Technical Change and the Multinational Corporation: Some British Multinationals in Kenya*

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The accumulation of capital is a necessary (although not sufficient) condition for development to occur. For accumulation to take place a society needs to obtain the savings which will finance this accumulation of capital. However financial capital although often equated with physical capital in economic literature, is not in itself sufficient to guarantee capital accumulation unless it is allied to the introduction of available production techniques. Embodied in these techniques of production is a certain level of technological knowledge, which together with specialised organisational inputs will determine the productivity of labour employed in production.

The level of technical knowledge embodied in capital is of critical importance in determining the rate of economic growth, and it is natural, therefore, that those concerned with the rate of accumulation in underdeveloped economies will be anxious to obtain capital which embodies the technology most suitable to their needs. This raises the question of the appropriateness of this technology, for what is suitable for one set of conditions may not be most suitable for another set. The relevant "set of conditions" evoked in economic literature generally relates to the different availability of factors of production and the different scale of operations in developed and underdeveloped economies. Increasing attention is however being given to the appropriateness of output, as well as to production techniques which are used in underdeveloped economies.

The basic dissimilarity in production and consumption conditions between developed and underdeveloped economies is widely accepted. The problem for underdeveloped economies is that the technology which they require to increase the productivity of labour is generally embodied in capital goods designed and produced in developed countries, with the aim of catering for the needs of producers and the taste of consumers in these economies. In spite of the inappropriateness of this technology, underdeveloped economies are dependant on developed

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economies for the capital goods which they require to increase their rate of accumulation.

It is necessary to move away from aggregative concepts such as 'developed' and 'underdeveloped' if this problem [illegible] is to be fully understood. Institutional considerations need to be introduced to disaggregate and thus enhance the analysis. It is not the 'developed' economies which produce these capital goods, but firms in the developed economies. One of the more significant developments in global accumulation in the past half century has been the emergence of the multinational corporations with production facilities in a number of economies. The tendency to oligopolisation is well-documented and producers in underdeveloped economies who seek capital goods turn to these multinationals and other large firms in developed countries as suppliers. It is not only producers in the underdeveloped economies who turn to these firms but also decision makers in Government who wish to expand production of commodities in their own economies.

It would be a mistake if the developed country firms were considered as passive observers, awaiting [illegible] requests from Governments or firms in underdeveloped economies. The nature of competition in the world economy makes it imperative for these firms to expand and diversify their production facilities and at the same time they actively respond to incentives (eg tariff-barriers to encourage local production) which are placed before them.(1) The flow of foreign investment from developed to underdeveloped economies is thus a result of pressures from both economies.

Research and Development cannot be equated with the embodiement of new technology in new machinery. Nevertheless it is increasingly true that new technological developments depend to a considerable extent upon the research and developmental activities of producing firms. The striking fact about global research and development is its concentration. It is estimated that 98% of global research and

development takes place in developed economies[2] and within these economies a large proportion is concentrated in a few firms. The largest four firms account for 20% of all industrial research and development in the US, for 25% in the UK, for 21% in France and for 46% in Italy.[3]

This concentration of research and development and the subsequent concentration of new technological developments within large firms in the developed countries underlies the underdevelopment of poor countries. It largely explains why these countries, such as Kenya, turn to foreign investment as a means of increasing their rate of accumulation. One other aspect of this desire for foreign investment concerns disembodied technical knowledge - the managerial and marketing exeprtise possessed by foreign investors. The result is that underdeveloped economies, particularly those with a lesser depth of technical skills and a less well-developed industrial structure, turn to foreign investors for a package of services which includes the acquisition of new technology, some of which is embodied in capital goods purchased from abroad.

Nature of the Research

This research project focusses on one aspect of this link between developed and underdeveloped economies as embodied in the presence of multinational firms in Kenya. The primary aim of the research has been gauge the different response/ as there is a noticable absence of empirical research into the activities of these subsidiaries with respect to the generation, and acquisition of new technology. Seven British multinationals have been chosen who operate in Kenya.[4] Detailed investigation has been undertaken through the medium of interviews and other supplementary research to establish how the subsidiaries of these firms set about obtaining technology for their operations and how the parent in the UK organises the acquisition and generation of technology suitable for the operations of their subsidiaries.

