What follows relies heavily on my Ph.D.-research, reported in Georg Sørensen: Transnationale selskaber og udviklingsprocessen i perifere samfund. Med en case-studie af Brasilien, Aalborg 1983 (Danish). An abbreviated English version of my thesis is Georg Sørensen: Transnational Corporations in Peripheral Societies: Contributions Towards Self-Centered Development? Aalborg 1983.

6) E.G. John H. Dunning: Multinatioanl Business and the Challenge of the 1980's, in: Multinational Business, No. 1, 1978. Cf. Arghiri Emmanuel: Technologie appropriée ou technologie sousdévelopée? Paris 1981.

7) Cf. Daniel Malkin: New Patterns of Capital Goods Production and Trade and Developing Countries' Technological Dependence, in Ernst (Ed.) 1980, op.cit., pp. 232-55.

8) Sanjaya Lall: Developing Countries and the Emerging International Technological Order, in: Journal of International Affairs, vol. 33, No. 1, Spring/Summer 1979, p.87.

9) The UN observes that real transfers are not secured by merely turning to other forms of transfer than direct foreign investment: "The unbundling of the technology package confronts developing countries with much bigger challenges than excessive pricing of technology or restrictive business practices. The idea accepted by many of them that the establishment of joint ventures results in such unbundling and a subsequent decrease in technological dependency is not supported by evidence. Unless the local partner, be it the state or a private party, has developed its own technological capability beforehand, the establishment of a joint venture even if majority-controlled by local interests, will not necessarily reduce its technological dependency upon the

TNC parent. It may lead to the increase of technology cost instead." UN CTC: Measures Strengthening the Negotiation Capacity of Governments in Their Relations with Transnational Corporations: Technology transfer Through Transnational Corporations. A Technical Paper. New York 1979, p. 35.

10) In view of the fact that oligopolistic control over advanced technology enhances profitability.

11) Jack N. Behrman & William A. Fischer: Overseas R&D Activities of Transnational Companies: Cambridge, Mass., 1980, p. 116.

12) Technologies situated at the end of the product life cycle may be termed "standard" whereas advanced technologies are at the beginning of the cycle. Cf. Raymond Vernon: The Product Cycle Hypothesis in a New International Environment, in: Oxford Bulletin of Economics and Statistics, vol. 41, No. 4, NOvember 1979, pp. 255-69.

13) Quoted from Dieter Ernst's summary of the negotiations, in Ernst (Ed.) 1980, op.cit., p. 36.

14) Jack Baranson: Technology and Multinationsla. Corporate Strategies in a Changing World Economy, Lexington, Mass., 1978, p. 159. Cf. Ernst in Ernst (Ed.) 1980, op.cit., p. 63n., where the following observation on aircarft manufacturing is made: "Even if a Country can produce locally 70 and more per cent 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 workign 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." (Italics in original).

15) Cf. the contributions in Ernst (Ed.) 1980, op.cit.

16) Malkin in Ernst (Ed.) 1980, op.cit., p. 236.

17) Bennaceur & Geze in Ernst (Ed.) 1980, op.cit., p. 264, quote a director of Siemens for the following observation: "We must develop our own micro-processors, not for cost reasons but because it is impossible today to develop process controls without a deep knowledge of microprossor technology; 3 to 5 years are necessary to perfect process control systems and if we only know suppliers catalogue contents this system could be obsolete when it reaches the market."

18) For example, a number of German machine tool producers have re-located their manufacture of standard epuipment to countries like Hungary, Poland, Brazil, and India. Cf. ibid., p. 274.

19) According to Ernst in (Ernst (Ed.) 1980) op.cit., p. 38: "My research forces me to conclude that these key elements (of an industrial system) almost invariably remain under the strict control of a handful of private firms and public R&D-centres predominantly located in the major OECD-countries. In fact it is possible to discern strong tendencies to exacerbate this hierarchy of control."

