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PREPARATION OF A PROGRAMME OF WORK

The channels and mechanisms for the transfer of technology from
developed to developing countries

A study by Charles Cooper with the
collaboration of Francisco Sercovitch

Note by the Secretariat

This study was jointly commissioned by the Office for Science and Technology of the Department of Economic and Social Affairs of the United Nations and the UNCTAD secretariat, in response to the request of the United Nations Advisory Committee on the Application of Science and Technology to Development made at its thirteenth session. The Ad Hoc Working Group of the Advisory Committee, dealing with Industry and Transfer of Technology, considered the provisional version of the study which has been revised in the light of the comments of the Working Group. The Advisory Committee at its fourteenth session agreed with the conclusion of the Working Group that "the revised study should be submitted to the UNCTAD Intergovernmental Group on the Transfer of Technology for its consideration" (E/AC.52/L.120, Annex V, para.11).

The views expressed in this study are those of the authors and do not necessarily reflect those of either of the secretariats.

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We have taken full account of the various comments we received in this revision. At the same time, we would like to have done more justice to some of the points made on earlier drafts, but in certain cases we could not do so because they raised issues which could only be resolved by further research. The faults remaining are, of course, our own.

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INTRODUCTION AND SUMMARY

1. This study reviews and analyses the ways in which developing countries get production technology from advanced, industrialized countries. The study categorizes some of the main mechanisms for such transfers of technology, discusses the implications which the various types of transfer might have for development, and outlines some of the main problems which need to be studied as a basis for policy-making.
2. The emphasis is very much on transfer of industrial technology for the manufacturing sector (there is not much analysis of primary sector problems). The transfer of industrial technology poses different problems from that of agricultural technology and needs to be analysed separately. The study is also limited to some extent to exchange of technology between developed market economies and developing economies. This is not by choice, but because it has proved difficult to collate and analyse the data available on transfers from socialist to developing countries in the time available.*
3. This study is merely a beginning: it poses more questions than it answers. It will have served its purpose if it puts the questions in an orderly and systematic way. The data on this important problem are lamentably inadequate - and often we cannot do more than indicate what more we need to know.

Summary

4. A difficulty in many discussions of the transfer of technology is the lack of clear definitions. Sometimes the concept is so loosely defined as to be analytically nearly useless. The first part of the study, therefore, is an attempt to define - or possibly to re-define - what is included in the "transfer of technology". The definition is based on the various elements of technical knowledge which enterprises in the developing economies normally have to get from the industrialized countries, when they set up new production facilities.
5. In the second part we describe the ways in which these various elements of technical knowledge are transferred from industrialized to developing economies. This amounts to a description of the mechanisms of transfer of technology. We attempt to include all the mechanisms discussed in the literature.

*/ For a useful study of transfers from socialist countries, see "Innovations in the practice of trade and economic co-operation between the socialist countries of Eastern Europe and the developing countries". (TD/B/238/Rev.1) report prepared for the UNCTAD secretariat by the Institute of Economics of the World Socialist System (Moscow), pp. 161 to 167.

6. It is useful to distinguish between two kinds of problem faced by enterprises in developing countries as far as technical knowledge is concerned. The first is that the elements of technical knowledge which are required (such as engineering design, machinery construction, process know-how and management) are often totally absent in the developing countries; the second is that even when these elements are available - or become available through transfers from the advanced countries - enterprises in the developing countries often do not know how to exploit them economically. There is, in other words, a double dependence: the elements of technical knowledge themselves have to be transferred, but so also does the capacity to use this knowledge in investment and production. Private sector enterprises in the advanced countries often possess the capacity to use technical knowledge to a high degree. For this reason, such enterprises, often dominate the transfer process. Sometimes they may contract other advanced country companies to supply some of the specific elements of technical knowledge involved in the transfer; sometimes they may be able to supply all the elements of technological knowledge from within their own organizations. At all events, the transfer of technology is often dominated by direct investment activities of advanced country enterprises or by wide-ranging licensing agreements. The main reason for this is that recipient enterprises have to rely upon such mechanisms to compensate for insufficiencies in their own capacity to put technical knowledge to commercial use, as well as insufficiencies in their technical knowledge per se.

7. In the third part, we examine the motivations of technology suppliers and recipients. It is argued that commercially-motivated transfers involving private corporations in the advanced industrialized countries play a predominant part in transfer to that majority of under-developed countries which are in the capitalist part of the world economy. The economic motivations of technology suppliers are examined, in the light of theoretical and empirical studies of the role of technology in competition - and also in the light of studies of the international strategies of private corporations. Technological knowledge - as well as the capacity to exploit it in production - is a source of quasi-monopolistic advantages for the corporations which possess it. Such advantages may be increased in developing economies with small but highly protected and consequently imperfect markets. On this view, there are areas of potential conflict between the interests of the technology suppliers and those of the developing country itself. A good deal of the policy discussion will centre around such conflicts.

8. The third part also contains an analysis of the costs, particularly the foreign exchange costs, of technology transfer, from the point of view of the developing countries. In addition, some problems which arise because of the terms of technology transfer (such as the limitation of exports from licensed technologies) are discussed.
9. In the fourth part we take a look at some of the policies which governments in the developing countries have followed in relation to the problems of transfer. There is, unfortunately, very little hard evidence on the efficacy of such policy. It is, however, possible to make some tentative policy proposals as a basis for further study.

PART ONE:

DEFINITIONS. THE NATURE OF TECHNOLOGICAL DEPENDENCE

IN THE DEVELOPING COUNTRIES

Technological dependence in the developing countries^{1/}

10. Technological change has apparently played a crucial role in the growth of production in both advanced and developing countries. There are, however, some differences between advanced and developing countries in the ways new technologies have been incorporated into production. In advanced countries, technological change has been generated "endogenously" for the most part and even where technologies have been "imported" from other countries they have rapidly become integrated into an internal process of technological advance. Each round of technological change to some extent laid a foundation for further advance. Technological advances in one part of the production system often created demand conditions which stimulated further technological changes in supplier or customer sectors.^{2/} Perhaps more fundamentally, each "round" of technological change resulted in a new differentiation of technical - and sometimes scientific - skills in the economy. These new, specialised skills provide factor inputs which are needed to sustain further technological advance.

11. This cumulative, endogenous process is not found to anything like the same extent in the developing countries. The older, traditional economies were, by and large, technologically static. The dualist structure of the "colonial" type of economy did little or nothing to generate technological advance. Monetisation of the economy gave rise to new demands for consumer goods - but initially these demands were met mainly by imports from the industrialised economies.

^{1/} This part - and particularly the distinction between technology as an endogenous or an exogenous factor - is a development of Celso Furtado's analysis in "Development and Underdevelopment". See Celso Furtado: "Development and Underdevelopment". University of California Press, 1964.

^{2/} David S. Landes: "The Unbound Prometheus". Cambridge University Press, 1969.

12. Depression, war and, after political de-colonisation, conscious development policies^{1/} have resulted in changes in the structure of production in many developing economies. Demands for consumer goods have been met increasingly from domestic production, and in some larger economies industrialisation has gone deeper, into intermediate and capital goods production.

13. From the technological point of view, industrialisation has taken place on different terms in developing countries compared with what happened historically in the advanced countries. In the developing countries, industrialisation has in most cases, been a response to domestic demands for consumer goods which were previously imported from the advanced countries. Naturally enough, it has been based on importation (or transfer) of technologies and production skills already existent in the advanced countries.

14. Wionczek has commented on this in the case of Mexico. He remarks that the "complications introduced into technology transfer by patent law" are at least partly accounted for by the existence of consumer markets which "demand known American-style goods". In these circumstances appropriate licencing arrangements (i.e. with the United States suppliers of the goods in question) are vital to local industries.^{2/}

15. Industrialisation in developing countries has not generally resulted in an endogenous process of technological advance. Nearly all new technologies used in these economies have been introduced from outside. In this sense technological change is an "exogenous factor" in the developing economies.

16. It is important to recognise here, that the exogenous nature of technology in the developing economies does not simply result from the convenience of using an existing technology to manufacture a well-established product. Basically, the problem is that the economic organisation of the developing countries simply did not generate the ability to create new technologies, nor the skills required to operate them. Dependence on external technologies is just as much a consequence of the very limited differentiation of technical skills in the developing economy as a result of the

^{1/} Celso Furtado, op.cit.

^{2/} See Miguel S. Wionczek: "Arrangements for the transfer of operative technology to the developing countries. Progress report of the Secretary-General: case study of Mexico", E/4452/Add.3/Rev.1 March 1968.

convenience of transferring existing technologies. The failure to develop technologies in areas where there are no advanced country techniques available attests to this (e.g. tropical agriculture)^{1/}. The lack of technical and administrative skills is one of the deep-rooted legacies of under-development, which even under relatively favourable conditions, will take a long time to overcome. It is important to bear this underlying condition in mind, in order to comprehend the origins of technological dependence as well as the inherent tendencies for technological dependence to perpetuate itself.^{2/}

17. From this point of view, the transfer of technology from advanced to developing countries is a natural result of attempts to industrialise on the base of a pre-existent economic structure which is incapable of generating the skills required to originate, introduce or operate the technologies required to meet growing consumer demands.

18. We shall define transfer as follows: "The transfer of technology from advanced to developing countries may be taken to cover the transfer of those elements of technical knowledge which are normally required in setting up and in operating new production facilities or in extending existing ones - and which are characteristically in very short supply (and often totally absent) in the developing countries."

The elements of technical knowledge

19. This definition leaves open the important question of what precise categories of technical knowledge are to be included in the concept of transfer of technology; in other words, the elements of technical knowledge must be more fully described. For the purposes of this study, we shall distinguish two groups:

Elements of technical knowledge needed in the pre-investment and construction stage:

- A. for feasibility studies and market surveys prior to investment;
- B. for determining the range of technologies which may be available to manufacture the product in question, and for choosing the most appropriate technique;
- C. for engineering design of new production facilities, involving both plant design and selection of machinery;

^{1/} See, for example, "The World Food Problem". President's Science Advisory Committee. The White House, 1966.

^{2/} Recent OAS publications have commented on this tendency in Latin America. For example, M. Halty-Carrere: "The Process of International Transfer of Technology", PAU, Washington, 1968, Mimeograph.

- D. for plant construction and installation of equipment;
- E. for the process technology proper.

Elements of technical knowledge needed in the operation stage:

- F. for management and operation of production facilities;
- G. for marketing;
- H. for improving the efficiency of established processes by minor innovations.

20. Most of these "elements" are self-explanatory. The process technology section, however, needs some discussion. It refers to technical knowledge actually "embodied" in the production process. For example, the chemical and engineering knowledge needed to "invent" a petroleum cracking plant is process technology; so is the engineering knowledge used in making a piece of textile machinery, or even the unsystematised mechanical knowledge required to build a hand-loom in an artisanal work-shop.

21. There are many sources of process technology. A production process may be the outcome of many years of research and development work, or it may result from the mechanical ingenuity of an individual craftsman. New process technologies may evolve from old through successive minor modifications.

22. Process technology is sometimes patented. Nearly all industrial patents apply to process technology or to new products, involving new or modified processes, rather than to other elements of technical knowledge. In addition, however, a considerable amount of unpatented technological knowledge is kept secret. We shall refer to patented and secret process technology together as proprietary process technology. It is estimated that about half of all industrially exploited inventions in this class of technology are unpatented but secret.^{1/} All other process technology will be called non-proprietary process technology.

23. The fact that a piece of process technology is 'proprietary' evidently implies some kind of restriction on its availability to other enterprises. It is necessary, however, to make some distinctions about the nature of these restrictions. Consider, for example, the case of a special purpose machine which has been developed and patented by a machine producer. The restriction involved here applies to the

^{1/} See V. Dolezil, "A Patents Bank for Developing Countries", Journal of World Trade Law, Vol. 3, No.6, November-December, 1969.

process of making the machine and, obviously enough, not to the machine itself. In other words, the machine-producer will wish to sell the new machine wherever he can, and the fact that the machine itself is patented, will not result in any restriction of its availability to enterprises which wish to use it as part of their production processes. On the other hand, the patent will put restrictions on other machine-producing enterprises which may contemplate the manufacture of the machine itself, or of something very like it. The case arise, of course, where the availability of a new machine is itself restricted. Suppose, for example, that the new machine is developed by a company for its own use, say for the manufacture of some new or highly differentiated product, and is patented by that company. In this case, evidently, the availability of the machine to other enterprises, which may wish to use it, is restricted. These distinctions are relevant in the case of transfers to developing countries, which very often involve new machinery and equipment. In these cases, the fact that the technical knowledge embodied in the new machinery is 'proprietary' may or may not affect the availability of the machine: whether it does so or not depends on whether 'ownership' of the technology is vested in the machine producer or in some other enterprise which uses the machine. In the latter case, there is normally some restriction: all discussion of "proprietary process technology" in this paper refers to this case (i.e. where there is a relevant limitation on the availability of technical knowledge), unless we specify to the contrary.

24. The ways in which process technology is transferred will be discussed later, but there is one point about the transfer process which should be mentioned immediately. It is sometimes suggested that whilst the transfer of proprietary process technology necessarily involves foreign payments by recipient enterprises in the developing countries (over and above payments for machinery and other hardware), non-proprietary technology can be transferred without cost. Non-proprietary process technology is, in this sense, a "free good". But, even if the process technology component is freely available and is obtained "embodied", so to speak, in imported equipment, it does not follow that the transfer is costless.^{1/} Obviously the transfer as a whole involves more than just the transfer of process know-how, and there will normally be costs (including foreign exchange costs) for other "elements of technical knowledge" such as engineering design or management or marketing. The technological dependence of the developing countries arises not only from their incapacity to invent new processes and products, but also from the lack of other, possibly more mundane skills.

^{1/} A recent theoretical discussion of choice and transfer of technology which assumes implicitly that because non-proprietary technology is a "free good" the whole transfer process is costless is J. Fei and G. Ranis. "Technological Transfer, Employment and Development" Yale Growth Centre Papers, 1969.

For example, Froes, Sepulveda and Wodzk^{1/} point out that, in the case where patented process technology is transferred, the unpatented components, which might appear as a 'mere implementing appendage of the patent', are in fact the 'more important and valuable component' of the transfer. Lightman^{2/} says that the 'most prevalent element in foreign licensing' is the supply of know-how required for production, maintenance and quality control. Lachmann^{3/} specifically discusses the case of unpatented or, more generally, non-proprietary process technology which is 'simple and stable'. Even in proprietary process technology which this case, enterprises in the developing countries depend on technical knowledge from advanced countries, without which the simple machine-embodied transfer of process technology is unlikely to be commercially successful.

25. Parenthetically, these examples demonstrate a difference between transfers of technology between advanced countries, and transfers between advanced and developing countries. It is true that the mere transfer of process technology is also generally insufficient for effective transfer between advanced country enterprises; here too, other elements of technical knowledge than those embodied in the process itself must be supplied to ensure commercial success. But in such cases, recipient enterprises are normally able to find the feasibility, design, plant, construction, managerial and marketing capabilities required in their own countries - if not in their own companies. In the case of enterprises in developing countries, the dependence on foreign skills is much greater - in many cases all the elements of technical knowledge required have to come from abroad.

1/ Carlow E. Henrique Froes, Cesar Sepulveda, Juan E. Wodzk: "Current Developments in Industrial Property Rights in Latin America"; Idea, Vol.7, 1963, pp.277-313.

2/ Joseph Lightman. "Compensation Patterns in US Foreign Licencing", Idea: The Patent, Trademark and Copyright Journal of Research and Education, Vol.14, No.1, Spring 1970, pp.1-31.

3/ Karl E. Lachmann. "The Role of Industrial Property in the Dissemination of Technical Knowledge in World Context". A United Nations View; Idea, Conference issue, 1965.

26. This designation of elements of technical knowledge is a way of setting boundaries to what is included in the concept of technology transfer. These boundaries confine the concept to those elements of technical knowledge which are immediately relevant to the installation and operation of production facilities. The categories correspond closely to the steps that are - implicitly or explicitly - involved in any decision to invest, and also to the technical inputs required in production. Traditionally, economists have tended to side-step the technical problems and complications of the decision to invest but in the context of technologically weak developing economies this is a crucial question.^{1/} Indeed, if we are to understand the nature and origins of technological transfer to developing countries, this is precisely the point we have to recognise.

27. Some other definitions show a similar pre-occupation with the transfer of technical knowledge required for the introduction and operation of new production facilities. Another United Nations study^{2/} defines the "process of technology transfer" in terms which are very similar to those we have used.

28. Quinn,^{3/} Hall and Johnson,^{4/} and Peter Gabriel^{5/} implicitly set similar limits to the transfer concept by defining it in terms of technical knowledge related specifically to setting up and operating new production capacity.

1/ One economist who has recognised this, just as he has recognised many other of the specific difficulties and contradictions of under-development, is Hans Singer. See Hans Singer. "International Development Growth Ways", 1967. The point is that the "pre-investment" problem that Singer describes can be assumed away in a context where all the technical, managerial and entrepreneurial skills for solving it are readily available. They are so in the industrialised economies, but not in the developing countries.

2/ "The promotion of the international flow of private Capital", fifth report of the Secretary-General, in Official Records of the Economic and Social Council, Thirty-ninth session, Annexes agenda item 8(E/4038 and Corr.1 and Add.1).

3/ James Brian Quinn: "Technology Transfers by Multinational Companies", Harvard Business Review, November-December, 1969.

4/ G.R. Hall and R.E. Johnson: "Transfer of US Aerospace Technology to Japan" Symposium of The International Economic Association, 1968, to be published.

5/ Peter P. Gabriel: "The International Transfer of Corporate Skills", Harvard University, Division of Research, School of Business Administration, 1967.

29. However, in each of these cases, there are some subdivisions of the elements of technical knowledge, which we shall make use of in later parts of this study. Thus, both Quinn and Hall and Knight distinguish three classes of technical knowledge or "technology" (using similar terminology). "General technology" is the kind of technical knowledge which is common to most firms in any industry. "System-specific technology" is knowledge possessed by a firm or individuals in it that differentiates the firm from its rivals and may give it a competitive edge. (Quinn - more specifically - identifies "system-specific technology" with the kind of technical knowledge which is likely to be protected by patents or other property rights). "Firm-specific technology" is the kind of technical knowledge which cannot be attributed or associated with any specific item the firm manufactures, but which results from its overall activity^{1/} and experience.