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It should be stressed that no attempt has been made to obtain detailed quantitative estimates of the operations of these subsidiaries or their parents. The main reason for this has been that the research has been undertaken in part in the form of interviews. It is not believed that the responses with regard to financial expenditure given in these interviews is sufficiently accurate to enable detailed analysis of a precise nature. Instead an attempt has been made to draw out the 'qualitative' aspects of their activities, focussing less on the precise estimates of expenditure on particular activities, but more on whether these activities take place, and in what form they occur.[5]

The discussion of the research will take the following form. Firstly an attempt will be made to define more clearly what is meant by technology and to differentiate between change in three spheres of technology - production, product and materials technology. The distinction will also be drawn between proprietary and non proprietary technology and between embodied and disembodied technology. Technical change in the three spheres may be generated within the subsidiaries or may be obtained from parent, or non-parent sources external to the subsidiary.

The second section of the research offers a brief description of each of the subsidiaries in the sample and compares their relative turnover, capital intensity etc. This is followed by a third section which discusses the orientation of technical change in the seven subsidiaries, drawing the distinction between changes in production, product and materials technology, and change resulting from other inducements.

The fourth and fifth sections of the research deal with the acquisition of new technology. In the former the generation of technical change within the subsidiaries is considered and particular attention is given to the role of quality control activities in this process. The latter section considers the purchase of parent and non-parent technology, and distinguishes between the rights and the ability of subsidiaries to determine their own sources of supply. Consideration is also given to the types of technological collaboration

entered into by the subsidiaries.

The sixth section of the research considers the mechanisms used by the seven firms to circulate new technology. Particularly important here is the use of disembodied technology as a mechanism of circulation. This is followed by a seventh section which deals with the stimulation of forward and backward linkages as a result of the presence of these seven subsidiaries in Kenya. Consideration is given to the nature of entrepreneurship which results from these linkages.

The conclusion follows and sets out the basic results of the research. It then considers the sources of variance in the behaviour of the subsidiaries with regard to the generation and acquisition of new technology. The research is concluded by a brief discussion of some other points of interest which have arisen.

The Three Spheres of Technical Change

Conventional economic theory focusses on technical change as the introduction of new production techniques which have the effect of lowering unit costs of production.[6] The world does not however proximate very closely to this idealised picture of technical change. Reference to empirical investigation immediately shows this. For example one survey of US industrial Research and Development in the early 1960's[7] found that 45% was intended to create new products, 41% to modify existing products and only 11% to lead to lower costs of production. This body of specialised economic theory largely relates to this latter 11%. So there is clearly a void to be filled in its understanding of technical change, particularly as traditionally empirical research on the choice of techniques and technical change has been focussed on the determination of these best-practice techniques.

Although the generation of new techniques which have the effect of lowering costs of production is an important sphere of technical change, there are two other spheres which are equally, if not more, important to consider if we are to fully understand the process of technical change. These are product technology and materials technology. It is worth discussing these three spheres of technology in a little more detail in order to generate a suitable framework to understand the generation and acquisition of new technology by the subsidiaries in the sample.

(a) Production technology

While technology may be constant in the (narrow) economic sense of the word in that the technical coefficients of production of a set of techniques are identical this may disguise a range of other differences which will influence the type of activities involved. That is, the 'way of doing it' may be entirely different - one technique may concern chemical reactions and another may require the bending of metals. These differences will have important implications for the organisation of production, the type of labour which is required and so on; differences which are of considerable importance when discussing technical change, but which are overlooked in the simple two factor model.

A further elaboration of production technology is important to make clear the distinction between the various processes involved in production. Pack[9] suggests that there exist five basic processes - material receiving, material processing, material handling among processes, packaging and storage of finished products. Generally discussion on technology doesn't distinguish these five basic processes and implicitly addresses itself to the core material processing. In certain situations this may only be a minor aspect of a firm's operations (particularly in assembly operations) and/or there may be little flexibility or adaptation possible. Technical change in a subsidiary, particularly that which is generated by the subsidiary in an underdeveloped country may well be concentrated in the other four stages. The distinction between this core processing stage and the four peripheral stages is thus important if we are to understand fully the operations of the subsidiaries in our sample.

(b) Product Technology

Product technology refers to the ability of an enterprise to generate new products and to adapt and differentiate its existing protfolio of products. These new products may 'embody' to a greater or lesser extent a certain 'level' of technology. - this a numerically controlled machine tool represents a higher 'level' of product technology than an ice cream, even though the production technology involved in the

manufacture of the ice cream may be more 'complex' than that involved in the manufacture of the machine tool. Generally the level of product ADAPTATION tends to be 'higher' in the case of capital and intermediate goods than for consumer goods. By contrast consumer goods industries, particularly in oligopolistic markets, tend to give more attention to product differentiation. It is worth giving brief attention to each of these areas of product technology - product innovation, differentiation and adaptation.

i) Product innovation.