20) Daniel Malkin in Ernst (Ed.) 1980, op.cit., p. 251.

21) This tendency for a hierarchization of countries as far as technological capabilities are concerned also involves increasing hierarchization within the group of advanced countries themselves, cf. Bennaceur & Geze in Ernst (Ed.) 1980, op.cit., p. 273.

22) This is reflected in various investigations of the situation for Brazilian research and technological development in the sixties. One survey covering 1967-69, counted 46 institutions (17 per cent private) engaged in industrial R&D, with a total of roughly 5,000 academic personnel. No less than 86 per cent of research activities were directed at the adaptation of existing technology to Brazilian conditions, and only 9 per cent involved creation of new products or processes; (cf. F.A. Biato et.al.: Potencial de Pesquisa Technologica no Brasil, IPEA/INPLAN, Relatorio de Pesquisa No. 5, Brasilia 1971.)
The investigation also looked at the R&D efforts of the 500 largest local firms. 64 per cent of the firms undertook "adaptive" R&D. None of them were engaged in R&D with a view to new products or processes. Consequently, 62 per cent of the firms reported that they employed imported foreign technology when starting new lines of production.

23) Cf. Peter Evans: Dependent Development. The Alliance of Multinational, State, and Local Capital in Brazil, Princeton 1979, pp. 172-80. Richard S. Newfarmer & W.F. Mueller: Multinational Corporations in Brazil and Mexico: Structural Sources of Economic and Noneconomic Power, Washington 1975, p. 178. D. de Faro Passos: Multinational Corporations and the Transfer of Technology: The Case of Brazil, in: D. Germidis (Ed.): Transfer of Technology by Multinational Corporations, Paris 1977.

24) There is no agreement as to a definition of the term "technological capabilities". UNCTAD (Towards the Technological Transformation of the Developing Countries. Main Policy Issues, Manila 1979, p. 8) employs a number of measures for indicating technological capabilities (i.e. "ratio and volume of capital formation, the import and domestic

manufacture of capital goods, skill formation and expenditure and manpower devoted to research and development.") Against this background, the discussion in the main text is clearly more limited. What is at stake there is the issue of real as opposed to formal transfers of technology, the former constituting a contribution to the country's technological capabilities.

25) Cf. Eduardo A. Guimaraes et.al.: Changing International Investment Stratetegies: The "New Forms" of Foreing Investment in Brazil, Rio de Janeiro (IPEA) 1982, pp. 33-61.

26) This must also be seen in the context of the military's attempt to construct a Brazilian military industry, cf. Clovis Brigagao: Brazil's military Industry: A Discussion of Recent Developments, LARU Working paper No. 27, December 1977, pp. 22-42.

27) Cf. Harvey Wallender III: Technology Transfer and Management in Developing Countries, Cambridge Mass., 1979, pp. 178-98; A.L. Figueira Barbosa: Propriedade e Quase Propriedade no Comércio de Tecnologia, Brasilia 1981. In the Years 1975-77, roughly 1.5 billion dollars were spent on the programme.

28) Georg Koopmann: Technological Dependence and Technology Policy - the Brazilian Conception, in Ernst (Ed.) 1980, op.cit., p. 409n. In the course of the seventies, new regulations have been added, strengthening INPI's capacity to take action in the areas mentioned in the main text.

29) Cf. Evans 1979, op.cit., p. 186.

30) What follows is exclusively based on Francisco Colman Sercovich: State-Owned Enterprises and Dynamic Comparative Advantages in the World Petrochemical Industry. Development Discussion Paper No. 96, Harvard University, Cambridge Mass. 1980.

31) Ibid., p. 32.

32) Ibid., p. 40n

33) R. Miragaya: A Technología Petroquímica No Brasil, mimeo, Bariloche 1976, quoted from ibid., p. 21.