30. Peter Gabriel's sub-classifications are similar. He distinguishes: "general technical knowledge" which is readily accessible; "personal skills" which are normally transferred by individual action; "corporate knowledge" which is often patented or secret process technology, transmitted at the initiative or with the consent of the company which possesses it; and "corporate skills and capabilities" which can only be transmitted by the 'direct and continuous participation of the supplying organization as a whole.'^{2/}

31. These sub-classifications are useful for describing and understanding terms on which enterprises in developing countries get hold of technical knowledge. We shall examine them later in the discussion of mechanisms for technology transfer. An important point about these distinctions is that they separate certain elements of technological knowledge (in the case of Quinn, these are his categories "general technology", and "system-specific technology", which corresponds to our process technology; in Gabriel they are "general technical knowledge", "personal skills," and "corporate knowledge"), from the capacity to use this knowledge for commercial advantage. The capacity to use and exploit the technical knowledge for commercial advantage may be identified with "firm-specific knowledge" (in the Quinn and Hall and Johnson cases) and with "corporate skills" (in Gabriel's analysis). We shall return to this distinction in the discussion of mechanisms of transfer of technology in Part Two.

^{1/} See Quinn, *op.cit.*, pp. 301-312 and Hall and Knight, *op.cit.*, pp.306-309.

^{2/} Gabriel, Peter, *op.cit.*, pp. 66 ff.

PART TWO:

MECHANISMS FOR THE TRANSFER OF TECHNOLOGY

Classification of transfer mechanisms

32. A mechanism for transferring technology is any means for making available to a production enterprise (in our case, in a developing country) those elements of technical knowledge, which may be unavailable in the domestic economy, required to set up or operate production facilities. Considering the range of technical knowledge which may be transferred it is hardly surprising that there are a variety of mechanisms for transfer of technology. Also, because the developing countries characteristically lack many elements of technical knowledge - and particularly those needed for more sophisticated types of technology - it is possible that the range of 'mechanisms' which are used in transfers between advanced and developing countries is greater than in the case of intra-advanced country exchanges.

33. This heterogeneity poses some problems for the analysis of the transfer of technology. Fortunately, however, there appear to be some unifying features. Mechanisms for the transfer of technology can be grouped together in some simple categories. The main purpose of this part is to explore this possibility.

Transfer of technology and the supply of technical information:

34. It is possible immediately to limit the range of mechanisms which enter the picture. If the concept of technology transfer is limited to the elements of technical knowledge which are needed to set up particular new production facilities - rather than new production facilities in general - the analysis is more manageable. This makes it possible to distinguish the 'transfer of technology' from the wider concept of 'supply of technical information', (though from certain points of view technology transfer may appear as a special case - a subset, as it were - of technical information).

35. This has the advantage, that it helps to sort out a particularly intractable and heterogenous group of 'mechanisms'. These are the more or less informal and unspecific ways in which production enterprises and individuals in developing countries may learn about new technologies - as well as about technical and scientific knowledge in general. The category includes such things as exchanges of books, learned journals, trade journals and sales literature; informal personal contacts and relationships, attendance at meetings and conferences, training abroad for technicians from developing countries - and so on. Some authors put a good deal of emphasis on these exchanges

as mechanisms for technology transfer. For example, Harvey Brooks lists ten different 'mechanisms' of which at least six fit into this category of unspecific ways of transferring technical knowledge.^{1/} The same is true of nearly all of the categories defined by Velasco^{2/} Freeman, Oldham and Turkcan also include some of these mechanisms^{3/}. 36. For our purposes, these exchanges will only be considered if they are used to transfer elements of technical knowledge which are needed to set up and operate specific new production facilities.^{4/}

37. None of this is intended to understate the importance of providing developing countries with scientific and technical information, nor to understate the problems involved in doing so. These problems are acute and there are no doubt, strong arguments for new policies - and possibly new institutions - which might help to solve them. All we are saying, is that the supply of technical information in general is a different, or from certain points of view, a wider problem than technology transfer. Access to technical information is essential in developing countries, if only because it is a factor in learning about the availability of new technology. And if this study only considers those bits of technical information needed in actually setting up new production capacity, it is simply because it is analytically useful to separate the problem of technology transfer from the wider issue. We shall, however, return briefly to the technical information problem in the final part of the paper.

Direct or indirect mechanisms: a distinction:

38. Even with these constraints, however, the range of mechanisms for technology transfer is large and heterogeneous. Each of the elements of technical knowledge may be transferred in a variety of ways and even the transfer of one "element" by itself

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- 1/ See H. Brooks; "National Science Policy and Technology Transfer." Proceedings of a Conference on Technology Transfer and Innovation. National Science Foundation, May 1966.
- 2/ Jose R. Velasco; "Transfer of technology among the developing countries with emphasis on promotion and the encouragement of such technology." ECAFE Conference, document E/CN. 11/1. NR/IND Conf. Z/L. 23. 9 June, 1970.
- 3/ See study by C.H.G. Oldham, C. Freeman and E. Turkcan; "The transfer of technology to developing countries" (TD/28/Supp.1)
Also, W.P. Strassman; "Technological Change and Economic Development (The manufacturing experience of Mexico and Puerto Rico)", Cornell U.P. Ithaca NY 1968. Strassman includes technical information in general as a mechanism for transfer. However, he points to the inadequacy of technical information alone as a means of transferring elements of know-how.
- 4/ The same kind of restriction is implicit in the definitions used in: OAS; "Recent Developments in the Andean Group of Countries." Technology Development Unit, Dept. of Scientific Affairs, OAS. Washington, November 1965.

may involve a number of mechanisms. Pugh,^{1/} for example, remarks on the complex mix of know-how involved in the design and construction phase of production facilities.

39. There is, however, a broad distinction which may help considerably in the analysis of transfer of technology. On the one hand, transfers may be done through direct relationships between a number of supplying enterprises - each responsible for some of the technical knowledge required - and the recipient company; on the other, a single advanced country enterprise may take overall supervision of the whole transfer - and sub-contract other specialist enterprises in the advanced countries.

40. We shall distinguish in this study between transfers where enterprises in a developing country get direct access to suppliers of technical knowledge and those where some enterprise in an advanced country is 'interposed' in the process and takes upon itself the business of contracting and organizing the individual suppliers of technical knowledge. Diagrams I and II show extreme cases which demonstrate the distinction. In diagram I, the recipient enterprise engages a number of separate suppliers to provide it directly with the various elements of technical knowledge it needs. In diagram II, the recipient makes a contractual arrangement with a single enterprise in the advanced country (often a production company), which then organizes the individual suppliers of technical knowledge. Most real cases of transfer are more complex than those in the diagrams. There are many possible intermediate combinations between Diagrams I and II. For example, in Diagram I there is no reason why there should be a one-to-one correspondence between the elements of technical knowledge required, and the separate supplying organizations. One supplier may cover a number of elements (for example, engineering design and machine and plant construction may be done by a single enterprise). In other cases, more than one supplier may be needed to provide a single category of technical knowledge (e.g. machine and plant construction may involve a number of enterprises particularly in big investment projects).

41. The role of the contracting enterprise may be more circumscribed than in Diagram II. The intermediary firm may be responsible for only a part of the transfer process; for example, the recipient enterprise may use separate suppliers for some elements of technical knowledge and may get the remainder through an intermediary enterprise. In certain cases, some of the technical knowledge required may be available in the developing country itself or even within the recipient enterprise.

1/ Pugh, R.C: in chapter I of "The promotion of the international flow of private capital" further report by the Secretary-General, in Official Records of the Economic and Social Council, Thirty-second session Annexes, agenda items 2 and 5 document E/3492, 1961.

In the same way the contracting enterprise can normally supply some of the elements of technical knowledge required from its own resources and does not have to sub-contract. Finally, in the case of very large investment projects there may be more than one contracting enterprise - often one or more intermediary companies supply the technical knowledge needed in the construction phase, while a different enterprise supplies management or marketing know-how.

42. Diagram III is intended only as an illustration of some of these complexities. By way of example it shows a transfer operation where:

- (i) the engineering design for the recipient enterprise is done by a consultant company which sub-contracts to other groups for feasibility analysis and determination of the most suitable technology.
- (ii) An intermediary company supplies process technology (possibly under licence) and engages a single consultant group to advise on management and marketing in the recipient enterprise.
- (iii) The recipient enterprise contracts plant and machinery contractors directly - and also engages a consultant group to supply it with information on technological developments relevant to the field of production in question.

43. These models help to show how complicated the transfer of technology may be in practice. (They might also be used as a basis for categorizing the various forms in which transfer of technology takes place). However, the models also indicate that, in spite of the complexity of the transfer process, mechanisms might be classified into two broad groups:

- (1) those mechanisms that are used when recipient enterprises are in direct contact with suppliers of technical knowledge;
- (2) those mechanisms that come into play when an advanced company enterprise plays an intermediary role in the transfer process. The intermediary enterprise transfers a 'package' or 'bundle' of elements of technical knowledge.

44. For brevity, we shall call these the mechanisms for direct and indirect transfer respectively.

Mechanisms for direct transfer of technology:-

45. Mechanisms for direct transfers include such things as direct contracting of individual experts and consultant companies, engaging engineering design and plant construction enterprises, training nationals for specific production projects, technical information activities and transfer of the process technology embodied in capital goods by importation of equipment purchased directly from machine manufacturers.

MECHANISMS OF TECHNOLOGY TRANSFER

DIAGRAM I: DIRECT TRANSFERS

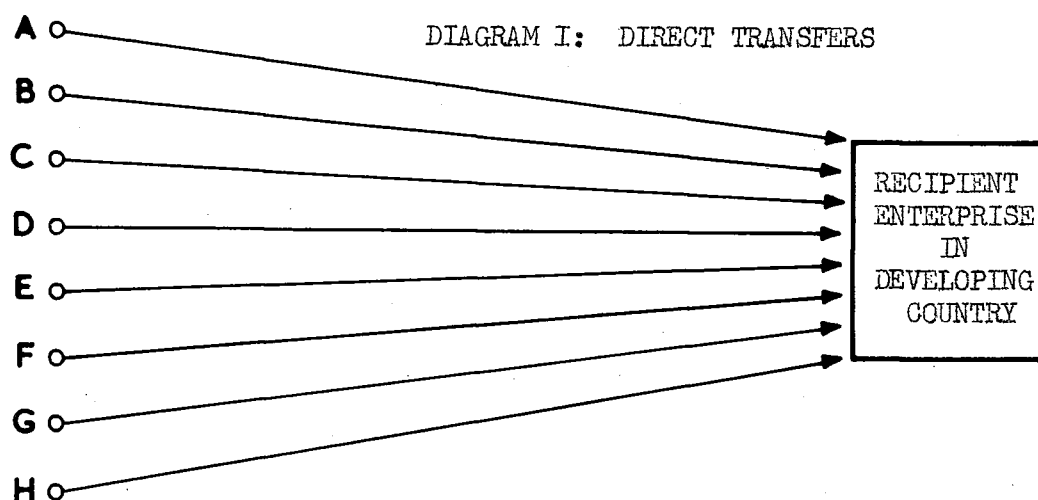


DIAGRAM II: INDIRECT TRANSFER

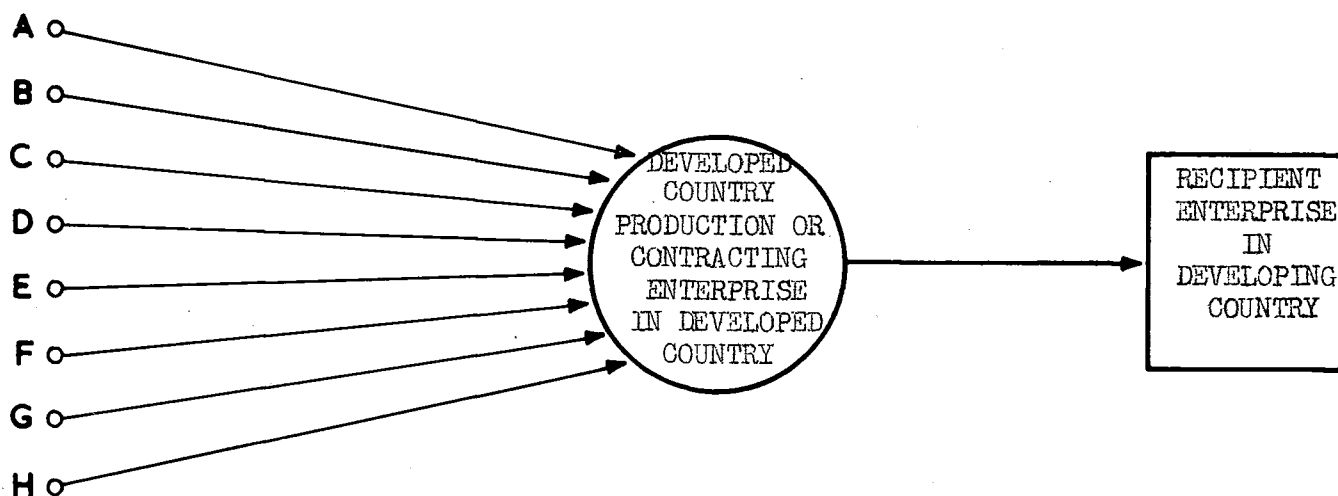
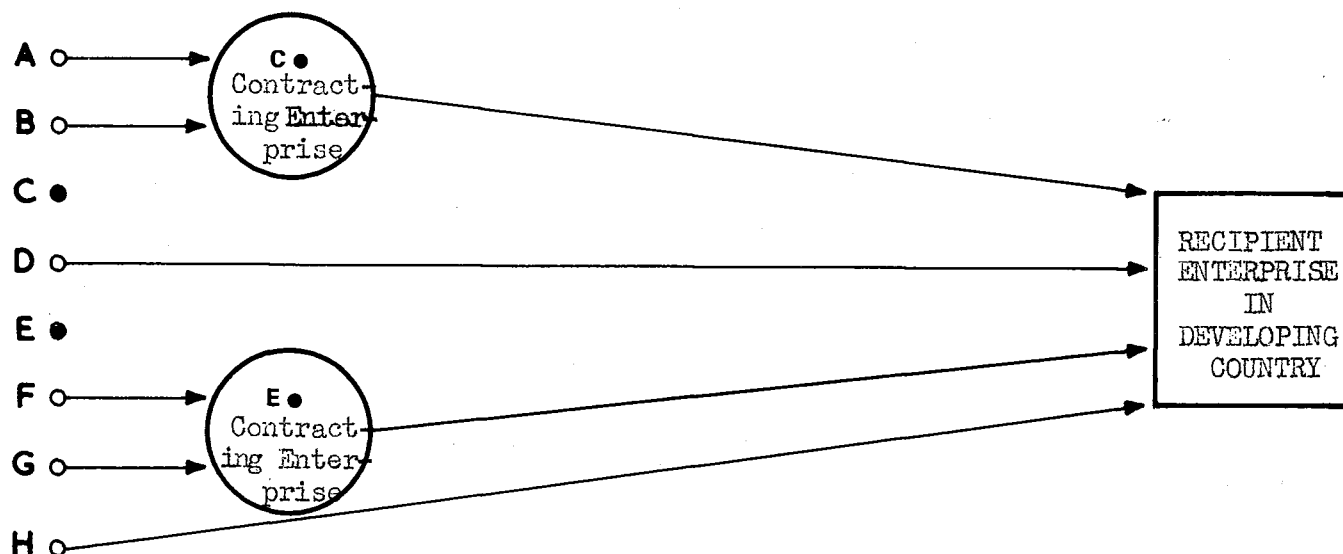


DIAGRAM III: HYPOTHETICAL EXAMPLE



46. An unknown, but no doubt substantial, part of the transfer of technology to developing countries takes place through such direct mechanisms. There are virtually no systematic data on direct transfers. Even if there were, there would be some very serious conceptual problems in interpretation, and particularly in comparing the relative importance of direct and indirect mechanisms. But it is probably safe to assume that a lot of the technical knowledge used in investment projects in developing countries is transferred directly. For example, it is our impression that a large proportion of plant and machinery imported by developing countries is the consequence of direct transactions between enterprises in developing countries and machinery suppliers in the advanced countries - (as opposed to plant and equipment imported under indirect transfer contracts, like licence agreements or investments by foreign enterprises).

47. Direct mechanisms of transfer are therefore likely to be quantitatively important in their own right. They are also important in relation to future policies for the transfer of technology. As we shall see, it is argued that there are economic as well as political problems associated with indirect transfers. For certain lines of production, it may be possible to use direct mechanisms as an alternative to indirect ones. The problem is to know where such alternatives exist and what economic consequences would flow from using direct rather than indirect mechanisms.

48. This question can only be properly examined later in the study. At this stage, we confine ourselves to a brief discussion of some of the main direct mechanisms, and to an outline of the advantages and disadvantages which are associated with them. Unfortunately, it is by no means easy to meet even this limited objective of description and preliminary analysis. The problem is that, although the direct mechanisms for transfer are in some sense obvious and well-known, there is as a matter of fact, very little systematic analysis of them or of the problems associated with them. Whilst the literature on indirect mechanisms (like foreign investments or licence agreements) is extensive - though still insufficient in point of empirical detail - the literature on such things as the role of machine suppliers or technical assistance consultants in the transfer of technology is very limited indeed. The imbalance is plainly reflected in this study, where a major part of the discussion is on indirect transfers.

49. It is probable that direct purchases of plant and equipment from machinery suppliers in the advanced countries can play an important part in direct transfers of technology. There are a number of factors which will determine whether or not

enterprises in the developing countries can get hold of the process technologies they require through direct transactions with machinery suppliers. In the first place, direct transactions of this kind are probably only possible where there are no restrictions on the availability of process technologies because of patents or proprietorship. As we have seen, patented machinery will be freely available in capital goods markets, if the patents are held by the machine producer. If, on the other hand, they are held by some manufacturing company which uses the machine, their availability will be limited - and in all probability transfer of the technology to an enterprise in a developing country is only possible through some indirect contractual mechanism.

50. Beyond this, it must be remembered that process technology embodied in machinery is only one of the elements of technical knowledge that the enterprise in the developing country is likely to need. Whether or not a direct transfer through machinery suppliers is a possibility may depend on the availability of other elements. A number of situations are possible. It may be, for example, that the technical knowledge required to use new plant and equipment into production is to some extent restricted and in the 'ownership' of production companies in the advanced countries. For example, whilst plant and equipment needed for petrochemicals production may be purchased directly - the technical knowledge needed to operate such plants may only be available from chemical companies in advanced countries. In spite of this availability of the machinery, an indirect contractual transfer may be unavoidable. In other cases, of course, machinery suppliers themselves are able to teach recipient enterprises how to use their equipment; this appears to be a very common practice in some sectors. In addition, in some sectors, enterprises in the developing countries have considerable operational experience, and will be able to supply the complementary technical knowledge needed to construct and operate the new production facilities in which the machinery is to be used. Alternatively, the recipient enterprise may have access to technical assistance experts and consultants to assist in construction and plant operation.