Most products have a life-cycle after innovation in which slow initial growth is followed by rapid growth until the market stabilises or decreases due to saturation or the inelasticity of demand for the product as income increases further. The suppliers of these products are therefore forced into generating new products if the rate of growth is to be maintained. They may also be forced into the search for new products in order to avoid excessive reliance on any one product which they produce.

ii) Product differentiation.

The (implicit) assumption of perfect competition in economic theory ignores the effects of market structure on technical change. It is by now well-established that one of the effects of oligopolistic markets is to substitute product differentiation for cost reduction. Not all product differentiation may entail changes in production technology (for example, new packaging), but some do. The best example of this is probably the motor car industry where frequent product changes are often accompanied by changes in technology, such as the use of different body-presses to meet superficial design changes.

iii) Product adaptation.

There are two aspects to product adaptation, 'technical' adaptation and 'market' adaptation. Technical adaptation refers to changes dictated by environmental conditions, for example changes induced by different levels of temperature and humidity. Market adaptation refers to changes induced by the nature of the market, as in

the case of the two subsidiaries in this study which adapt their drug and cosmetics to reflect the taste patterns of the African market.

(c) Materials Technology.

The materials used by an enterprise is another important sphere of technology. As with product technology, material technology may also embody to a greater or lesser extent a certain 'level' of technology. For example, the intermediate inputs used in the manufacture of pharmeceuticals embody a higher 'level' of technology than lime and some other raw materials used in the manufacture of cement. Another important aspect of materials technology may arise when production techniques are designed with one set of inputs in mind and transplanted to another setting where there may be minor or major changes in input quality. This may affect the operating characteristics of the production technology. Adaptations to existing production technology may therefore have to be made - in some cases these adaptations may be relatively minor (eg changing the setting on machine but in other cases the necessary changes may be more fundamental. The distinction has been drawn between production, product and materials technology, in an attempt to better understand the technical change which takes place in subsidiaries. This distinction should not be taken to mean that there is no link between these three spheres of technical change. On the contrary it has been argued that they are intimately linked - changes in product invariably induce changes in production technology. Similarly changes in materials technology may well lead to changes in production technology. The point of separating these three spheres has been because the primary inducement of technical change will vary with circumstances.

Our concern has been with broadening our understanding of the concept of technology in order to understand the process of technical change. In addition to production, product and materials technology, government regulations may also induce technical change. The most prevalent of these pressures in underdeveloped countries is the desire to cut down on the consumption of imports. Producers may be forced to switch from foreign to local sources of supply, or may well be forced into a backward linkage itself if no local supplier exists. This switch may affect the quality of the inputs and thus necessitate a change in technology through adaptations to existing

technology. In some of the more recently decolonised economies (such as Kenya) the dominant concern of Government may be to localise manpower, and this, too may affect the technology which is used.

Embodied and Disembodied Technology.

The distinction has been made between production, product and materials technology. It is important also to distinguish embodied and disembodied technology. In the case of embodied technical change, new technology is embodied in capital equipment, inputs and products. This is the most common meaning of the word technology. Yet in fact much of the technological input is of a disembodied nature, and particularly in the case of a foreign investment package in an underdeveloped economy, the disembodied technological input may be of considerable importance. In some case the technology may be man-disembodied, that is a set of organisational and managerial skills developed by particular individuals. When these individuals depart from an enterprise, they may well take their disembodied technological input with them. This differs from firm-disembodied technology where a particular organisational system is specific to a firm, and the departure of specific individuals need not necessarily lead to loss of the particular disembodied input.

Proprietary and Non Proprietary Technology.

Not all technology is subject to the laws of private property. This is generally true of disembodied technology, whether man - or firm-disembodied. The skills are not patentable / but they may be held in such a secretive manner that few people or organisations have access to them .

. A particular type of non-proprietary technology results from much of basic and applied research undertaken in goverment and academic institutions. Given the availability of certain skills this is a relatively free pool of knowledge which enterprises may dip into in their quest for new technology.

The same cannot be said of proprietary technology. This technology can only be used with the agreement of the 'owners' and in most cases its use is subject to payment by agreement (eg royalties lump-sum payments, technical contracts etc). Here a distinction must be made, in the case of a subsidiary's operations, between parent - and non-parent - proprietary technology. The acquisition of technology by a subsidiary will inevitably be subject to these laws of property.