34) Ibid., p. 1: "By 'technological frontier' it is not meant that involving just operating but also innovative capabilities. Put another way, reference is made not just to scale, efficiency, and sophistication of plant, but also to organizational, R&D, and engineering capabilities. The capacity to get to the frontier entails that of staying there. It is not just a one-shot,but a permanent gain".

35) The Dutch firm KTI played a minor role in the contract, which is why reference in the main text is to Technip only.

36) Sercovich adds three further reasons for Technip's accept of the contract. Firstly, Technip is a state enterprise; consequently its main aim is not corporate profitability but that of promoting the products of French Industry abroad. Secondly, the market situation at the time of the contract, with stagnation in sales for Technip. Thirdly, the enterprise wished to gain a solid foothold in the Latin American market, particularly in Brazil. Ibid., pp. 81-93.

37) Which is exactly why the other three firms entering the bid for the contract pulled out, cf. ibid., p. 32.

38) What follows in this section is largely based on Carl J. Dahlman: Foreign Technology and Indigenous Technological Capability in Brazil. Paper presented at the University of Edinburgh Workshop on Facilitating Indigenous Technological Capability, Edinburgh 1982.

39) Ibid., p. 28. At the same time, the Brazilian share of equity was raised to 80 per cent.

40) From half a million to 1.2 million tons of steel. Ibid., p. 29.

41) Ibid., p. 31n. When Usiminas undertook a third phase of expansion in 1975, the firm was able to take responsability for the engineering part, being able to "...scan the whole technological frontier and draw up its own specifications for what I wanted to purchase." The Brazilian share of equipment went from 10 to over 40 per cent.

42) Ibid., p. 32.

43) Loc.cit.

44) Ibid., pp. 30-35.

45) Quoted from Latin America Regional Report: Brazil, 13 March 1981, p. 6.

46) Quoted from Ibid., p. 7.

47) CAPRE is the state authority supervising the computer industry.
As far as I am informed, there is no comprehensive analysis available covering the computer field in Brazil. What follows is based on information from Latin America Economic Report, Latin America Regional Report: Brazil, Business Latin America, and interviews taken in Brazil.

48) At this point, IBM was already well established in Brazil, claiming almost 60 per cent of the market for larger computers, cf. Latin America Economic Report, 2 March 1979, p. 68.

49) Cf. Clovis Brigagao, op.cit., pp. 30-32.

50) Quoted from Latin America Economic Report, 6 January 1978, p.7.

51) SYCOR held 2,000 employees as of 1976.

52) Cf. Peter Evans: Shoes, OPIC, and the Unquestioning Persuasion: Multinatioanl Corporations and U.S.-Brazilian Relations, in: Richard R. Fagen (Ed.): Capitalism and the State in U.S.-Latin America Relations, Stanford 1979, p. 311n.

53) Coming from leading transnationals in the industry, but also from parts of the military government itself.

54) According to the critics the consequence would be that Brazil was saddled with non-competitive computer technology, cf. Latin America Economic Report, 6 July 1979, p. 207, and Business Latin America, 6 June, 1979, p. 178n.

55) Latin America Economic Report, 2 March 1979, p. 68n. It should be added that IBM's go-ahead was tied in with a number of conditions harsher than the company had envisioned. The required share of Brazilian components was set at 20 per cent (11 per cent in IBM's proposal); the patents involved were to expire within a prefixed time frame; and finally, IBM promised to export 75 per cent of the output.

56) Latin America Regional Reports: Brazil, 3 July 1981, p. 7. In the light of these difficulties, the government considered bringing private capital into COBRA.

57) Koopmann in Ernst (Ed.) 1980, op.cit., p. 407.

58) Latin America Economic Report, 14 September 1979, p. 286.

59) Loc.cit.

60) Latin America Regional Reports: Brazil, 30 May 1980, p. 6.

61) Cf. Sercovich 1980, op.cit., p. 30n.