51. The conditions for direct transfers through machinery suppliers are probably most favourable in manufacturing sectors which are already well-established in developing countries (and where there is therefore some indigenous technical capability) and in which technologies are 'mature' and technological advance relatively slow. In such sectors, the incidence of proprietary technology will tend to be small. These conditions are probably met in the so-called traditional consumer goods industries

like textiles and clothing, food processing, leather production and so on - and this is one area where direct transfers through machine suppliers probably play an important part.

52. Direct purchases of machinery as a basis for transfers of technology present certain advantages. Such transfers may well avoid some of the difficulties (associated with indirect transfers (like price mark-ups on plant and equipment, or like transfer of inappropriate techniques) which we shall discuss in more detail later. But there are also problems.

53. First enterprises in developing countries may face highly imperfect market conditions in purchasing plant and equipment abroad. For example, even though there are no restrictions on the availability of machinery patented by machine producers, the existence of the patent obviously implies that the producer is in a quasi-monopolistic position. The degree of market control he can exercise will depend on the availability of alternative machines and - probably more crucially - on whether or not the recipient enterprise is aware of the existence of those alternatives. More particularly, market imperfections may be enhanced because enterprises in developing countries may be particularly dependent on machine suppliers for other elements of technical knowledge and also for adequate credit facilities for the purchase of the machinery. A machinery producer who is able to provide such services may have particularly strong bargaining power vis-a-vis the recipient enterprise and may be able to mark-up machine prices (as well as making payments for the complementary services he provides). In some large public sector projects financed by tied project aid, machinery suppliers are able to establish a virtually captive market - and price mark-up on imported machinery can be considerable. Research on these problems has been very limited.

54. It is argued that machine producers are much more likely to be willing to adapt a machinery to the specific conditions of production in developing countries, than say foreign investors who rely on the machinery they normally use in industrial countries. Once again, there is hardly any data on this. On the face of it, there are reasonable grounds for the argument - but there are also some fairly obvious constraints on the kind of adaptations which machine suppliers may be willing to undertake. Where adaptations are costly - say because they can only be made by large teams of highly skilled scientists and engineers - the potential market for the adapted machinery will be crucial in the decision whether to undertake the adaptation or not. Markets for machinery in developing countries are small; they may be too small to allow the machine producer to cover costs of adaptation without raising machine prices to a point where the private returns to the recipient company are diminished rather than increased.

55. And even if there is a sufficient market to amortize the costs of adaptation, the machine supplier must consider the returns he might have got by using his scarce scientific manpower for other purposes. We return to this problem later, in discussing indirect transfers where similar difficulties arise. It is probably true, however, that there are some possibilities for co-operation between research institutes in developing countries engaged on adaptive research and machine producers - and that such co-operation is easier in direct 'machine-supplier' transfers than say in transfers through foreign investments.

56. Individual experts and various kinds of consultant enterprise are used in the transfer of many elements of technical knowledge. Experts and groups may be contracted directly on a commercial basis by enterprises in developing countries, or they may be recruited on behalf of technology recipients by official multi-lateral and bi-lateral technical assistance agencies, and paid for by the agencies as part of a grant or soft loan aid programme. Indeed, the supply of experts and consultants (as well as the training of nationals for specific projects) is probably one of the main contributions that technical assistance activities make to the transfer of technology. It is worth noting, however, that the main difference between engaging consultants on a commercial basis and getting them through official technical assistance schemes, is that in the latter case the aid agency is responsible for recruiting and for payment. For the rest, the same consultant groups (and individuals) tend to be used in both commercial and technical assistance transfers. Strassman points out that officially financed transfers call on much the same groups as are used by those recipient enterprises which are willing or able to finance consulting services on their own account.^{1/} One consequence of this dual reliance on a single group of consultants, is that there is no guarantee that technical assistance experts and groups are more independent than consultants engaged on a direct

^{1/} W.P. Strassman. "Technical Change and Economic Development," op.cit.

commercial basis. The complaint, which is frequently voiced in the developing countries (and which certainly has some justification), that consultants tend to be linked formally or informally to particular suppliers of plant, machinery or process technology, applies as much to those financed out of technical assistance as to those engaged commercially.^{1/}

57. Parenthetically, we should mention that technical assistance programmes are not only used to support 'direct transfers'. They also play a part - though probably a quite limited one - in indirect transfers, involving an intermediary enterprise. J.P. Lewis^{2/} mentions that in the case of India, the United States Government Agency for International Development "increasingly needs to rely on the contract device with private industry" as a basis for transferring technology.

58. The role of research institutes as mechanisms for the international transfer of industrial technology is not often discussed, and most discussions centre on the contribution which research institutes could or should make, rather than on what they actually do. Applied research institutes obviously have a potential if unrealized role in creating appropriate process technology for developing countries

^{1/} The idea that there may be subjective biases in advice given by consultant companies engaged, for example, in feasibility studies or the selection of tenders, does not necessarily imply bad faith on the part of the consultant group itself, (though sometimes it does). The point is that any individual or group will inevitably be better acquainted with some potential supplying enterprises than others - and this itself may introduce biases. Generally consultant companies are best acquainted with other technology supplying enterprises in their home country.

^{2/} J.P. Lewis: "Quiet Crisis in India: Economic Development and American Policy," The Brookings Institution, Washington, D.C.

and in supplying other elements of technical knowledge. At the same time, there are a number of factors which have limited their contribution.^{1/}

59. For all the limitations in the contributions of research institutes to technology transfer, the few "success stories" that one finds indicate the role they might play. For example, Cockcroft quotes the work of the Mineral Science and Technology Division of the Warren Spring Laboratory in the United Kingdom. This laboratory provides technical assistance through the United Kingdom Ministry of Overseas Development: it has examined mineral extraction and processing methods for Malawi, Sierra-Leone and Kenya; officers of the institute have given technical advice in Turkey, Bolivia, and Kenya through United Nations programmes. Cockcroft^{2/} also mentions the United Kingdom Hydraulics Research Station, the Atomic Energy Authority (in connexion with the highly disputed and disputable sea-water distillation projects) and the Overseas Liaison Unit at the United Kingdom National Institute of Agricultural Engineering and the Tropical Products Institute. To a considerable extent the existence, and the research interests of these institutes stem from the period of political colonialism - but, at least in Cockcroft's account, they nowadays show an ability to tackle and solve specific production problems in and for the developing countries. The same might be said of the research institutes associated with ORSTOM in France, and there are no doubt examples of this kind in other ex-colonial powers and in the United States.

^{1/} On the inefficiency of research institutes in the developing countries and on the limited contribution of research in the advanced countries to solving the problems of developing countries see The Sussex Group;

^{2/} Cockcroft, Sir John; "Technology for Developing countries" Lecture delivered under the auspices of the Overseas Development Institute, London, W.1.

Mechanisms for the indirect transfer of technology

60. We have defined mechanisms for the indirect transfer of technology as those where an enterprise in the advanced country is, so to say, 'interposed' between the various individuals, groups and enterprises which can supply technical knowledge, and the recipient company in the developing country. The intermediary enterprise may simply be some kind of contracting group. Often, however, the intermediary is an advanced country enterprise engaged in production activities of the same kind as are being transferred. Also the intermediary enterprise is not simply 'interposed', in some neutral sense. It is frequently the initiator of the transfer, particularly in the case where the transfer is accomplished by the intermediary company setting up a wholly owned subsidiary in the developing country.

61. It is very difficult to reach any firm conclusions about the relative importance of indirect as opposed to direct mechanisms in transfers to developing countries. It is clear, however, that indirect mechanisms (like wholly-owned subsidiaries and various kinds of licensing agreements) play an important role in some sectors: generally those sectors where technology is highly sophisticated and changes rapidly.

62. The obvious question is why indirect mechanisms are used at all. Why do recipient enterprises depend on production companies in the advanced countries as intermediaries in the transfer process? There are, on the face of it, three main reasons for this dependence. These are associated with:

- (i) deficiencies in the capacity to use technical knowledge in developing countries;
- (ii) the role of proprietary process technology in the transfer process;
- (iii) the role of trade-marks, brand names and the like in transfer process.

Deficiencies in the capacity to use technical knowledge in developing countries

63. The problem for enterprises in the under-developed countries is not only to get the technical knowledge they need to set up and operate new production facilities. It is also - and this may often be more important - to use the advice and the knowledge in an economically efficient way. To do this, the recipient company must have, for example, the managerial and entrepreneurial skills to make business decisions from feasibility and engineering studies. It must be able to organize the experts, consultant groups, machine suppliers and plant constructors that are required in the construction phase - particularly in those direct transfers where these suppliers of

technical knowledge are all independent of one another. It must also be able to manage the production line efficiently and to market the goods it produces. In other words, over and above the problem of getting a supply of technical knowledge, there is the problem of developing the capacity to use the knowledge once it is available. It is precisely these corporate skills which are often deficient in enterprises in the developing countries.

64. Because of these deficiencies in their capacity to organize and use technical knowledge, enterprises in developing countries often have strong incentives to rely on the intermediary role of production companies in the advanced countries, which possess these capabilities. As we have seen the intermediary company may sub-contract for the various 'elements of technical knowledge' or it may be able to supply them from its own resources. The crucial point, however, is that it takes control of a large part of the overall transfer operation, and in doing so, it makes available its own ability to organize the construction phase of the project and sometimes also undertakes to manage the newly-installed plant, and to market the product. The transfer operation - or a large part of it - is carried out by one or another form of contractual agreement between the supplier and recipient.

65. This reliance on indirect transfers can and does arise, whether the process technology is patented or not. It reflects the fact that the dependence of recipient enterprises extends well beyond the need for proprietary process technology.

66. In Part One we identified the 'capacity to use' technical knowledge with "corporate skills" as Peter Gabriel^{1/} describes them, and with "firm-specific knowledge" as described by Quinn,^{2/} and Hall and Johnson.^{3/} Gabriel emphasizes the importance of mechanisms for the indirect transfer of technology transfer precisely because they are ways of transferring "corporate skills". J.P. Lewis^{4/} argues that industrial technology "is most effectively transferred by those organizational entities that know most about using it." (Whence the tendency for United States Government aid projects to rely on 'contract devices' with United States private enterprises). Wionczek^{5/} points out that

^{1/} Peter Gabriel, op. cit.

^{2/} J.B. Quinn, op. cit.

^{3/} Hall and Johnson, op. cit.

^{4/} J.P. Lewis "Quiet Crisis in India", op. cit. p.292. Our underlining.

^{5/} Wionczek, "Case Study of Mexico", op. cit. p.17.

in the Mexican case, the failure to recognize that the capacity to use technical knowledge is often crucially important, resulted in inefficiency and even break-down during the construction phase of new projects, in cases where local enterprises tried to go it alone without entering contractual agreements. A United Nations Report mentions that the value of contractual arrangements (for indirect transfer) is that they enable the 'receiving enterprise to draw on the know-how' as well as other advantages of the technology supplier.^{1/}

67. The extent of 'corporate skill' deficiency as a factor leading to the use of "indirect mechanisms" is not properly understood. This is certainly an area for more thorough enquiry. One would expect deficiency in 'corporate skills' to vary considerably from country to country and hence its relative importance in determining the kind of transfer mechanism which is used should vary also. No doubt there are also inter-industry variations within countries, and it is also possible that larger companies in the developing countries have better managerial capabilities than smaller units. One might expect the larger companies to employ direct transfer mechanisms more frequently. There is some support for this in various studies, for example, contributions to a National Bureau of Standards Symposium^{2/} suggest that larger firms in Mexico have a growing ability to 'shop for technology' and diversify their sources of know-how, hiring 'consultants for feasibility studies and advisors on the choice of technologies'. This should not be taken to mean that larger companies are able to by-pass indirect transfer mechanisms entirely. For example,

"diversification of sources of know-how" may not necessarily mean a shift from indirect, contractual transfers to direct ones: it may equally well mean that the larger companies enter more than one contractual arrangement for a given production project. In spite of these caveats, however, there is some evidence that the larger companies are able to move away from total dependence on a single intermediary company for the whole transfer process. (e.g. from the extreme situation illustrated in Diagram II). One reason

1/ See "The promotion of the international flow of private capital". Fifth Report of the Secretary-General, in Official Records of the Economic and Social Council, Thirty-ninth Session, Annexes agenda item 8 (E/4038 and Corr.1 and Add.1)

2/ United States Department of Commerce/National Bureau of Standards. Symposium Nov. 6-17. 1966 "Technology and World Trade" NBS Misc. Pub. 284. p.133.

why they are able to do so, is no doubt the fact that they are better supplied with managerial and technical skills than the smaller companies."

68. There are also indications that state-sector projects in the developing countries often involve a larger component of direct transfers than private sector operations^{1/} and generally use a greater diversity of sources of technical knowledge. This is a point which needs to be studied. It may be, for example, that the diversification of sources is a consequence of the sheer size and complexity of some public sector investments, or it may be that there is a concentration of managerial and technical skills in the state-enterprises in some countries; alternatively there may be some lessons to be learned from contracting and tendering procedures in the state sectors.

The role of proprietary process technology in transfers:

69. This brings us to a second reason for the use of indirect mechanisms in international transfers. It is that where proprietary process technology is involved in the transfer, the tendency towards wide-ranging contractual agreements appears to be reinforced. The company which owns the process technology, takes on the 'intermediary' role and usually controls other parts of the transfer as well. This tendency is reflected in the variety of elements of know-how that are usually covered by contractual agreements which involve patented processes. A number of authors point to the range of non-proprietary technical knowledge which is covered by agreements involving patented processes. A United Nations Report^{2/} describes the extreme case where the patent supplier takes charge of the entire transfer. This case, where the patent supplier also supplies the full range of technical knowledge required for the project (normally by subcontracting) is an example of the 'turnkey' project, (which we discuss in more detail later in this section). Pugh also refers to the diversity of the elements entering contractual arrangements, which often makes it difficult to draw hard and fast lines between different kinds of contract.^{3/} Elsewhere Lightman, points out that there

1/ See Kopelmanas, Lazare; "Study of the Legal Aspects of Contract Practices concerned with the Transfer of Technology from Enterprises of Developed to those of Developing Countries". UNIDO, ID/WG 64/1, 1970.

2/ "The promotion of the international flow of private capital", op. cit., p.6.

3/ Pugh, R.C. "The promotion of the international flow of private capital", op. cit., p.12.

are very few instances where agreements involve^{1/} patent rights alone. Normally patents and know-how (as well as brand-names) are licenced as part of a combination of technical property rights to the licensee.

70. Enterprises in developing countries which receive transfers of proprietary technology suffer from the same deficiencies as any other enterprises in that environment. They lack not only technical knowledge, but also the capacity to use it. Transfers which simply provided them with permission to exploit patents might often fail commercially. They need other elements of technological knowledge and, in most cases, access to a variety of 'corporate skills' to make the patent work. This much is obvious from earlier discussion. It explains why companies receiving patented technical knowledge, need other kinds of technical knowledge as well and why they enter 'indirect' transfer arrangements. It does not, however, explain why the supplier of proprietary process technology tends to dominate the transfer operation. On the face of it, it should be possible for the recipient to get process technology from one supplier, and to use a variety of indirect and direct transfer mechanisms for the other kinds of technical knowledge (and corporate skill) that it requires. Some technology recipients probably are able to diversify sources of know-how in this way, but where proprietary process technology is involved there is a very strong tendency for owner of process technology to play a dominant intermediary role in the transfer.

71. There are several factors which might account for this.

72. First, the recipient company has no incentive to diversify its sources of technical knowledge unless there are advantages to be gained from doing so. It is not certain that there always will be. The supplier of proprietary technology nearly always has well-established links with engineering designers, construction companies and the like, who are better acquainted with the peculiarities of his process technologies than any other groups. Where the technology owner is a vertically-integrated company, many of these elements may actually be present in the company itself. In these cases, there is little incentive for the recipient company to look for alternative suppliers for unpatented technical knowledge and skill. It is not only more convenient but probably less costly, to leave a large part of the transfer to the process supplier.

73. Second, this argument is strongly reinforced where process technology is differentiated from other technologies which might be used to manufacture the product or

^{1/} Lightman, Joseph. op. cit., pp.3-4.

a near substitute. Where there is technological differentiation, the recipient company has little choice as to who is to supply the complementary inputs of technical knowledge needed to set up the project. Once there is a decision to employ a particular process technology the rest follows. Indeed the design consultants, engineers and construction companies normally used by the owner of the process are often the only ones available. The recipient company may have to accept a wide-ranging contractual agreement with the owner of the process technology,^{1/} because it will certainly be prevented from making a separate approach to the sub-contractors to the process suppliers, and it is questionable whether it would be commercially advantageous to do so.

74. Third, it may be in the interests of the supplier of process technology to dominate the transfer. The returns to the supplier normally depend on the economic performance of the recipient. For example, the technology supplier may get his returns partly from royalties based on sales and partly through profits from equity participation in the recipient company. The supplier therefore has incentives to ensure, first that the plant is properly designed and constructed; and second, that production and marketing operations are managed efficiently. Often the most effective way to do this is to obtain an agreement which will give de facto control over the construction and possibly also the operation of the project. Control over construction is probably fairly easy to arrange: the supplier of process technology contracts the crucial stages in the investment programme, such as design, supply of machinery and plant construction and uses its usual sub-contractors to do the work. Control over operation - that is over production and marketing - is more complex and is achieved in a variety of ways. Some of these are mentioned in the Report on "The Role of Patents in Transfer of Technology to Developing Countries".^{2/} For example, the licensor may demand a measure of control over day to day management, or the recipient may be obliged to seek approval from the licensor for price and marketing policies. Pugh^{3/} suggests

^{1/} See a Report by the Fiscal and Financial Branch of the Department of Economic and Social Affairs, "Trends and problems in world trade and development", TD/37, 1967, where it is pointed out where a new enterprise is based on the use of a particular patent or secret process, the recipient may have no alternative but to deal with the know-how owner and accept the arrangement he demands.

^{2/} "The Role of Patents in the Transfer of Technology to Developing Countries", United Nations publication, Sales No. 65.II.B.1.

^{3/} Pugh, R.C. op. cit., pp.22-23.

that technology suppliers normally seek to control managerial policies and that the degree of control is determined by relative bargaining positions. (Pugh also discussed the potential for control implicit in different types of contractual relationship).