WP // With this broader description of technology in mind, it is instructive to look at the various activities which may lead to the generation of technology. This technology may be generated within the firm (either by a subsidiary or by the parent) or it may be purchased from other suppliers. In each case it is of interest to establish to what extent the subsidiary itself is responsible for generating or purchasing this technology.

1.6 Generation of Technology within the Firm.

There are three types of activity within the firms which may lead to the generation of new technology. These are:-

i) Research and Development. The OECD Frascatti Manual[10] characterises both basic and applied research as the generation of scientific and technical knowledge. As such research may be an essential condition for the development of new technology. On the other hand [illegible] "Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products and devices; to installing new processes and systems, and to improving substantially those already produced and installed" (p 10) The costs associated with Research and Development have become so large that many small firms (and even some 'large' ones as is shown in the results which follows) are only able to develop new techniques in the absence of research. It is for this reason that the large multinationals do the expenditure on Research and Development. Subsidiaries in a country such as Kenya are unlikely to undertake any Research (and often do any Development either) of their own and may rely for new technology generated in this way on associates in the UK and elsewhere.

(ii) Adaptation.

Another source of new technology which has been relatively neglected in the literature comes from the adaptation of technology. Only Katz has given any detailed consideration to this phenomenon in his study of 'trouble-shooting' in Argentinian industry in which he found that significant increases in capacity and productivity of factors resulted from these 'trouble-shooting' activities.[11] It is not clear what exactly Katz means by 'trouble shooting', but there is evidence that changes in Kenyan subsidiaries do occur as a result of adaptation of production techniques and products to local conditions.

(iii) Quality control.

It is feasible also that changes in technology may result from quality control activities which force a subsidiary to note that the technology which is being used is unsuitable because the product which it produces is not suitable for the local market or does not meet standards set by the parent. This observation may force the subsidiary to either adapt an existing, or develop or purchase a new technology.

(b) Purchase of Technology

The ability to purchase technology is itself a technological capability of the disembodied kind. Increasing attention over the years has been given to this subject,[12] particularly with regard to an enterprise's ability to 'unpackage' the source of its technology. In a situation of extreme dependence an enterprise will be forced to turn to a single supplier to meet all of its technological requirements - the supplier will provide a complete package of equipment and, in some cases, disembodied technology as well. This dependence may well lead to 'monopolisation' by the supplier as well as the purchase of some non-optimal production lines as the supplier may have a particular strength in only some aspects of the technology.

The ability to 'unpackage' purchases of technology may therefore be a considerable asset for a subsidiary, if it is to reduce the costs of this technology and to buy the technology which most suits its needs. Attention has therefore also been focussed in this research on the rights and ability of the subsidiary to make its own technology purchases independent of the parent.

The Sample of Firms

Subsidiaries of seven British multinationals were interviewed. Three of these firms were in the consumer goods sector, of which two produce pharmeceuticals, cosmetics and baby foods. For the other firm in this group, the largest in the sample, tea, and coffee are the main products. Two of the other firms were in the intermediate goods sector. One of these, which produces cement, is the most capital intensive subsidiary in the sample; the other, assembles buses, trucks and four-wheel drive vehicles. Finally there are two capital goods subsidiaries. One is an engineering design and installation - firm and the other manufactures tea processing equipment. It is of some value to give a brief description of each of the seven subsidiaries in the sample. Table 1 summarises the most important features of each of these firms, and table 2 provides an estimate of the degree of capital intensity.

FIRM A (Tea and Allied Products)

This firm is one of the largest producers of tea and coffee in Kenya. It began its local operations in the 1920's and has grown steadily over the course of the years. Recently in anticipation of increasing localisation of tea growing it has complemented its tea growing by further moving into purchasing and marketing of tea and coffee. It has in addition begun to diversify its operations by producing cinchona (used in the manufacture of quinine) and tara (used to manufacture tanin). The firm has also taken a share in a fruit canning factory, The major investment in recent years has been to construct an instant tea plant and the decision was made by the parent to locate its instant tea plant in Kenya.

In 1971 Firm A became a public company and sold off 11.25% of its shares to local shareholders. The subsidiary produces about 27% of all the country's tea - there is one other large British Company and the Kenya Tea Development Authority which represents over 90,000 small growers operating in Kenya. It is the largest firm in the sample with a turnover of over £17.5 million and a labour force of over 14,000. Approximately 60% of output is exported and the firm is working at full capacity.