62) A recent example: In 1980, Petrobras made a contract with the French firm Elf Acquitane to build facilities for manufacturing fuel based on alcohol. This is a field where Brazil has devoted substantial efforts to developing its own technological capabilities. According to a Brazilian technology expert, Elf's supply of technology was "totally unnecessary" from a technological point of view. The same observer found that the deal was made with a view to the

ongoing negotiations between France and Brazil, concerning Brazil's external debt. (Interview, Rio de Janeiro, 1982).

63) This procedure was used in contracting a 1 billion dollar World Bank loan to Brazil's alcohol fuel project, cf. Latin America Regional Reports: Brazil, 17 April 1981, p. 3n.

64) Business Latin America, October 22, 1980, p. 344.

65) The interviews covered three main groups: state officials in charge of technology policies; representatives of transnationals operating in Brazil; and Brazilian researchers within the social sciences.

66) This valuation rests primarily on interviews with Eduardo A. Guimaraes,head of Instituto de Economia Industrial at Universidade Federal do Rio de Janeiro, and A.L. Figueira Barbosa, representative of INPI. Guimaraes based his comments on an as yet unpublished survey of technology payments before and after the founding of INPI.

67) In addition, transfer-pricing may be employed to secure technology payments, cf. Koopmann in Ernst (Ed.) 1980, op.cit., p. 410n. The study by Business International Corporation: Coping with the Brazilian Bureaucracy and Key Regulatory Agencies: A Corporate Guide, New York 1980, holds a section entitled: "Ways to avoid INPI and still get paid" (pp. 168n)

68) Cf. Latin America Economic Report, Vol. VI, No. 9, 1978, p. 66.

69) I have no systematic data to back this valuation. It is based on the general account given by Evans 1979, op.cit. pp. 178-95, and interviews taken in Brazil, cf. note 65. It should be mentioned that there are exceptions to the general picture outlined in the main text. For example, the European transnationals that have been awarded the supply of turbines to Brazil's gigantic hydroelectric power station at Itaipu, have agreed to install part of the R&D related to turbine-technology in Brazil. The main reason is that Brazil is the world's largest market for turbines and the companies involved were already large-scale manufacturers in the country. Cf. Latin America Economic Report, 30 June 1978.

70) It should be stressed that I am thinking primarily of R&D involving new products and processes. When considering technological capability in a wider perspective (training of personnel, establishing norms and standards with local suppliers, etc.) transnationals are making contributions, cf. Dahlman 1982, op.cit., p. 22, referring in particular to the upgrading of technological capabilities of the transnational carmanufacturer's local suppliers.

71) In industries heavily dominated by transnationals, the first precondition for real technology transfer, i.e. the existence of locally controlled firm capable of demanding such transfers, is simply not there.

72) Wallender 1979, op.cit., p. 198. An additional problem in this context is the so-called "internal brain-drain" referring to the fact that transnationals are often able to offer career possibilities capable of attracting highly qualified Brazilian manpower, cf. loc.cit.

73) Priority has clearly been given to areas considered to be of importance for "national security" by the military government.

74) Cf. Erber in Ernst (Ed.) 1980, op.cit., pp. 422-29.

75) By technological dependence, I do not primarily refer to the fact that Brazil imports more technology than it exports. A similar situation applies to most industrialized countries, cf. The Economist, July 26, 1980, p.75. I am thinking more of what Koopmann calls the discrepancy between "...the technological demand arising from the productive system and country's scientific and technological capacity", Koopmann in Ernst (Ed.) 1980, op.cit., p. 405.

76) Cf. Business Latin America,April 15, 1981, p. 114n.

77) A number of OPEC countries have had to realize, in recent years, that coffins full of money cannot and could not buy them into the control of advanced technologies overnight.

78) See for example Emmanuel 1981, op.cit. versus Ward Morehouse: Technological Autonomy and Delinking in The Third World: Confronting the Unholy Alliance of Power, Privelege and Technology in Rich and Poor Countries, in Ernst (Ed.) 1980, op.cit., pp. 529-56.

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