Vernon^{1/} suggests that from the point of view of the developing country, there is a trade-off between relinquishing control and getting access to technical knowledge.

75. Other techniques that may be used in achieving control: the licensor may retain the right to appoint technical directors in the recipient company, or it may install a quality control department of its own choosing. The licensor sometimes appoints the marketing manager. Wionczek points out that the technology supplier may get control over the project by 'divorcing production from marketing and arranging in the contract for the sale of the entire output of a jointly-owned production facility to a wholly-owned marketing company',^{2/} although this is probably rare.

76. So far we have suggested that the technology supplier has an interest in controlling the transfer operation since this gives greater assurance of commercial success. In fact, the incentives to control recipient enterprises may be more profound. Where the supplier is a company with large international commitments, it presumably seeks to maximize returns over its whole operation. In this case the supplier seeks control over the recipient to run the project so that it will fit in with an overall international strategy. This may lead to clauses in the transfer contract which limit the export markets open to the recipient company, and which restrict the recipient in its choice of suppliers for intermediate goods. These restrictions may have the effect of limiting the commercial success of the new enterprise. Export restrictions may result in low capacity utilization; supply restrictions often result in high prices for intermediate goods. The point is, however, that these limitations in the commercial success of a particular new enterprise may increase the overall profits of the international operation.

77. Again these problems require more examination. The forces which lead technology suppliers to control recipients, are only partly comprehended. There is only limited evidence about the success and frequency of different forms of control. Nevertheless, the evidence seems to support the argument. There are factors which push suppliers of

1/ Vernon, Raymond, "Conflict and Resolution between Foreign Direct Investors and Less-Developed Countries", Public Policy, Vol. XVII, 1968.

2/ Wionczek, "Case Study of Mexico", op. cit.

proprietary process technology to control technology transfers - and this is one of the reasons why 'indirect mechanisms' play an important part in exchanges between advanced and developing countries.

78. It must be recognized that it is often in the interests of the recipient company to relinquish control, where to do so is perceived as the best - and perhaps the only - way of ensuring commercial success. The question of control may not be a major issue in negotiations, unless the recipient company is thoroughly convinced that its own managerial and technical capabilities are adequate. But this is probably rare. There are certainly cases where recipient companies have actually encouraged technology suppliers to take a high degree of control.

The role of trade-marks and brand-names in the transfer of technology:

79. In order to discuss the third reason for indirect transfer mechanisms, we must return to the idea that technology is an 'exogenous' factor in the developing economy. Underlying this, is the argument that technological change in the developing countries is based on technologies which are transferred from abroad in order to manufacture consumption items which were previously imported. Frequently the market for the products which are to be manufactured with transferred technology is well-established. What is more important, this market is often conditioned to the brand-names and trade-marks of specific foreign suppliers. More generally, it is sometimes argued that consumers in developing countries often show an "irrational" preference for foreign goods.

80. In these cases enterprises installing new production facilities may be concerned as much with the right to use established foreign brand-names on their products as with the technologies needed to manufacture them. The importance which recipient enterprises place on the use of brand-names and trade-marks leads them into indirect transfer agreements even when the technologies required to make the product are simple, well-established and available through direct transfer mechanisms. Wionczek has indicated the constraints that this puts on the transfer process.^{1/} These practices account for repeated references in the literature that contractual agreements commonly cover brand-names and trade-marks as well as exchanges of patents and know-how.

* * *

81. A number of factors - mainly acting in combination - account for the use of indirect mechanisms of technology transfer. The most fundamental of these are the

^{1/} Wionczek, *ibid.*

deficiency of technical knowledge and the inability to use it commercially in enterprises in developing countries. Because of this, production companies in the advanced countries play a crucial intermediary role in technology transfers. Indirect mechanisms may be used even if the process technologies involved are simple, well-known and readily available (say through machine suppliers). The tendency to use indirect mechanisms is probably reinforced when process technology is owned by a production enterprise in the advanced countries. The technology owner has incentives to control both the construction and the operation phase of the project so as to increase the returns he gets for the process technology he supplies - and possibly to fit the production activity into his international strategies. The tendency towards indirect transfer mechanisms is reinforced also where recipient companies seek the right to foreign brand-names and trade-marks, in order to respond to pre-existent patterns of consumer demand.

Varieties of contractual agreements

82. A number of kinds of contractual arrangement are used in the indirect transfer of technology. Their diversity probably reflects the multiplicity of factors which determine the precise bargaining relationship between 'intermediary' companies and technology recipients. Some of those factors are external to the enterprises involved. These are things like the nature and complexity of the process technology, the rate of technological advance, the number of alternative suppliers of technology, and institutional factors like government policies on foreign private investment, foreign technical collaboration and foreign trade. Other factors are specific to the firms: the sophistication and 'uniqueness' of the corporate skills in the intermediary company, the availability or lack of such skills in the recipient company.^{1/}

83. The contracting companies and the technology recipients must respond to a wide range of socio-economic and political situations; the response has been the evolution of many different kinds of agreement used in different combinations. It may also be that the mechanisms which are preferred in transfers to a given developing country have changed over time at various levels of development. It is impossible unfortunately to

^{1/} It is probable that subjective evaluation as well as objective circumstances influence the decision on what kind of contract to use. For example, a supplying company which has seen several of its wholly-owned subsidiaries nationalized, may develop a preference for licence contracts rather than wholly-owned subsidiaries as a means of transfer, even though the possibility for direct investments exists.

say which kinds of agreements are used in which circumstances; for the present about all we can do is describe the more important types of contract, and to mention the claims made for and against them.

84. Transfers of technology often take place by companies from the advanced countries setting up wholly-owned subsidiaries in developing countries. By stretching our definitions they can encompass this case. The wholly-owned subsidiary may be regarded as a recipient which is controlled completely by the supplying company. The transfer operation may or may not involve specific legal contracts between the parent and subsidiary, but whether it does or does not is beside the point. The whole transfer is anyway dominated by the parent company and the only substantial negotiation is that which takes place between the parent company and the government of the developing country. Evidently, this negotiation will cover many things other than the supply and cost of technical knowledge. It is in fact, unclear whether technological factors are examined explicitly in such negotiations. In many cases, choice of technologies, machine suppliers, plant contractors and the like are probably left entirely to the parent company. Also charges made by the parent on the subsidiary company for technology and know-how, may be quite unrepresentative of the resources of knowledge flowing between them. The values imputed to such 'transfers' are often more a reflection of accounting requirements than of the exchange of real resources.

85. This makes it difficult to work out the importance of wholly-owned subsidiaries compared to other transfer mechanisms. Nevertheless, the wholly-owned subsidiary is generally taken to be one of the more important and sometimes the most important transfer mechanism.

86. There is a considerable general literature on the advantages and disadvantages of foreign private investment for the developing countries and there is not much to be gained by repeating well-known arguments. We shall confine ourselves to a few aspects which are relevant to the wholly-owned subsidiary as a mechanism for technology transfer.

87. It is often argued that the wholly-owned subsidiary is a particularly useful mechanism for supplying technologies, in cases where the production base and technical capabilities in the developing economy are non-existent or so rudimentary that domestic enterprises cannot act as a 'receiving station' for the technology. In these cases investments by foreign companies may be the only mechanism through which the developing country can get access to certain kinds of technology, and perhaps the only means whereby some local resources can be exploited.

88. The argument needs to be qualified. In the first place, there are many cases where the argument does not apply. For example, an international brewery company sets up a subsidiary in a country where there is already an established brewing industry. Apart from some doubtful gains from increased competition, the most substantial change is simply that beer (perhaps better beer) becomes available under a well-known brand-name. This may increase consumer satisfaction for those who can afford the new beer. But it is at least arguable that the technological knowledge made available is of rather low priority and the transfer may well involve real opportunity costs in the developing country; for example, if it stimulates luxury consumption or if the investor calls on local savings.

89. In short, a number of transfers by direct investment in consumer goods industries do not necessarily supply skills which are totally deficient or process technologies which are unknown and - in some sense - needed; they are intended to reap advantages conferred by an international brand-name in a market which is supplied already with the product. This does not mean that all subsidiaries selling brand-name products fall into this category - but some certainly do.

90. Secondly, it may be more difficult for governments to control the monopolistic practices that unique possession of a differentiated technology or product permits in the case of wholly-owned subsidiaries, than where there is a contractual agreement involving local capital and managers. This does not by any means imply that local participation or ownership is a guarantee against such practices. But it probably restricts the freedom with which resources can be expatriated.

91. For all this, the wholly-owned subsidiary will doubtless remain a dominant mechanism for transfer, if only because technology owners appear to prefer it to other transfer mechanisms. Its effects on the developing countries will depend considerably on the policies followed by governments, both in setting criteria for the kinds of direct investment to encourage and in controlling prices, profits and repatriation of resources in what is usually a highly imperfect market situation.

92. A second and very common mechanism for indirect transfer is the licence agreement. Licence agreements are defined in a number of different ways. The definitions given by Kopelmanas^{1/} and by the United Nations study on "The Role of Patents in the transfer

^{1/} Kopelmanas, Lazare; Study of the Legal Aspects of Contract Practices", UNIDO, ID/WG, 64/1, 1970. op. cit.

of technology",^{1/} are perhaps the clearest because they centre upon the distinguishing feature of the licence agreement. This is that it gives the licensee access to proprietary process technology. The United Nations study defines the licence agreement as a contract 'under which the licensee is granted certain rights to manufacture and sell products utilizing inventions, process techniques and other industrial property rights of the licensor'.

93. Licence agreements vary considerably in content. Some agreements give the licensor equity in a joint venture with the licensee - others do not involve ownership. Equity participation may sometimes be given in payment for the technology (often in addition to royalties);^{2/} in other cases the licensor buys the equity in a separate transaction. Ownership is only one of the ways by which the licensor may get control over the licensee. We have already noted some of the other methods: for example, the licensor may appoint technical directors and managers to the licensee, or may undertake the whole management function.^{3/} Alternatively, particularly where brand-names are exchanged, licensors sometimes appoint quality control experts - and even control marketing through a separate wholly-owned subsidiary or a joint venture.

94. Licence agreements also vary in the "elements of technical knowledge" they cover. There is nearly always some transfer of technical knowledge other than the patented or proprietary process. Clearly, the various ways in which the licensor exercises control over the project all involve some transfer of technical knowledge and corporate skills. In addition, agreements may or may not include provision for training, for engineering design, machinery supply, plant construction and the like. At the extreme the licence agreement becomes a "turnkey" transfer.

95. We have already given some reasons why such a wide range of different contractual agreements are used in indirect transfer agreements. These reasons apply equally to the variations amongst licencing agreements. The coverage of a licence agreement may reflect the availability or deficiency of technical and managerial skill in the recipient firms and requirements for skill vary with the kind of technology involved.

^{1/} Report of the Secretary-General; "The role of patents in the transfer of technology" op. cit.

^{2/} This practice is usually called the "capitalization of know-how".

^{3/} This is a case of a licence agreement which embodies what is called a management contract. Management contracts are discussed later.

A large number of testable hypotheses could be drawn up to explain variations in licencing contracts; an empirical study might well reveal a good deal about the nature of transfer of technology which would be invaluable for policy-makers.

96. The variations in the content of licencing agreements and also the variety of circumstances they are designed to meet, makes it difficult to reach general conclusions about the appropriateness of these transfer mechanisms. What is true of a given type of licence agreement in one circumstance, may be false in another.

97. There are, however, some general arguments which raise important points. Occasionally, it is argued that licence agreements are a way of getting access to technology whilst relinquishing the minimum of control. This may be true, but it must be remembered that ownership is not necessary for control. The licensors objective is not control in some general sense but the degree and kind of control required to attain his specific objectives. Given his strategies, it is conceivable that a licence-agreement, with or without equity participation, may suit his purposes as well as a wholly-owned subsidiary.

98. Licence agreements are criticized because they frequently include clauses, which put restrictions on the licensee. The United Nations study on Patents^{1/} lists "potentially unduly restrictive features" of licence agreements. Amongst them are clauses which oblige the licensee to purchase materials and equipment from the licensor; clauses which limit sales to the domestic market or to specified foreign markets only; and clauses which limit the quantity of production. Vaitzos has raised strong objections to the first kind of restriction in his study of transfer to Colombia.^{2/} Pugh^{3/} discusses export restrictions. A recent UNCTAD paper contains an excellent analysis of such restrictive practices.^{5/}

99. In some countries a large proportion of licence agreements include export restrictive clauses.^{4/} The relative importance of tied-purchasing clauses is difficult to assess at this stage.

1/ "The role of patents in the transfer of technology to developing countries" Report of the Secretary-General. op. cit.

2/ Vaitzos, Constantine; "Transfer of Industrial Technology to Developing Countries through Private Enterprises". Mimeograph.

3/ Pugh, R.C. op. cit.

4/ Vaitzos, C. op. cit.

5/ "Restrictive business practices: A preliminary report by the UNCTAD Secretariat", TD/B/C.2/104, Jan. 1971. Mimeograph.

100. A third mechanism for indirect transfer is the turnkey agreement. The defining characteristics of the 'turnkey agreement'^{1/} are that the technology supplier "carries out the full range of technical and managerial operations needed to establish an enterprise ... and turns over the management of the enterprise in full operating condition to the local owner as soon as he is prepared to assume it."^{2/} One supplier provides all the 'elements of technical knowledge' needed to bring new production facilities to the point of operation.

101. There is some variety in the content of turnkey agreements. Where proprietary technology is involved, the turnkey agreement is in fact an extreme form of licencing agreement. But turnkey agreements do not always include proprietary technology. For example, Baranson^{3/} mentions a United States company, Business and Industry Development Company (BIDCO), which will "standardize, package and sell small universally needed industries" to developing countries. Presumably, this company will deal mainly in non-proprietary process technology.^{4/}

102. Turnkey agreements vary in other ways. Some include training of operatives and managers, others do not. In some cases the supplier manages the plant for a period - in others the plant is handed over on completion. A United Nations study^{5/} argues that where turnkey agreements are "supplemented by management or technical assistance contracts", the recipient has a 'more meaningful' guarantee of plant performance. The United Nations study mentions a further variant: some contracts allow for equity participation by the supplier whilst others do not. Again, it is argued that the direct financial interest of the technology supplier is an assurance that the plant will be efficient.

103. Discussions of the merits and demerits of turnkey agreements reflect many of the more general contradictions involved in the transfer of technology. The advantage of

^{1/} See "Foreign investment in developing countries", Dept. of Economic and Social Affairs. United Nations publications, Sales No. E.68.II.D.2. Kopelmanas, Lazare. op. cit. and "The promotion of the international flow of private capital", fifth report of the Secretary-General (E/4038 and Add.1). Also the third report by the Secretary-General E/3665/Rev.1

^{2/} Fifth Report op cit. (E/4038 and Add.1).

^{3/} Baranson, Jack. "Industrial Technologies for Developing Countries", Praeger Special Studies, 1969.

^{4/} Since owners of process technology generally perceive it to be in their interest to control at least part of the transfer operation themselves.

^{5/} "Promotion of the international flow of private capital", Third report. op. cit.

the turnkey agreement is that all the skills required to marshall and organize market consultants, engineering designers, machinery suppliers, plant constructors and the like, are provided by the supplier. There are of course risks that the supplier may turn out to be inefficient or incompetent but these are presumably much lower^{1/} than the risks of failure or inefficiency if the inexperienced recipient enterprise were to take on the job itself. One has, however, to set against these advantages, the consideration that if recipient enterprises continuously rely on turnkey contracts they are unlikely ever to develop the skills required to organize projects. There is no easy way around this problem. Turnkey projects may provide for the training of operatives and managers to run the plant once it is set up, but they cannot easily create a local supply of the skills needed to bring a new investment project to the point of commercial viability. Kopelmanas^{2/} points out that the advantage of having a number of separate contractual agreements (as opposed to the turnkey contract) is that this encourages development of 'national technological capabilities'.^{3/}

104. A further problem with turnkey contracts is that they may result in high 'hidden' costs through the marking up of equipment prices.

105. Investments in wholly-owned subsidiary enterprises, licence agreements and turnkey contracts are mechanisms for transferring large 'packages' of technical knowledge. They are also ways of transferring that other essential kind of knowledge: corporate skill or the capacity to 'use technology'. There are also more limited forms of contractual agreement, which cover fewer of the 'elements of technical knowlege'. These are sometimes subsumed in licence or turnkey agreements.

106. The management contract is one such form. Pugh^{4/} defines management contracts as "arrangements where operational control of the enterprise ... is vested by contract in a separate enterprise which performs the necessary managerial functions in return for a fee". Gabriel has a similar definition.

1/ They are, however, real. See Kilby, Peter: "Industrialization in an Open Economy, Nigeria 1945-1965", Chapter on "Import-substituting industrialization" for an account of problem with turnkey projects.

2/ Kopelmanas, Lazare; op. cit.

3/ No doubt, at a certain cost in terms of inefficiency and delay. A great problem is how to decide when the benefits exceed the costs and when they do not, and hence when it is better to go for an alternative to the turnkey arrangement.

4/ Pugh, R.C. op. cit.

107. Gabriel, particularly, insists on the advantages of the management contract. For the contractor, it is an effective way of controlling an enterprise in the developing country, without committing capital resources. Furthermore - he argues - since local entrepreneurs retain ownership, management contracts will not give rise to the political and economic objections that are made against wholly-owned subsidiaries. There are some problems about this argument: the political and economic objections to foreign investment are not only concerned with the question of ownership. They are concerned with ownership as a vehicle for control. Since the management contract is precisely a mechanism for functional control (albeit temporally limited and informal control), it is open to similar objections as the wholly-owned subsidiary. Spencer^{1/} points to some other drawbacks. The 'management agent' may indulge in "unwarranted swelling of output" to increase his commissions. Also the management agents may be able to make 'secret rake-offs' on the sales and purchases of the company. Finally, the management contract results in a de facto limitation of the powers of stockholders and directors.

108. Other fairly common contractual agreements include: engineering and construction agreements, where the recipient brings in a contractor to carry out the design and construction phase of the project; and technical service agreements, where the recipient draws on specific kinds of operational know-how and advice available in the contracting enterprise.

Notes in conclusion:

109. We have pointed out how difficult it is to reach any general conclusions about the advantages and disadvantages of the various transfer mechanisms. There are, however, certain judgements which are repeated in the literature. An important one is that diversification of sources of technology is desirable. Diversification may mean either that the recipient uses as many direct transfer mechanisms as he can, or that he avoids all-embracing contractual agreements and - whilst relying on indirect mechanisms - has agreements with a number of intermediary companies.

110. There are two main arguments in favour of diversification. The first is that undiversified transfers leave the intermediary company with too much freedom to set prices of equipment and possibly also intermediate goods. The licensee in such

^{1/} Spencer, L. Daniel; "Indian Mixed Enterprise and Western Business", Martinus Nijhoff, The Hague, 1959.

agreements is in no position to 'test' the international market for the various components and intermediates. It is argued therefore that diversified transfers cost less. Secondly, there is the point that the recipient companies will only learn by experience. Diversified transfers make heavy demands upon the management and technical capabilities of the recipient and it is only by responding to these demands that recipient companies will ever build up the relevant skills.

111. There is on the face of it, a case for diversifying sources of technology as far as the managerial capabilities of the recipient enterprise will allow. The diseconomies that may result must be borne in order to build up skills for the future. Recipient enterprises must make mistakes, because that is the only way to learn.

112. Whatever the merits of these proposals in principle, they are rather imprecise about practice. They do not say much about how far to push diversification in particular cases. There are really two problems for policy-makers. The first is that it is very difficult to work out whether the diseconomies that may result from pushing diversification to the limit will in fact be justified by the vaguely defined (and possibly unmeasurable) gains in corporate skill that are supposed to accrue in the longer term. This is a little like the infant industry problem: it is hard to predict in any particular case whether the infant will grow strong enough to justify short-term protections.

113. The second problem concerns those cases where diversification cannot go far because the supplier possesses patented process technology and will not release it unless he is allowed to control the whole transfer process. Any 'diversification policy' must define to what extent such unavoidably undiversified transfers are to be allowed. This again, is often difficult.

114. These remarks lead to a final - and tentative - argument that comes out of the analysis in this part of the study. We have noted that one reason for indirect transfer mechanisms is the lack of a capacity to use technical knowledge in the recipient company; this lack also leads to undiversified transfers. At the same time, however, where proprietary process technology or brand-names are important, the inherent tendency to undiversified transfer may be considerably strengthened. This happens because it is in the interests of the technology supplier to control the transfer process and also production activities.

115. This reinforcement of the inherent tendency to rely on the foreign intermediary company may give rise to some difficulties. Thus, the diversification of know-how sources permitted by the technology supplier is often no less than the recipient company may conceivably have been able to cope with in other circumstances. In short, the recipient company may have some capacities to organize and use the knowledge it received, but the process technology supplier may prevent the recipient from using those capacities. The recipient is in effect prevented from learning about plant construction, design and the like, because it is excluded from project construction - and possibly from parts of the production and marketing operations as well. In short, the more the supplier controls the transfer process (i.e. the construction and production phases), the less the recipient will be required to use and develop its skills. Undiversified transfers of technology transfer may therefore tend to perpetuate the technological dependence of the developing countries and to ascribe their enterprises to an essentially passive role in industrial activities once they have signed a contract with the owners of technology.

PART THREE
THE IMPACTS OF TECHNOLOGY
TRANSFER ON DEVELOPING COUNTRIES

116. As far as developing countries are concerned, the transfer of technology is necessary for rapid industrialization because, they have limited technical knowledge and equally a limited capacity to use such knowledge. From this point of view, the transfer of technology is a rational way of remedying fundamental deficiencies.

117. At the same time, technology transfers raise deeper problems than this might suggest; particularly transfers done by indirect mechanisms.

118. Technology suppliers are concerned with the commercial advantages they can obtain through the transfer operation. There would be no problem about this if the pursuit of commercial advantages by the suppliers led to results which were in line with the economic and social requirements of the developing countries. There is, however, a good deal of evidence (some of which we discussed in Part Two), that this kind of coincidence is rare. Particularly in the case of 'indirect' transfers, the developing countries face a contradiction: they need the technology and the capabilities which the supplying companies possess, but the terms on which they can get hold of it may be disadvantageous for economic and social development. It is this problem which is explored in this part of the study.

119. In order to describe the impacts of technology transfer on the developing countries - and to work out policies - it is necessary to make an analysis of the incentives that lead technology owners to indirect transfers. This is done in the first section. This section also examines why technology owners choose one kind of transfer mechanism rather than another. Against this background, some of the impacts which indirect technology transfer has on the developing economies are discussed in the second section. Finally, there is a brief comparative discussion of direct transfer mechanisms. It should be noticed that in most of the discussion in this part, we abstract from the rôle of government. In the final part of the paper we shall examine some possibilities for government action in relation to the problems discussed here.

Incentives to transfer technology to the developing countries by indirect mechanisms

120. The motivations of the intermediary companies in indirect transfers are complex. To discuss them, we must first of all examine the part which corporate skills, and particularly technology, play in competition.

Technology and Competition

121. Most analyses of technology and competition stem from Joseph Schumpeter's^{1/} concept of innovation.

122. Schumpeter's original formulation is probably the easiest way into the argument, (even though it needs considerable modification to bring it into line with economic reality). Schumpeter argues that at the equilibrium position defined by perfect competition, there will be an incentive for firms to seek new products or lower cost methods for manufacturing older ones; in other words to innovate. When a firm succeeds in innovating its competitors will try to copy it, but they will take time to do so. Whilst its competitors are learning to copy the innovation, the innovating company itself will earn profits over and above the 'normal profits' defined by the perfect competition equilibrium situation. These profits are similar to monopolistic rents, though Schumpeter defined them as "entrepreneurial profit". Schumpeter regarded them as the returns to entrepreneurship, and he defined entrepreneurship as the capacity to make 'new combinations' of factors of production leading to new products or lower costs of production. 'Entrepreneurial profit' is transitory, because when competitors copy the 'new combinations' the innovators profit will be sharply reduced.

123. Schumpeter's 'entrepreneurial' function is very similar to Gabriel's 'corporate skill'^{2/} which we have identified with the capacity to use technical knowledge to commercial advantage.^{3/} For Gabriel 'corporate skills' are the source of 'distinctive

1/ See particularly "Theory of Economic Development" Chapter 3, "Entrepreneurial Profits"

2/ Ray Vernon, op.cit. and Gabriel, op. cit.

3/ Actually, it would be more correct to say that 'corporate skill' in the sense which Gabriel uses the term, embraces our concept of the capacity to use technical knowledge; 'corporate skills' may, however, cover more than our concept, and so may 'entrepreneurship' in Schumpeter's terminology.

competence' in the enterprise. Like 'entrepreneurship' (in Schumpeter's strict definition) it is 'corporate skill' which enables the enterprise to distinguish itself from its competitors in the market. Provided that 'distinctive competence' is sufficiently distinctive, the enterprise may achieve a near-monopolistic position, at least for the time it takes for its competitors to learn to copy or surpass its performance. Vernon, in particular, has discussed such 'quasi-monopolies'.^{1/} The

origins of "distinctive competence" in Gabriel's definition, seem to lie in what Schumpeter called the capacity to make 'new combinations' of factors of production.

124. Just as Schumpeter argued that there are many different ways in which entrepreneurs might make 'new combinations', so also there are many ways in which enterprises might develop distinctive corporate skills. One way is by developing and 'owning' process technology and having the capability to exploit it commercially. In other words, proprietary process technology is a source of monopolistic advantage. Near-unique process technology allows the enterprise to manufacture a differentiated (and sometimes better) product than its competitors; or to produce existing products at lower costs. The advantage that this confers lasts until competitors copy the technique or until the patent expires.

125. Firms in industrialised countries tend to institutionalise the search for new technologies. Research and development (R and D) is often carried out in the firm itself. This is different to the original Schumpeter model. At first Schumpeter looked upon the 'entrepreneur' as a person who picked up relevant bits of scientific and technical information costlessly, and applied it to create a 'new combination'. This may be an acceptable characterisation of relations between science and industry in the early twentieth century. Today, however, the 'in-firm' R and D laboratory symbolises a far more systematic search for commercially useful scientific and technical knowledge.

126. There are at least two reasons which might account for the way the relations between science and industry have evolved. First, it is probably much harder for competitors to imitate a new process technology, than to copy other potential sources of competitive advantage, such as an efficient after-sales service, or improved plant lay-out. Differentiated process technology may, therefore, confer quasi-monopoly for longer than other kinds of corporate skill. Also process technology may be patented, and get legal protection from competition for extended periods.

^{1/} See, for example, Vernon, Gruber and Mehta; "The R and D factor in international trade and international investment of US industries". Journal of Political Economy (1967), 75(1), 20-37.

127. A second reason why R and D has been integrated with industrial production, is that the laboratory is potentially a source of a succession of new technologies. When the advantage from one innovation is eroded by competition, a new technology may take its place. The competitive relationship is characterized by a systematic search for quasi-monopolies through the origination and use of successive 'generations' of technology. Of course, the enterprise incurs costs in order to maintain the R and D laboratory, and these costs must be covered before one can account the Schumpeterian entrepreneurial profit or monopoly rent.

128. Another and important way in which modern industry differs from Schumpeter's model, is that industrial markets are normally highly imperfect. Very frequently they are oligopolistic. It has been argued that scale requirements in R and D activity may themselves be a barrier to new competition and reinforce the tendency to oligopoly in some industries.^{1/}

129. In summary, the unique possession of process technologies is one way in which enterprises differentiate themselves from their competitors, and is therefore a source of monopolistic advantage. As Vaitzos has argued, the enterprise relies on a mix of organizational skills, capital resources and technological differential to establish its competitive position.^{2/} The importance of the technological factor probably varies from industry to industry and from firm to firm. In some sectors - consumer goods for example - technology may be less important as a means of differentiation than, say, design or packaging or simply brand-names.

130. The varying importance of these ingredients of 'corporate skill', is one reason for variations in the content of licencing agreements. We have seen how the main component of some agreements is the proprietary process technology, whilst others centre around brand-names or simply the organizational and managerial skills of the supplier.

The Decision to Transfer Technology by Indirect Mechanisms:

131. Transfer of technology by 'indirect mechanisms', may be re-examined in the light of this rather general account of the role of 'corporate skills' and 'technology'. The main thesis is that the 'intermediary' enterprises which typify indirect transfers, usually possess, in one form or another the kinds of distinctive capability we have described. Their distinctiveness may depend on marketing advantages (supported by

^{1/} Schumpeter recognized this. See his defence of oligopoly as necessary to innovation in "Capitalism, Socialism and Democracy".

^{2/} See Vaitzos, C; "Monopoly Power and the Transfer of Resources to the Under-developed countries". Mimeograph presented to the Dubrovnik Conference of the Harvard DAS, 1970. Also Vernon is quoted on this point in OECD "Analytical Report on Technological Gaps" Book IV, p.266, Paris 1970.

brand-names or trade marks), on process technologies, or on management and organization. From the point of view of recipient enterprises, the importance of the intermediary enterprises is either that they own an element of technical knowledge which is commercially important (to the recipient) - or that their other capabilities (marketing, management etc.) are essential to the commercial success of the new venture. The tendency for the 'intermediary' enterprise to dominate the transfer is now seen as the outcome of the fact that it possesses a unique or near-unique combination of capabilities.

132. The question which is unanswered, and which we now examine, concerns the motivation of the 'intermediary' company. Why do the intermediary companies get involved?

133. An enterprise which has monopolistic advantages may seek to widen its markets to exploit them fully. Sometimes scale factors may oblige the enterprise to sell internationally. For example, the fixed costs of R and D in parts of the electronics capital goods industry are so high that producers must control substantial parts of the world market to amortise them.^{1/}

134. But whatever may be the incentives to sell the product internationally, it does not necessarily follow that the enterprise has to transfer its technology in order to do so.

135. After all, one option open to the enterprise - which presumably has numerous advantages - is to export its products. The various mechanisms for the transfer of technology are, therefore, alternatives to exports as a means of selling abroad. The question is, why do enterprises choose to transfer rather than to export?

136. There are a number of answers to this question. For example, where transport costs are a high proportion of the value of the product, the incentives to produce abroad rather than to export is probably greater. Apart from this, however, there are two arguments which come up repeatedly. These are:

(i) international differences in relative factor prices - and particularly in wages rates relative to the price of capital - account for the decision to transfer technology;

(ii) transfer takes place because of restrictions on trade imposed by the governments of the developing countries.

137. The implication of the first argument is that the availability of cheap labour in developing countries makes it possible to produce some outputs at lower unit costs

^{1/} See Freeman, Christopher "R and D in Electronic Capital Goods Industry" National Institute Economic Review, No. 34, Nov. 1965.

than in the advanced countries. At a given price level, determined in the first instance perhaps by the price of imports, this leads to higher unit profits - at least for a defined period.

138. This explanation for transfer of technology is implicit in some formulations of the 'product-cycle' theory of international trade.^{1/} This theory is a development^{2/} of Schumpeter's concept of entrepreneurial competition. In the early phase of the life of a product, there are very few producers, technologies change rapidly and 'innovative inputs' like R and D are critical. Later on, as the technology becomes established, new entrants appear, mass-production methods develop and the advantages enjoyed by the innovating companies are eroded. Then when the technology is standardized, unskilled and semi-skilled labour may be used and wage levels play the main part in determining the competitive position of enterprises. In this final phase when the product is 'mature', transfers of technology take place to developing countries in order to take advantage of cheap labour.

139. There is little systematic evidence for this thesis, insofar as it affects transfers to developing countries.^{3/} Though there are a number of cases where technology transfers appear on the face of it to take place as a response to factor price differences. It is suggested, for example, that a number of United States and Japanese direct investments in labour intensive industries in S.E. Asia are essentially a response to cheap labour availability. This appears to be the case, also in some foreign investments in Greece and Mexico. The fact that these transfers appear to be associated with considerable development of exports of manufactures lends some support to the idea that they were basically motivated by possibilities of cost reduction. Notwithstanding these examples, it is unlikely that factor price differences can be used to produce a general explanation of the incentive to transfer technology.

A priori there are a number of reasons for this. First of all, cheap labour is often inefficient, and wage rates may not be sufficiently low to compensate for low productivity. Second, the domestic markets of the under-developed countries are often protected and highly imperfect (sometimes the transferring company is virtually the only producer) and in this situation wage levels may be relatively unimportant to the

^{1/} For a comprehensive list of references on 'product cycle theory' see Vaitzos, C. "Transfer of Resources and Monopoly Power", op. cit.

^{2/} Particularly S. Hirsch: "Location of Industry and International Competitiveness", Oxford University Press, 1967.

^{3/} There is however some evidence that wage differentials play a part in transfers between the United States and Europe. See for example, Krein, M.E. "Freedom of Trade and Capital Movements. Some empirical evidence"; Economic Journal, December 1956, pp. 748-58.

producer. Finally, where the transferred process technology is capital-intensive - which is often the case - the advantages of cheap labour are likely to be quite small since labour costs play a relatively small part in total costs. In summary, then, whilst differences in factor prices no doubt account for some transfers, they cannot account for all.

140. It is possible of course that international differences in factor prices would play a more important part in technology transfer in a world economy which met the assumptions of classical trade theory. But this is somewhat beside the point. As matters stand most of the developing countries have highly protected and imperfect markets. The evidence is that a large proportion of technology transfers are in fact a response to this protection of foreign markets rather than to factor price differences per se. Kreinin shows that this factor accounts for many United States transfers (by direct investments and licence agreements) to Europe and Canada.^{1/} Protection has probably been an important factor in technology transfers to Japan. More particularly, in the case of developing countries, there are numerous references to protection as a factor in stimulating transfers. Peter Gabriel, for example, argues that the decision to set up wholly owned subsidiaries in developing countries may be a 'defensive' response to the fact of market protection. A company which has established an export market in a highly protected economy, is liable to be ousted by competitors, who set up production in the country itself. The transfer of technology is a defence against this possibility. Robinson^{2/} similarly shows evidence that transfer by direct investment is motivated by "the desire to expand or maintain sales by entering new markets or preserving established markets in the face of a tariff or exchange barrier". Aroaz gives evidence which supports this argument in the case of the chemical industry^{3/}. Much of this evidence concerns the decision to set up wholly-owned subsidiaries or joint ventures, but similar arguments apply to other kinds of transfer.^{4/}

141. It would probably be wrong to look upon this kind of technology transfer simply as a defensive move on the part of intermediary companies. The intermediary enterprise

1/ Kreinin, op. cit.

2/ Robinson, H.J. "Motivation and flow of private foreign direct investments". International Development Centre, Stanford Research Institute.

3/ Aroaz, A.B. "The Chemical Industry goes abroad". Journal of Industrial economics, Vol. X (Nov.1961) p.21-35.

4/ Preliminary results of studies on the Indian Scientific Instruments Industry at the Science Policy Research Unit support this argument and so do the first results of studies on Transfer to the Andean Group of countries, in process at SPRU. Also, Peter Kilby "Industrialisation in an Open Economy" op.cit., gives an excellent historical account of the 'market defence' incentive in Nigeria.

transfers technology where this is the most effective means for exploiting its 'quasi-monopolistic' advantages in the international market. It is very likely that the market conditions which result from protection in the developing countries, actually reinforce its monopolistic advantages. Thus, domestic markets in the developing countries are often small - in some cases, so small that there is only room for a very few producers. The intermediary company may achieve a higher degree of market control in the developing country than it could in larger markets in the advanced countries. In some cases, this control may be guaranteed by the authorities: there are examples where foreign investors in the developing countries have received assurances from governments that competitors will not be allowed to enter the country where they are investing. But even where there is no formal arrangement of this kind, the barriers to new entrants may be considerable.^{1/} Vaitzos has suggested, the 'technological monopoly' may be reinforced by an 'institutional monopoly'.^{2/}

142. One aspect of this reinforcement of the 'technological monopoly' which has not been thoroughly examined, is that it may lengthen the period over which the technology owner can get quasi-monopolistic returns. In other words, the technology suppliers enter transfer agreements to widen their markets, but once established in the protected markets of the developing countries, they are relatively immune to competition. They may continue to enjoy high returns in the markets of the developing country even after their competitors in the industrialized countries have copied or surpassed their technological capabilities. Seen in this light, the transfer agreement is a way of extending the period of quasi-monopoly.

Choice of mechanisms by the intermediary company:

143. We have pointed out that the form of contract used in indirect transfer operations is determined by the interaction of many factors. Even though the intermediary company is in a quasi-monopolistic position, (for example because it is the unique owner of a piece of technological knowledge), it is limited in various ways in its choice of transfer

1/ Merhav, Meir "Technology, Monopoly and Development". London 1969. Merhav gives a detailed analysis of the imperfect market conditions which characterize the developing countries. He does not, however, discuss the role of foreign enterprise.

2/ Vaitzos, Constantine "Transfer of Resources" op.cit. Vaitzos also argues that if indeed technology transfers take place along these lines, the 'product cycle theory' of trade needs re-consideration, and should be looked upon as a 'monopoly cycle' theory.

mechanisms. Government legislation in the developing country may exclude some mechanisms, or make them commercially unattractive. Political and economic uncertainties may make the supplier unwilling to risk capital resources. Recipient enterprises, even though they are at some disadvantage in negotiation, may nevertheless impose conditions on the nature and terms of transfer. The decision on how to make the transfer is not entirely uni-lateral. This should be borne in mind in the following discussion.

144. A crucial question for the supplier, is the extent and nature of the control which is necessary to fit the production operation in the developing country into an overall international strategy. From this point of view, a wholly-owned subsidiary is usually the most advantageous mechanism for the supplying company. With near-total control the supplier is able to adapt the operation in the developing country to changes in domestic and world market conditions, which are unforeseeable at the time the transfer is made. Other mechanisms may give the supplier the kinds of control he needs at the time of the transfer itself, but these might prove inadequate if circumstances change. Supplying companies also tend to favour wholly-owned subsidiaries, because of the real or imagined difficulties of finding a suitable counterpart company in the developing country, and because of the disagreements that often arise between supplier and recipient companies on management decisions and methods.^{1/}

145. On the other hand, total control of the foreign operation by the supplier is not always possible or necessary. Legislation may preclude direct investment and there may be efficient counterpart companies in the developing country. In these cases, the licencing agreement is frequently used. According to Pugh, the licencing agreement has the advantage to the supplier that he can "participate in profit resulting from production and marketing of product without having to make substantial commitments of personnel, capital and other resources which might be required in direct equity investments".^{2/} Licence agreements sometimes involve equity participation and, as we have seen, one way in which this arises is through 'capitalisation of know-how'.^{3/} This has considerable advantages to the supplier because it gives a considerable degree of control without transfers of capital.^{4/} Also, licencing agreements are sometimes the first step towards

^{1/} See Freeman, Oldham and Turkean, op.cit.

^{2/} Pugh, op.cit.

^{3/} Behrman, J.N. "Advantages and disadvantages of foreign licencing;" Idea, Vol. II, Spring 1958.

^{4/} Vaitsos, Constantine, op.cit.

direct investment. For the licensor they are a low-cost, low-risk way of establishing a market prior to a major commitment of capital resources.^{1/}

146. The main problems about licencing for the supplier are the limitations it puts on control of the project, the inefficiencies which arise because of the limited technical and managerial skills of the recipient and the risk that the licensee may subsequently become a serious competitor.^{2/} The supplier has to make a trade-off between these risks and disadvantages and the gains he can get from licencing rather than using another mechanism. The decision whether to invest and/or to licence may also be strongly influenced by policies on profits tax and repatriation of resources in the developing country.

147. Evidently, the nature of the 'distinctive capability' possessed by the supplying company may influence the mechanism which is used. We have seen how licence agreements sometimes centre around the exchange of a trade-mark rather than a process technology; or the predominant element may be the technical service skills of the supplying company. Variations in the nature of the advantages possessed by the intermediary companies also account for the use of more restricted forms of contractual agreement, such as the management contract of the technical service agreement.

148. The choice of mechanisms is a complex decision for the supplier and we know little about it. The supplier has to take account of external factors - such as tax legislation or the capabilities and bargaining strength of potential recipients - as well as internal questions like the degree of control he requires to meet his own strategic objectives, and the returns he expects from the transfer operation.

The impact of indirect transfers of technology on the developing countries

149. Up till now, we have emphasized the relations between enterprises which supply technology and enterprises in the developing countries which receive it. At this point, we shall examine a wider issue: the consequences of transfer of technology for the developing countries.

150. It is hardly necessary to stress the importance of access to foreign technology. If rapid and sustained^{3/} industrialization is a major objective - which it nearly always is - there is virtually no alternative but to rely on the technical knowledge already acquired by the advanced economies. The diseconomies involved in technological autarchy are

^{1/} Behrman, J.N. op.cit.

^{2/} This latter risk is probably only significant in intra-advanced country licence agreements.

^{3/} Some countries seem to have achieved quite high rates of growth of industrial output over limited periods without much foreign technology.

likely to be very large. Industrial development would almost certainly be slower and more costly under such conditions. And apart from inefficiencies and high costs, there must be serious doubts about the technical feasibility of autarchy. The technical knowledge acquired in the advanced economies results from a long process of development, in which the development of industry stimulated the growth of technical knowledge, just as much as technical knowledge stimulated industrialization. This suggests that development of technical knowledge and skills may be difficult and time-consuming - if not impossible - in societies where the industrial base hardly exists. The importation of industrial technologies from the advanced countries may be necessary for the local development of technical skills, just as much as a compensation for the lack of skill in the short run. In this sense a policy of technological autarchy could be self-defeating.^{1/}

151. Technology transfer is important not only for development of domestic production, but also if the developing countries are to change their position in the international division of labour. In most developing countries, a high priority is to escape from reliance on the export of primary goods and to trade in industrial products where there is a more rapid growth of international demand.^{2/}

152. A recent OECD study discussed the effects of technological transfer on the trading position of recipient advanced countries.^{3/} Certain countries - notably the United States - have comparative advantages because of technological superiority. Nevertheless, the technologically less advanced industrialized countries enjoy rapidly growing exports of the so-called 'science-intensive products', because there is a transfer of technology to them - largely through the investments by United States companies.

^{1/} The Japanese example is interesting from this point of view. Whilst it certainly does not prove that technology transfer is necessary for the local development of technical skills, the fact remains that transferred technology was used - often consciously - as a basis for such a development.

^{2/} See Sussex Group; op.cit. This is discussed in detail in a recent article; "The Transfer of Technology", Journal of World Trade Law, Vol.4, No.5, Sept./Oct. 1970 pp.602 ff, which reprints the substance of TD/B/310.

^{3/} See OECD; "Analytical Report on Technology Gaps", Directorate for Scientific Affairs. Paris 1970. The study only concerns advanced countries.

153. But, whatever importance is attached in principle to the transfer of technology, it is uncertain whether transfer, as it has actually taken place, has had uniformly positive effects on development. To some extent this may be because transfers from advanced to developing countries have been relatively few in number. It has been argued that the scale of technology transfer is too limited to have the desired impact on international development. But, above and beyond this, there is the problem that in those countries which have imported a good deal of technology, the developmental benefits have been offset by disadvantages. Instead of stimulating local skills, indirect transfers may tend to perpetuate technological dependence. Whilst transferred technology adds to the productive power of the developing economies, it has not always allowed them to diversify their export patterns. Transfer often results in high cost production which is internationally uncompetitive. And, the foreign exchange burdens which result from technology transfers are often higher than might be suspected.

154. This contradiction between what might be termed a fundamental need for foreign technology, and the practical consequences of actual transfers is, perhaps, the central problem for policy-makers.

155. Many of the contradictions arise from the monopolistic nature of the transactions by which most technology transfers take place and also from the fact of market protection which stimulated them in the first place. We shall now examine some of the difficulties in more detail.

156. The problems we discuss in this section are associated with indirect transfers. They are often the consequence of monopolistic advantages possessed by the 'intermediary' companies. In a sense, indirect transfers are essentially mechanisms whereby the supplier, so to say, shares his monopoly power with the recipient company. In exchange, the supplier is able to demand commercially restrictive terms. These terms may be acceptable to the recipient, but they are not necessarily to the advantage of the country as a whole. For example, where the terms of transfer increase the costs of production, the recipient company may be able to pass on the burden to the consumer, in the form of higher prices. The monopolistic advantages inherent in the technology which is transferred helps of course, to make this possible. In other words, there is the possibility that private returns to the companies

involved in the transfer are greater than social returns in the developing country. High-priced consumer goods are one example of such a distortion.

157. Ideally, it should be possible to examine the impact of technology transfers on the development of the economy as a whole - for example, in terms of growth of GNP, distribution of income, intersectoral relationships and balance of payments effects. A comprehensive analysis of this kind, however, would require a much more sophisticated model of the economy and its relationship to foreign technology suppliers than we have at present. In the circumstances, all that we can do at this stage is to list a number of respects in which the indirect transfer of technology might give rise to problems in relation to development - and, somewhat unsystematically, give a partial analysis of them.

158. The problems we shall examine are: the foreign costs of technology transfer; restrictions on export development and the effect of mechanisms for transfer on the choice and adaptation of production techniques.

Foreign exchange costs of technology transfer

159. The foreign costs of transferred technology arise in a number of ways.

Baranson^{1/} lists the following ways in which technology suppliers get their returns:

- (i) by profits on equity investments (the equity may, of course, represent 'capitalised know-how');^{2/}
- (ii) by sales of components and intermediate materials to the recipient¹
- (iii) by royalty payments from the recipient;
- (iv) by technical licencing fees.

^{1/} Baranson, Jack: "Industrial Technologies for Developing Countries"; Praeger Special Studies in International Economics and Development, 1969.

^{2/} It may be argued that strictly speaking profit payments should only be counted as a return to technology transfer when the equity participation is the result of capitalization of know-how. But - as we shall see - the problem is more complex than this might suggest.

160. Pugh^{1/} gives a similar list of methods of payments. He also points out that some licence agreements involve lump-sum initial payments 'intended to cover out of pocket costs involved in negotiating the agreement'.^{2/}

161. Because the supplier can take out his returns in so many different ways, it is often very difficult to determine the foreign exchange burdens resulting from particular transfers. The problem is further complicated, because the supplier and recipient may have considerable freedom to shift the burden of payment from one heading to another depending on which means of payment are most advantageous from the point of view of repatriation and tax laws. Royalty payments are often preferred because they may be easy to repatriate. Normally royalty payments are controlled by governments but where there is no control they can be very high. Froes et al^{3/} say that in Brazil prior to 1958 when there were no controls on royalties, rates as high as 20 per cent of turnover were charged. In this case royalties were a convenient means of tax-evasion. Where royalties are controlled payment may be made through marking-up the prices of intermediate goods, or through 'capitalisation of know-how'.

162. This means that there is no certainty that payments made under any one heading will represent the real value of resources transmitted to the recipient enterprise under that heading. And, of course, where the transfer is done through a wholly-owned subsidiary, the parent company has greater freedom to use a method of accounting which minimises tax burdens and makes it as easy as possible to repatriate returns.

163. An important problem about these practices is that they may result in a loss of government revenues in the developing countries. There is, however, a further problem. This is that the costs of transfer are determined by negotiation with a supplier who by virtue of the technology he has to offer (or by virtue of other advantages such as trade-marks) is in a quasi-monopolistic position. In addition - as Vaitzos has pointed out - the recipient is often ignorant of the nature of the technology he is bargaining for^{4/}. In combination, these factors inflate the costs

^{1/} Pugh, op.cit

^{2/} See Vaitzos, C. "Transfer of Resources and Monopoly Power" for discussions of methods of payment. Also Behrman "Advantages and disadvantages", op.cit.

^{3/} See Froes et al, op.cit.

^{4/} Vaitzos, C. "Transfer of Resources" op.cit.

of technology transfer to levels which are very much higher than the costs which the supplier incurs in acquiring and transferring technical knowledge to the recipient. These costs i.e. the real costs of transfer, may be rather low: Vaitzos argues that the opportunity costs of transfer by licencing, without equity participation, are virtually zero. However, since the transfer process normally involves more than simply supplying blue-prints and calls on the technical skills of the supplier company, there are almost certainly higher costs than Vaitzos suggests. Equally certainly however, the returns to the supplier may be out of all proportion to the costs he incurs. The situation arises because the supplier has a degree of monopoly power and also because the potential recipient perceives the opportunity costs of not having the technology or the brand-name as very high.

164. These monopolistic returns to technology transfer are normally taken out through various 'implicit' payments. Royalty payments as the most evident and explicit form of payment for technology are often effectively controlled in developing countries. Payments for equipment and material are far more difficult to control; it is difficult to work out a 'fair price' for machinery components or highly differentiated intermediate goods. This means that technology suppliers may be able to take a return by marking up the prices of intermediate goods and equipment they supply^{1/}. The practice of price mark-up may be facilitated by a clause in the contractual agreement which obliges the recipient company to buy the intermediate goods from the technology supplier. In other cases, where the process technology is highly differentiated from other technologies, the recipient may have little choice but to purchase intermediate materials from the technology supplier. In either case the supplier gets a monopoly over intermediate goods supply.

165. The incidence of these hidden costs on the balance of payments of the developing countries is hard to assess. It is known that they are sometimes high. Vaitzos studied some sectors of Colombian industry and found very large price mark-ups, associated with technology agreements. He mentions a weighted average overpricing ratio (above world market levels) of 165 per cent for 17 pharmaceutical companies, 54 per cent for 11 electronics companies, and 44 per cent for 3 rubber producers. He has calculated that the balance of payments 'overcharge' of this was about \$3.8 million for these firms alone. These returns were much higher than

^{1/} See Vaitzos, and also United Nations; "Arrangements between enterprises for the transfer of operative technology to developing countries"; Progress Report by the Secretary-General (E/4319).

those received from royalties, though royalties alone were 0.4 per cent of Colombian GNP in 1966. Vaitos suggests that Colombian experience may be typical for Latin American countries, but as yet there is little evidence on how important price mark-ups really are. Studies on the Indian Scientific Instruments industry by Clarke, Bennet, Oldham and Parthesarathi indicate that overpricing has not been a problem there^{1/}. This is consistent with the argument that effective import licencing leaves little room for marking-up prices. It may also be that technology suppliers will accept lower proportionate returns for transfers in large economies like India, because of the importance of getting a foothold in the market, and because the absolute amount of returns is likely to be large even without mark-ups^{2/}. The question of implicit or 'hidden' payments for technology evidently requires more attention.

166. One aspect which is virtually unexamined is the question of the determinants of the costs of transfer. Vaitos appears to argue that costs are determined by relative bargaining power, in which the crucial variable is the relative ignorance of the recipient company. There is no doubt that recipient companies often are ignorant about the technologies they bargain for; and this must influence the bargain. At the same time, however, other factors might be expected to influence the costs of technology transfer. For example, technology suppliers presumably cannot push their demands to the point where the recipient is unable to make profits out of the transfer^{3/}. This may not be too serious a limit where the transfer gives the recipient company considerable monopolistic advantages in the home market. It might be expected, therefore, that returns will be higher where the transfer gives the recipient a greater control over the domestic market. In addition the possibility of marking-up prices of intermediate goods probably depends on the degree to which the intermediates are differentiated from potential substitutes. For example, it may be easier to mark-up prices for components sold to an assembly industry

^{1/} Ongoing research at the Science Policy Research Unit, University of Sussex. We are indebted to our colleagues for this information.

^{2/} Counting in 'normal profits' from intermediate sales and returns on capitalised know-how as well as royalties and explicit payments of that kind.

^{3/} This constraint may not apply in the case of wholly-owned subsidiaries. In certain circumstances - largely determined by taxation regulations - it may be in the interests of parent companies to show a 'book loss' for the subsidiary and to take out returns by over-pricing materials and equipment sold to the subsidiary - or in other ways.

(because it is difficult to determine a price for - say - the door of an automobile), than in the case of raw materials sold to a chemical plant. There are usually more suppliers of raw materials inputs than of highly differentiated components, and international prices are easier to determine in the former case. These questions are practically unresearched at present, and indeed we are far from solving the methodological and practical problems of measuring the real costs of technology transfers. We know however that royalty payments are often only a small part of the total^{1/}.

Export development and technology transfer

167. There are many reasons why it is difficult for the developing countries to build up exports of manufactures. Companies in the developing countries do not have facilities for marketing, distribution and technical service, which are needed to sell in foreign markets. Export marketing often requires that company personnel should travel abroad and exchange shortages in developing countries limit foreign travel by nationals. Above all many industrialised countries have tariff restrictions against imports from developing countries, in order to protect their 'traditional' industries.

168. Problems like these are part of the reason why transfers of technology have not generally resulted in changes in the export pattern of developing countries. At the same time, however, these factors are not always sufficient to explain the failure to develop exports. For example, many technology transfers are done through wholly-owned subsidiaries or joint ventures, where the parent company in the advanced country already has a developed export capability in third markets. Indeed, it is argued that one of the advantages of foreign investment for the developing countries, is precisely that it makes available to them the exporting skills of the parent company. In these cases, at least, there is an 'infrastructure' for exports.

169. Even so, wholly-owned subsidiaries, and joint ventures do not appear to have much impact on export performance in developing countries, except in those cases where the transfers have been a response to lower factor prices, e.g. south east Asian countries.

170. This suggests that there are obstacles to export development over and above those which have been mentioned. Some of these obstacles may result from the terms and nature of technology transfers, and from the conditions which stimulate transfers in the first place.

^{1/} See Vaitsos, Constantine, op.cit. The findings of the Sussex project on Scientific Instruments confirm that royalty payments are seldom a major source of revenues.

171. A first problem is that process technologies are transferred on terms which strongly reflect the interests of the companies which possess them - and these interests may preclude exports to third countries. If a technology supplier has licencing agreements with a number of companies in neighbouring countries, it may not be in his interests to have them compete against one another or against the parent company. For this reason, where there is a possibility that the licensee might be internationally competitive (or sometimes even where no possibility exists) there is often a clause in the licence agreement which prevents export of the product or which specifies the countries to which the licensee may export.

172. Frequently, however, the costs of production in licensee companies (and also in wholly-owned subsidiaries) are so high that they cannot export even where there are no restrictive clauses in the agreement. There are many reasons for this inefficiency. Amongst them, there are two which are directly related to the transfer of technology.

173. First, the costs arising from the transfer of technology itself, may contribute to inefficiency. For example, if the prices of intermediate materials are inflated, and if imported materials account for a large proportion of total production cost (say in assembly industries), they may have an appreciable effect on overall costs.

174. Second, high costs of production are often a consequence of general inefficiencies arising from heavy protection. Ignacy Sachs has pointed out these inefficiencies are often external to the firm which installs the new techniques of production. They may, for example, arise from the high cost of locally-produced components. In general, the inefficient forms of production which can develop in highly protected economies appear to undermine the possibilities of export promotion from transferred technology.

175. This gives rise to a kind of impasse. On the one hand technology transfer is very often a response to import restrictions; on the other, the conditions which protectionism creates preclude export development from transferred technology. We shall return to this problem in Part Four of this study - in the discussion of policies.

The Transfer of Technology and the problem of appropriate technology:-

176. It is argued that the technologies which are transferred to the developing countries are frequently 'inappropriate' to the needs and resources of these countries. The concept of an 'appropriate' technology is variously defined (and sometimes left undefined), but it is not central to this study to enter into the problem. It will suffice to mention, by way of example, that at present the idea that transferred technologies have been 'inappropriate', is usually linked to the unemployment problem

which characterises many developing countries. The argument is that an underlying reason for large-scale structural unemployment is that the technologies which have been imported into the developing countries, have had a strong labour-saving bias, appropriate to relative factor endowments and prices in the advanced countries, but inappropriate for developing countries.

177. For the present, however, we shall beg the problems raised by the concept of 'appropriateness' - and simply take note of two corollaries of the general argument. The first is that for a given line of production some advanced country technologies may be more appropriate than others, and that developing countries should therefore make a careful selection from the spectrum of technologies available. The second is that even where the range of choices is very limited, it may be possible to widen it by adaptations of the technologies which are available.

178. The main argument of this section is that the mechanisms for technology transfer which have been discussed in this study, may themselves put serious constraints on the possibilities of choosing the most appropriate technology for any given line of production, and on the possibilities of adapting existing technologies.

179. The institutional arrangements for transferring technology may restrict choice in a number of ways. First, whilst a number of technologies may exist for manufacturing a product, there is no certainty that they will all be accessible to the developing economy. Particularly if the technologies are in the possession of different companies, there is no certainty that all the companies will wish to invest in the country or have technical agreements. Second, even if all the technologies are accessible, it is most probable that the cost involved in transfer will differ considerably from one case to another - and this will constrain the possibility of choosing between technologies purely on the basis of their 'appropriateness' to the internal requirements and problems of the country. Third, even in the case where direct mechanisms are used for the transfer, choices may be influenced by factors other than - the 'appropriateness' of the technology to domestic conditions. For example, if the investment project is financed by 'tied aid', there may be serious constraints on choice. And above and beyond these 'objective' constraints there are 'subjective' ones as well. It is suggested, for example, that advanced country consultants and experts used in direct transfer operations often recommend the most up-to-date and hence usually the most capital-intensive technologies available. The technical experts are conditioned to regard such technologies as the 'best' available in some absolute sense. Largely because of the way they are trained - they fail to understand that what is best or most appropriate in the environment of the industrialised countries, is not necessarily so in the developing country they are advising.

180. The ways in which technologies are transferred, also limit the possibilities of technological adaptation. For example, the interests of the various enterprises in the transfer operation (wholly-owned subsidiaries, licencees and 'intermediary' supplying companies) may be opposed to labour-using/capital-saving adaptations, though they may increase profitability. The risks and uncertainties of having to deal with a larger - and possibly inexperienced - labour force, may outweigh profit advantages in the perception of the companies involved. Also, the gains in profitability from technical adaptation may be proportionately small in highly protected, oligopolistic markets. The conditions that increase the incentives to transfer technology (i.e. protection of the market in the developing countries), may diminish the incentives to adapt technologies to conditions in local factor markets.

181. There is a further consideration which seems to play an important part in indirect transfers. The technologies that are transferred by indirect mechanisms can probably only be adapted, if the intermediary companies themselves are willing to alter them. The technology suppliers are most unlikely to allow recipient companies or independent research institutes to adapt their processes. The financial returns to the supplying companies usually depend on the effective operation of the technology and on product quality, and these considerations alone make technology suppliers suspicious about attempts to tinker with their production techniques. For the most part, however, the question never arises: the intermediary company alone has sufficient knowledge of the technology to make adaptations, and it alone has the R and D personnel which are usually needed. In these circumstances, everything depends on whether it is worthwhile for the supplying company to make adaptations.

182. The desirability of technological adaptation from the viewpoint of the supplying company does not simply depend on whether the adapted technology will be more profitable than the unadapted one in the developing country market. The crucial consideration is the opportunity cost of using highly skilled technicians and research and development staff to adapt an existing technology. The problem is that technology suppliers nearly always consider that it is more profitable to use scarce scientific and technical personnel in the search for new technologies and products for the large markets in the industrialised countries, rather than for adapting old technologies for small markets in developing countries. The fact that adaptation is potentially profitable is beside the point. The question is whether adaptation is more or less profitable than innovation^{1/}.

^{1/} Research in progress at the Science Policy Research Unit offers some confirmation of this argument.

183. It is true, of course, that suppliers sometimes adapt technology. Baranson^{1/} and Strassman^{2/} quote a number of examples of product and process adaptation in transfers to developing countries. This is, however, consistent with our argument, which does not exclude the possibility that supplying companies will sometimes decide that their interests lie in adaptation. It is probable, however, that they will only adapt under rather special circumstances. For example, if for one reason or another, the supplying company has under-utilised scientific and technical staff, it may be more inclined to use them on adaptation research. Alternatively, if the adaptation is simple from a technical point of view, and does not make demands on the R and D department of the supplying company, it is probably more likely to be undertaken. This means that there are likely to be inter-industry variations in the frequency of adaptation. Process technologies are inherently complex in some industries and simpler in others; one might therefore expect that the level of skill required for adaptation and hence the opportunity costs involved will vary between industries.

184. The probability that the supplying company will adapt process technology depends also on the market situation it faces. Suppliers will be more inclined to make adaptations if they are likely to improve their positions in a number of developing countries, rather than in just one market. In addition, companies which are proportionately more dependent on markets in developing countries are more likely to adapt their processes and products than companies which make most of their profits in the industrialised countries.

185. The extent and nature of technological adaptations need to be more systematically studied^{3/}, before one can reach any firm conclusions. It would appear, however, that there are fairly strict limits on technical adaptations at present. These limits are probably more severe in some industries (say chemicals) than others - and for some kinds of adaptations (e.g. scaling-down and labour/capital adjustments) than others.

^{1/} Baranson, Jack; "Industrial Technologies for Developing Countries", op.cit.

^{2/} Strassman, W.P.; "Technical Change and Development", op.cit.

^{3/} W.P. Strassman has made some empirical studies of adaptations. See Strassman, W.P. "Technical Change and Development", op.cit. There is a good survey of the current literature in Campos, Mauricio; "Technological adaptations in Under-developed Countries"; Unpublished MA dissertation, University of Sussex. 1969.

Direct Transfer Mechanisms as an Alternative

186. This discussion of problems associated with indirect transfers explicitly abstracts from the action that Governments might or should take to control matters. Evidently, policy-makers have to face the problem of getting a positive contribution to the growth of production from indirect transfers whilst reducing foreign exchange costs or export limitations or whatever. And clearly also there are some policies they might follow in this respect. These are discussed in greater detail in Part Four of the paper.

187. In addition, however, there is the possibility, which we have already mentioned, that direct mechanisms of transfer may be used in some cases to obviate some of the difficulties associated with indirect ones. There are, of course, some immediately obvious limitations on the use of direct mechanisms: in some sectors, the process technologies which are required are simply not available except through one or another indirect mechanism. Decisions about how far to rely upon indirect transfer mechanisms and proprietary process technologies will obviously have some implications for sectoral priorities in development planning; at least it would hardly be rational to make such decisions without considering their broader implications from this point of view.

188. At the same time, however, it seems quite possible that direct mechanisms might be used for a wider range of transfers than at present. That is to say that in many cases where indirect mechanisms are used at present, process technology and other elements of technical knowledge might well be available through direct transactions with machine suppliers and the like. (For the moment we shall ignore the problem that there may be high efficiency costs in using direct mechanisms, because the recipient enterprises might lack the organizational and managerial capacity to use technical knowledge).

189. The most obvious cases where a switch to direct mechanisms might be accomplished in the short run, are where the main motivation for the indirect contractual arrangements are access to brand-names and trade-marks and where the process technologies themselves are widely available and possibly relatively unsophisticated. A pre-condition for a switch to direct mechanisms in these fields, is that there should be a clear decision on whether or not to accept consumer preferences for branded articles. But - over and above such obvious possibilities - there may well be other areas, where at some cost in terms of efficiency during construction and operation of production facilities, direct mechanisms might be used.

190. The most common argument in favour of direct reliance on machine suppliers and the like, is that this approach will obviate many of the problems which we have listed, associated with indirect transfer. In particular, it is argued that direct transfers avoid the situation where enterprises are controlled from abroad - and where that control is used to restrict their development (say through export limitation) in the interests of the overall strategy of the foreign company. It is also argued that direct transfers avoid the continuing foreign exchange chain that may result from licence agreements and wholly-owned subsidiaries, through royalty payments, profits repatriation, transfer pricing and the like. And finally, it is suggested that direct mechanisms are more likely to provide technologies which are appropriate to conditions in developing countries.

191. There is no doubt a good deal to be said for these arguments. But there are also some real difficulties; direct transfer mechanisms do not necessarily provide a way out of the problems even if a greater reliance upon them might have positive developmental effects. Direct transfers - practically as a matter of definition - obviate some of the problems of foreign control - and where for example export limitations are a direct result of the policies of foreign enterprise, a switch to direct transfers might well be useful from this point of view. At the same time, however, there is no guarantee the projects based on direct transfers will stimulate manufactured exports. If the failure to develop exports is a consequence of diseconomies external to the recipient company they will not do so, without complementary policies to increase the efficiency of the economy in general. Added to this, direct transfers may result in high efficiency costs in the recipient company and undermine competitiveness. And finally, the recipient company may not have any organizational capacity to develop export trade.

192. Direct transfers may be expected to reduce the foreign exchange burdens associated with external technological dependence. But again the question is not as simple as it might appear. As we have seen, machine suppliers may achieve a high degree of market control vis-à-vis recipient companies in developing countries, and they can use it - and apparently have done so in some cases - to inflate the prices they charge for their products. And whilst it may appear that direct transfer will reduce continuing expatriation of investible resources, they may not do so, if the local classes to whom profits accrue have a high propensity to export their earnings - legally or illegally. Nor is it certain that the behaviour of nationals in this respect is easier to control than the behaviour of foreign enterprises.

193. And finally direct transfers may well provide access to technologies which are more appropriate from various economic and social points of view than those which are imported by foreign investors. But insofar as more appropriate technologies can only be got by adaptation - which is not always the case - there is no guarantee that foreign machine suppliers will be any more willing than foreign investors to adapt techniques for the relatively small machine markets of the developing countries.

194. Intuitively, it seems likely that the most compelling arguments for direct transfers are likely to be that they may have a more positive impact on the development of technical capabilities inside local enterprises, than indirect transfers (where much of the project management and technical capability is provided by an intermediary company). It may well be that certain kinds of indirect transfer result in under-utilisation of technical capability available in developing countries and slow down the development of skills that can only be acquired through 'learning-by-doing' (say in organizing plant construction). As we have pointed out, diversification of sources of know-how in general, and a switch to direct mechanisms in particular, might well increase the opportunities for such skill differentiation and development in the local population. We have already shown, however, that there are costs involved in this learning process, because it will normally be associated with inefficiencies. One of the problems for policy-makers is clearly to develop some means of assessing the long run benefits (in the form of new skills) that may accrue from direct transfers, against short-term costs (in terms of inefficiency and foregone production). It may be, for example, that short term costs are higher where the gap between the skills required by a given technology of production and those available locally is larger - and a measure of this "internal technology gap" might provide some basis for ranking projects in terms of the suitability of direct transfer mechanisms.

195. Clearly, the choice between direct and indirect transfer mechanisms is not easy, and will generally involve careful assessment. The data required for such assessments is not generally available at present and the need for further research in this field is obvious.

PART FOUR:

SOME POLICY PROBLEMS

196. Ideally a policy towards the transfer of technology should resolve the conflicts between the need for technology in the developing countries, and the negative consequences which result from the terms on which it is transferred and from the context in which transfers take place. In practice, this is asking too much. Many of the problems have their origins in the role which technology plays in competitive relationships - and that is something which policy-makers in the developing countries (and in the international agencies for that matter) accept as a datum.
197. This leaves a problem. If it is not possible to consider ways of resolving the conflicts, the best that can be hoped for is to cut down some of the anti-developmental consequences associated with technology transfers. The problem is that whilst the basic conflict remains, much that will be done, say to reduce the costs of technology transfer, or to obviate restrictions on the commercial activities of the recipient company, could be a disincentive to potential technology suppliers. If one improves the terms of transfer from the standpoint of the developing country (and not just the recipient company), technology owners may be less willing to transfer. The major difficulty for the policy-maker is to know how sensitive the 'supply' of technology is likely to be to the constraints he may set on the terms of the transfer contract.
198. This is a difficulty which we cannot answer in this study. The fact of the matter is that no-one knows how much room to ~~manoeuvre~~ governments in the developing countries have. Furthermore, since the incentives to transfer - and the terms that suppliers demand - are influenced by many factors, it is most probably that there is no general answer to the question.
199. This means, of course, that one cannot make definitive policy proposals on the basis of our existing knowledge. This final part of the study therefore is not so much concerned with policy proposals as with isolating a number of areas for policy as a basis for research.
200. The discussion is divided into three main sections. In the first we discuss the relationship between technology policies and other policies. The content of a policy on transfer of technology depends crucially on the policies the government is following in other areas like consumption, industrial development, trade and so forth. In the second section, there is a discussion of national policies in the developing countries. The third section discusses international implications.

Relations between policies for transfer of technology and other policies

201. The transfer of technology has been looked upon as a response to various specific conditions in the developing countries - and particularly to the market for consumption goods, to protectionism, and to the lack of local technical skills and capabilities. It follows that policies towards the transfer of technology will to some extent, be derived from broader policies on consumption, import-substitution and education and technical training. This is, of course, nearly self-evident. The main reason for making the point is simply that it sets some limits to what should be expected from a technology transfer policy per se. For example, it is not sensible to expect that a technology policy itself should prevent brand-name or trade-mark transfers which are essentially aimed at a luxury consumption market. The problems that may be associated with this kind of transfer result in the final analysis, from the existence of certain consumption patterns - and it only makes sense to try to solve them, if there is an appropriate policy on levels and patterns of consumption in the country itself. Similarly, many transfers result in inefficient, high cost production. To some extent the costs of transfer itself may contribute to uncompetitiveness. But generally high production costs result from a much wider constellation of factors - some of which are discussed in earlier Parts of this study. Probably the main difficulties arise when new industries are set up indiscriminately with very high protection. To the extent that technology suppliers may ask for and get promises of market protection before they are willing to make transfers, they contribute in some sense to the problem. But the real solutions involve far more than policy towards technology transfer; they involve decisions on the patterns of industrialization, on relationships to international markets - and hence, implicitly on the appropriate pattern of protection.

202. Finally, in the long run, the control of the costs and negative consequences of transfer operations probably depends more upon developing local skills and capabilities than on policies concerned directly with transfers of technology from abroad.

Policies at the national level

203. The policies which governments in developing countries follow relating to the transfer of technology, may be grouped into three main categories:

- (i) policies which are designed to increase and direct transfers;
- (ii) policies which influence the costs and terms of transfer;
- (iii) policies which are designed to develop local skills so as to reduce external technological dependence.

204. In each category there are some policies and government activities which are directly focussed on the transfer of technology, and some which have an important influence on the direction and terms of transfer although they may have been drawn up to meet quite other objectives. In this section there is an attempt to discuss both these kinds of situation.

Policies to increase and direct transfers of technology

205. Policies towards direct investment by foreign companies play an important part in this category. The 'intermediary' companies in indirect transfers generally prefer direct investments in wholly-owned subsidiaries or joint ventures for transferring technology. It may be expected, therefore, that national policies on foreign private investment will influence the volume of transfers and also the relative frequency with which various transfer mechanisms are used. Policies on direct investment vary widely between countries. There are 'open-door' policies, where by means of a variety of incentives (tax-holidays, investment allowances, free repatriation and the like), foreign investors are more or less indiscriminately encouraged to come into the country. There are also highly restrictive policies, where foreign investors are virtually excluded or are only allowed in certain industries. It is probably true to say that technological factors are seldom explicitly considered in the former case - i.e. in 'open-door' policies, and that they play an increasingly important part as policies towards foreign investment become more restrictive. Japan is an example of a country where technological factors are virtually paramount in deciding upon the acceptability of foreign direct investment (and of other forms of foreign collaboration). The history of Japanese policy on foreign participation is one of successive trade-offs between the desire to raise Japanese production technology to the levels of the industrialized countries, and the desire to minimize external technical dependence and to develop local capability. The implementation of Japanese policy has required detailed technological evaluation of individual proposals for foreign entry. In India also restrictions on foreign direct investment activity are accompanied by a fairly explicit consideration of technological factors. Industries are divided into three broad groups for the purposes of foreign investment policy. There are industries where foreign investment and technical collaboration is permitted; industries where 'foreign technical collaboration' (i.e. indirect transfer) is allowed, but not investment; and industries where neither foreign technical collaboration nor foreign investment

are allowed.^{1/} In some other countries, foreign investment policies are more liberal, but there is nevertheless some explicit examination of the nature of technologies being transferred. South Korea^{2/} for example has a system of priorities for technology transfers. At the other end of the spectrum, Mexico appears to operate something like an open-door policy to investments without detailed consideration of the nature and consequences of technological transfers^{3/} where direct investment is concerned.

206. The policies that a country may follow towards the transfer of technology in general and towards foreign investment in particular, are constrained by factors that are beyond control at the national level - at least in the short run. For example, where the domestic market is small and slow-growing, the only way to get access to foreign technology may be to encourage foreign investors by concessional terms. Also, the structure of local industry and, particularly, the availability of local technical capabilities are likely to be critical in determining the choices which are open to policy-makers. These constraints are implicit, for example, in the Indian policies on foreign collaboration: there are certain industrial branches where it is impossible to develop local production without accepting foreign investors - either because there is no local capability or production structure, or because technology suppliers have a monopolistic hold on process technologies. Similarly when the Mexican Nacional Financiera attempted to transfer technologies by cash purchases of know-how, there were an unacceptably large number of commercial failures, because the foreign supplying firms were not sufficiently committed to the success of the project.^{4/} Local capabilities were insufficient, and it was necessary to adopt more liberal policies to foreign direct investment. And, at an altogether higher level of technological development, Japan has liberalized some of its policies towards foreign investment in order to get access to certain technologies which are considered crucial to industrial development. Foreign companies tend to demand greater equity participation in transfers of more sophisticated technologies.^{5/}

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- 1/ Federation of Indian Chambers of Commerce and Industry: "Procedures for Industrial Licencing", New Delhi.
 - 2/ The South Korean authorities give priority approvals to technical agreements involving transfers to an export industry and to the local machine manufacturing industry.
 - 3/ Victor Urquidi has criticized Latin American policies of this kind. See Urquidi, Victor: "Latin American Development, Foreign Capital and the Transmittal of Technology", *El Trimestre Económico*. January/March 1962.
 - 4/ Maddison, Angus: "Foreign Skills and Technical Assistance in Economic Development", OECD Development Centre, Paris 1965. See also Wionczek, op.cit.
 - 5/ Baranson, Jack: "The role of science and technology in advancing development of Newly Industrializing States"; Pergamon Press, 1969.

207. In general, there is little empirical knowledge on the various constraints that restrict the options open to the developing countries in their policies on these questions. Factors like market size, local skill availability in relation to the technologies required, and local industrial structures must have an effect of being selective about transfers. Until there is better information on how serious these constraints really are, it will remain very difficult to design policies. The problem is complicated by the fact that these constraints must vary considerably from industry to industry and from technology to technology. This implies that a policy of selectivity towards the nature of technology to be transferred and towards transfer mechanisms, must of necessity involve detailed analysis of economic and technological conditions at the industry level.

208. Governments usually implement policies of selectivity simply by applying appropriate criteria in deciding whether or not to pass a contract proposal. This is a somewhat passive approach. A few governments are more active; they consciously encourage local companies in priority sectors to enter negotiations for foreign technology. The Ministry of International Trade and Technology in Japan performs this function. It actively seeks out local companies which are likely to undertake projects in the priority areas, and establishes a list of firms in foreign countries specialized in the types of production in question. It then takes the best deal it can get from the offers made by the potential technology suppliers.^{1/} The Japanese case is probably the best example of 'active' policy towards transfer, which is otherwise rare amongst the developing countries.

209. An active policy of selection puts heavy demands on the national administration. To be effective, it has to be based on a thorough 'monitoring' service which, so to say, scans technical developments in the world economy in priority industries. It requires also a relatively sophisticated capability for choosing between technical alternatives and for selecting the most favourable offers. Both these functions demand a level of administrative efficiency and technical skill which is relatively rare in developing countries - and practically unattainable in the least developed countries. Hence, whilst there are obvious advantages in these more aggressive forms of technological selection, they may often be inapplicable. Many smaller countries are therefore in a position where local entrepreneurs and managers are incapable of monitoring technical developments and where the administrative system is in no position to correct the deficiency. In these circumstances, there is virtually no choice for

^{1/} See also Baranson, Jack: "The Role of Science and Technology". op.cit.

governments but to accept a passive role in the transfer operation. Indeed, even 'passive' policies (where the state merely approves or disapproves contact proposals), may be reduced to pure formality when the level of technical comprehension in the administration is very low.

210. A selective approach - whether passive or active - which allows or encourages transfers in certain sectors and industrial branches, is obviously only possible where there is a reasonably clear view of priorities in economic policy in general.

The terms and costs of technology transfer

211. This category includes policies which are designed to control the foreign exchange costs associated with technological transfers as well as policies on the restrictive practices associated with transfer operations.

212. Probably nearly all countries limit the proportion of net sales or total output which can be paid in royalties and licencing fees. Typically the royalty percentage is restricted to about 5 per cent or less of sales or output. Some countries - notably India - set different limits in different industries, in line with the priority attached to various kinds of technological knowledge. Others - like Japan - vary the maximum royalty proportion for agreements of differing duration. In Japan, maximum royalties on agreements lasting up to five years are $2\frac{1}{2}$ per cent, and on longer agreements - lasting up to 10 years they are 5 per cent. Japanese legislation, therefore, puts a premium on longer term agreements. This bias is not uniformly shared by other countries. In South Korea, for example, it is not permitted to sign an agreement for more than three years. The short maximum period may, however, reflect a preference for frequent re-negotiation, rather than for short-term agreements as such. A further restriction which is often put on licencing agreements concerns guaranteed minimum payment conditions. These are conditions which assure a certain absolute return to the licensor, when the value of sales by the licensee falls to very low levels. Many countries forbid such guarantees. Some countries forbid the payment of royalties by wholly-owned subsidiaries to parent companies (e.g. India, Brazil).

213. By and large governments in the developing countries seem to take the view that control of royalty payments is a sufficient guarantee that foreign exchange costs associated with transfers will be kept within 'reasonable' limits. To this extent technology transfer policies are based on an inadequate appreciation of what actually takes place in the transfer relationship. As we have seen indirect transfers usually

result in the recipient company relinquishing some degree of control (and sometimes ownership as well) to the supplier; they also create conditions in which the supplier can get his returns through a variety of procedures, and is relatively free to shift from one procedure to another. Failure to recognize the nature of indirect transfer process as a totality, results in situations where governments control royalty payments, whilst leaving technology suppliers free to take returns for example, by inflating the prices of intermediate goods. This kind of situation - which is typified by the case of Colombia as described by Vaitos - is probably fairly common.

214. Thus controls over the terms on which intermediate goods are supplied to licencees are relatively rare. The United Nations study on patents^{1/} points out that "tie-in" clauses granting licensors a monopoly of supply of intermediate goods are forbidden in some advanced countries like the United Kingdom, Australia and New Zealand; but many developing countries seem to accept such clauses without question. The control of prices of imported intermediates is, of course, a complicated business, which involves much more than the mere prohibition of tie-in clauses. Many intermediates used in transferred processes are highly differentiated, and since they are not normally sold on an open market, it is difficult to know how they 'should' be priced. This does not mean that intermediate price control is impossible - just that it may be very difficult.

215. There is, of course, some control over the prices of intermediate materials and equipment by import licencing procedures. The United Nations study on "Transfers of Technology to India" suggests that strict import controls as well as local content legislation have meant that technology suppliers get little scope for price mark-ups. Also, it is argued, the dependence on tied credits for essential imports, means that it may be hard to predict from one year to the next which supplier countries will be accessible to the licensee seeking intermediate materials. This means that tie-in clauses are often ineffective, though it does not necessarily prevent price mark-ups. Indeed, it is argued that tied credits themselves often allow machinery and intermediates suppliers in the advanced countries to mark-up their export prices.

216. Licencees sometimes take returns through dividend payments on equity - and often they receive the equity in the first place as payment for the technology they supply. The control of payments through capitalization of know-how is inherently difficult, and this may be part of the reason why it is seldom attempted. Presumably it requires not

^{1/} "The role of patents in the transfer of technology to developing countries" op.cit.

only some means for settling on a 'fair price' for the technology - in terms of the equity exchanged for it, but also some means for monitoring dividend policies. Both of these requirements are likely to be difficult to meet in practice.

217. There are various other restrictive aspects in transfer operations which some governments attempt to control. The most widely discussed is the limitation of export markets: agreements often include a clause which prevents the recipient enterprise from exporting to third markets.

218. Export limitations are a strategic response by the supplier company to specific circumstances. In other words, technology suppliers do not always demand or require them: for example export restrictions are probably rare in transfers from the United States to EEC, and most United States companies operating in Europe probably plan their operations on the basis of a total European market. In other areas - like Latin America - strategies are more strongly oriented to national markets and export limitation clauses are common. This probably results from the fact that Latin American markets are highly protected in the first place - so that ab initio the technology suppliers see little hope of an international scale of operation. At the same time, however, the policies followed by technology suppliers probably reinforce the emphasis on import substitution as opposed to export promotion.

219. The undesirability of export restrictions is widely recognized in the literature. Vaitsos in particular has discussed the obstacles it raises when technology receiving countries attempt to change the basis of their international economic relations - say by entering a common market. Once the pattern of transfer into a region has been based on developing similar lines of production in the various national markets, it may be very difficult to change. The 'export clause' is, of course, only part of the problem - but it is at least a contributory factor.

220. Whilst many governments dislike restrictions of this kind and attempt to avoid them, there is very little evidence on how successful they are, or on how seriously they take this kind of problem. One reason why they may not take it very seriously, is simply that the removal of export restrictions is normally an insufficient condition for the promotion of exports. Normally, export restrictions are not likely to be crucial unless there are real possibilities of competitive production - and this often involves a revision of the framework of protection and import substitution.

221. There is one other restrictive aspect to technology transfers which is worth mentioning. This concerns patent procedures. Many technology owners patent their processes in the developing countries. In some cases they take out the patent - not because they intend to start production in the developing countries - but because the patent itself will protect their export markets. Some governments have legislated against this, by reserving the right to compel the patent owner to licence his process to local producers - on pain of losing patent protection. Often compulsory licencing of this kind is resorted to priority industries. In India, for example, the government may expropriate unworked patents or demand licence agreements in industries like food, medicine or insecticides.

222. Generally, policies designed to control the terms of transfer agreements have been very 'patchy'. For example, they may control royalty payments, but other forms of return untouched. There is little evidence that the policy-makers have taken an overall view of transfer operations. There is apparently room for new and more coherent policies in this area, but there is a prior need for research.

Local capabilities and external technological dependence

223. There is a spectrum of policies through which governments in the developing countries attempt to build up local capabilities and reduce external technological dependence. These are essentially policies aimed at overcoming the tendencies towards self-perpetuating dependence of the kind which is discussed in earlier parts of this study. In general, these policies meet up with the problem that development of technical skills is a slow process, particularly when the industrial base itself is under-developed. The types of policy which we shall discuss here are:

- (i) policies on employment of local personnel by foreign enterprise;
- (ii) policies on diversification of the sources used in transfers;
- (iii) policies on building local scientific activities in relation to industrial sectors.

224. Policies of the first kind, i.e. on employment of locals by foreign enterprise, are very common in the developing countries. The Indian government for example, sets fairly rigid standards to determine the kinds of foreign personnel which are indispensable to the production operation - and puts considerable pressure on foreign companies to employ nationals in skilled and unskilled occupations. Similar procedures are used in some Latin American Countries. In many countries also firms are required to run

training operations for locals. There are of course conflicts of interest in this area. The use of relatively inexperienced local personnel may lead to inefficiencies and costs for the company. This may also be in conflict with the short run interests of the country itself, but from the national point of view, short run costs arising from inefficiency have to be set against long-run gains in terms of increased skill availability in the economy. The advantages may be external to the foreign firm which undertake the training and employment of locals. The demand that foreign companies should train locals is not confined to the case of wholly-owned subsidiaries or joint ventures. It may also arise in licencing agreements: the licensor may be required to train personnel from the recipient company. In this case, there may be a somewhat greater identity of interest between technology suppliers and governments.

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225. Policies designed to 'diversify the sources of technical know-how' have two main objectives. First they are sometimes regarded as a way of reducing foreign exchange costs of transferred technology, (though this may be done at the expense of inefficiency and high local costs in the construction phase of the project). Second, they are a way of building up local managerial and technical capability. We have already discussed the problems and limitations inherent in this kind of policy - and particularly the difficulty of weighing short costs against rather vaguely defined (but potentially very important) long term gains in terms of corporate ability at the enterprise level.

226. These policies take many different forms. They range from relatively limited efforts for example, to make suppliers use local engineering consultants wherever possible (India); to more severe restrictions where, for example, governments may simply refuse to allow local companies to sign licence agreements and demand predominantly local development of the technology. These more extreme restrictions are unlikely to be workable except where there has already been a considerable build up of local capability, or where the technology is simple (and perhaps the main motive behind the licence agreement was access to a brand-name). Japan, for example, has been able to follow restrictive policies in certain cases where local technical capability is highly developed. It appears that the Indian government has also limited technical agreements from time to time and de facto stimulated some local development in various fields of

process technology.^{1/} These 'hard-line' diversification policies are probably inapplicable in many smaller developing countries, particularly the least developed ones.

227. At the extreme, policies on diversification of sources of know-how may throw recipient companies back on direct mechanisms for transfer. Apart from the difficulties which the recipient has to deal with in organizing and using the knowledge it receives through such mechanisms, direct transfers pose their own problems, some of which have been discussed already. There is, for example, the problem of bias in the recommendations of experts and consultants. Biases - as we have seen - may simply arise from the experience - background and engineering training of experts. They do not necessarily involve acts of bad faith. But they introduce a number of problems which are difficult to resolve - particularly in relation to the choice of process technologies.

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228. As a long-term policy, some countries attempt to build-up R and D activities in local enterprises or in government laboratories associated with the industrial sector. Again the Japanese example, though its relevance to developing countries is questionable, is interesting. Particularly in the last decade, the Japanese authorities appear to have encouraged local industry to build up its own R and D activity. Partly this reflects the fact that as Japan has caught up with the Western countries technologically, by licencing foreign techniques, it has been seen as more and more necessary to have a local innovative capability. Partly, however, the recent push to build-up local R and D is an outcome of earlier developments. For many years, Japanese industries have used foreign technology as a basis for further technological development. In this respect there is an interesting finding by Freeman, Oldham and Turkcan^{2/} that industrial R and D in Japan tends to be concentrated in precisely those branches which are also major importers of technology by licencing.

^{1/} This appears to have happened in certain lines of instrument production. See "Instrument Industry in India" (DAE, Bombay; Indian Inst. of Management, S.P.R.U., Sussex University; All India Manufacturers and Dealers Assn.), Bombay: 1970.

^{2/} Freeman, Oldham and Turkcan, *ibid.*

229. There is obviously a great deal to be said for a conscious effort to use imported technology as a basis for further technical development and also perhaps to learn how to adapt it to local conditions. But for most developing countries, this course of action is difficult to implement. Often they simply do not have the scientific skills that are needed at the R and D level and these take a long time to build up. And, in countries which have at least some industrial R and D manpower, it normally has to be organized into government research institutes, which often have great difficulties in relating their work to local industries. The organization of the scientific system in the country is often so inadequate that even if there is R and D work it has little chance of becoming economically effective. Furthermore, the orientation of such R and D is sometimes irrelevant to local requirements. These problems, combined with the fact that local enterprises may have strong economic incentives to continue to rely on external sources of technology, create serious problems in many countries and are only just beginning to be recognized.

International implications

230. There is a growing discussion of the possibility that various forms of international action may help to solve some of the problems which developing countries have to face in technology transfers. These discussions are sometimes unrealistic in the sense that fail to take account of the nature of the transfer process. On the other hand, however, they have isolated a number of functions which, at first sight, might well be carried out by various forms of international co-operation. We shall not discuss in detail the proposals that have been made for specific international institutions, such as Patent Banks,^{1/} International and Regional Technology^{2/} agencies, and Technology Transfer Banks.^{3/} By examining functions that may be performed we shall, in fact, cover much of the content of these institutional proposals. But since the question of what form of international institution is required to carry out in these functions, raises special problems, needing separate study, we have purposely avoided it.

^{1/} Dolezil; op.cit

^{2/} M. Hatty Carrere; op.cit

^{3/} Freeman, Oldham and Turkcan; op.cit

231. The problems associated with transfer of technology have two kinds of implication for international action:

- (i) there are some possibilities for joint action by developing countries;
- (ii) there are some functions that may be carried out in a broader international context.

232. Two kinds of proposals have been made for regional co-operation between groups of developing countries. The first kind covers measures which may help to control the terms of technology transfer. The second is concerned with methods of monitoring the technological advance in sectors and branches which have some priority for the various countries in the region.

233. The most concrete proposals of the first kind are those which Vaitos has drawn up in relation to the Andean Group of countries. Essentially, Vaitos is concerned to outline ways in which joint action by developing countries may improve their bargaining position vis-a-vis technology suppliers. His proposals include: regional selection of the country where specific new plants are to be sited (particularly where there are scale problems); and regional representations in negotiations for major new production facilities. Regional representation may help to avoid situations where technology suppliers play one country off against another. Vaitos also argues that countries should align their negotiating procedures so as to avoid clauses which might restrict regional trade. And finally he recommends a greater exchange of data and information between governments on the terms of individual transfers.

234. Evidently regional co-operation - if only on the exchange of information on individual transfers - may help to strengthen bargaining power of recipient countries and enterprises. At the same time, however, it is clear that there are constraints on this kind of co-operation. To be fully effective, joint technology policies probably require that the countries involved enter into some form of customs union, and co-ordinate their industrialization policies. This, no doubt would greatly strengthen bargaining positions (because of larger markets) but the political constraints are, of course, very serious as Latin American experience seems to indicate.

235. The second kind of proposal is that the monitoring and technical information functions discussed in the previous section should be done through regional co-operation. The argument is that there will be dis-economies if all countries start their own

technology monitoring institutions. Again, there is some force to this argument but there are also problems. First of all, there is no reason to presume that monitoring and selection can be done at lower cost by regional co-operation. A great deal will depend upon the precise content of the industrial plans of countries in the region. If these involve a high degree of specialization between countries (which they presumably would in the ideal case of co-ordinated regional planning), there may be more to be said for national monitoring services than for regional ones. Also monitoring services can only lead to more 'active' selection of foreign technology if they are properly linked to local industries. This may be difficult with regional centres - though it is probably not an insuperable problem.

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236. A rather heterogeneous group of proposals have been made for action at the international - as opposed to regional - level.

237. First, there are a number of suggestions which relate mainly to direct transfer mechanisms. Many of these concern the improvement and re-direction of multi- and bilateral technical assistance operations. Plainly technical assistance has a potential role in transfer of technology, though in order to increase its effectiveness it will be necessary to reconsider technical assistance functions explicitly in relation to the transfer problem. One aspect which almost certainly needs to be looked at, is the problem of the biases in terms of technology choices proposed by experts and consultants. To the extent that these biases are inherent in the training of the engineers and technicians involved, it may be possible - as a short term measure - to correct for them by special induction courses. And in the longer run there may be possibilities of special content academic courses.

238. Beyond this, it has been proposed that an internationally organized technical information service may help to obviate reliance on indirect mechanisms in cases where direct ones might be used. Essentially such a service would have to provide information on consultancy and research services, machine suppliers plant contractors and the like which are available to enterprises in the developing countries.

239. A second group of proposals essentially concerns the improvement of the terms of transfer by indirect mechanisms. Some of these proposals have obvious advantages. For example, it is suggested that international institutions might provide comprehensive

information on the range of technologies and technology supplying companies in various fields. This would presumably help in bargaining processes. It is also suggested that information exchange through an international mechanism might strengthen the bargaining position of developing countries and possibly lead to a "most-favoured recipient" basis for international transfers.

240. Beyond this, however, it has been suggested that multi-national funds might be used as a means of supplying technology on concessionary terms. Some proposals along these lines envisage an agency which would - so to say - purchase proprietary technology from 'intermediary' companies and sell it concessionally to enterprises in the developing countries. It is most unlikely that this would be practicable. The active participation of technology suppliers - over and above the mere supply of proprietary technology - is often crucial in successful transfer. Also the level of funding required for such purchases might be very high indeed - in order to compensate suppliers for the overall profit returns they would have to forego.

241. It may be that less extreme forms of concessionary finance could be used to support recipient enterprises, but any policies along these lines need a great deal more study than they have had in the past.

Annex

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