The new instant tea plant has required a large input of technological expertise and has had a gestation period of about ten years. But aside from this new plant, the operations of this firm are not characterised by a complex technology and this is evidenced by the increasing localisation of production of tea and coffee.

The parent dominates the world tea market and in 1965 - 70 it was directly or indirectly involved on the production and distribution and sale of about a quarter of the world's tea crops

FIRM B. (Phameceuticals, cosmetics, baby foods)

Firm B is a wholly owned subsidiary of one of the three largest British pharmeceutical companies (with an annual expenditure on Research and Development)(It has been operating locally for about 10 years in the UK of over £10 million a year). / It has been operating locally for about 10 years. By comparison with Firm A it is relatively small with a turnover of just less than £1 million and employs 132 people. There are firms (all foreign owned) producing pharmeceuticals in Kenya.// This subsidiary produces three lines of product. The major product is cough syrup/tablets where it holds approximately 60% of the local market. Other products are baby foods (about 15% of the local market) and pharmeceuticals (about 3% of the market). In addition to producing locally, the subsidiary also imports final products from the parent. Approximately 10% of output is exported. The local market is extremely competitive and is characterised by high expenditure on advertising - the subsidiary spends about 23% of its total revenue on 'selling expenses'.

Firm C (Pharmeceuticals, Cosmetics, baby foods)

This firm was begun as a locally owned firm in 1955 and became a wholly owned subsidiary of the British multinational in 1970. It is also amongst the three largest pharmeceutical firms in Britain and it is the largest cosmetic and toiletry firm in Kenya and until recently had the largest pharmeceutical plant in the country. It has a similar product portfolio as Firm B, and by comparison exports more of its output. It has a lower value added per employee than its competitor, but this may in part be due to the fact that it appears to spend proportionately less of its revenue on advertising and marketing. It dominates the local market for cosmetics and toiletries.

FIRM D (Portland Cement)

Firm D does not strictly qualify as a 'subsidiary' of a British multinational, since 52% of the equity is owned by the Government of Kenya. Only 14% is owned by the British 'parent' and a further 14% by a Danish multinational. The rest is held by local shareholders. The reason why this subsidiary, which produces portland cement, has been introduced into the sample is because it has a technical agreement with the British 'parent', which not only supplies technical manpower to the Kenyan subsidiary, but also assists in the purchase of new technology.[15] It was established in 1933 and it is the second largest firm in the sample, with a turnover of over £5 million and employs 380 people. This firm produces an undifferentiated product in a seller's market and shares the market about equally with one other firm which is also a subsidiary of the same multinational.[16]

FIRM E (Vehicle Assembly)

Firm E is a subsidiary of the largest motor car and heavy vehicle manufacturer in Britain. It was established 14 years ago and in the past it was a wholly owned subsidiary, The firm is at present constructing a large new assembly plant and 35% of the equity is now owned by the Government of Kenya and 20% by a locally owned distributor of motor vehicles. It will be facing competion from two other assembly plants on Kenya. It, too, is a relatively large firm with an annual turnover of about £2.5 million and employs 125 people. The firm holds about 80% of the local market for bus-chassis, 17% for trucks and about 60% for four-wheel drive vehicles. This subsidiary does not engage in manufacturing, but assembles knocked-down kits.[17] The new assembly plant will increase the local content and the degree of assembly but these will only be marginal changes from present practice.

FIRM E (Refrigeration and Air Conditioning Design and Installation)

Firm E is unlike any other firm in the sample in that it does little manufacturing locally and is primarily an engineering design and installation firm. This, as we shall see has an important influence on its tendency to adapt to local conditions. It is a relatively autonomous subsidiary by comparison with other firms in the sample even though the parent's share of equity (ie 74%) is high. It is a relatively small firm with a turnover of under £900,000 and employs 115 people. It is the largest of three such firms (two foreign) in Kenya. By comparison with other firms it possesses a considerable technological expertise in a technologically complex sector, in which it holds about 50% of the market. The share of revenue gained through exports is high (30%) and is an indication of the apparent autonomy of the subsidiary. The subsidiary has been designing and installing refrigeration and air-conditioning equipment in Kenya for about 15 years.

The parent of this subsidiary is primarily engaged in the manufacture of heavy refrigeration equipment and is the market leader in Europe.

FIRM G (Tea processing equipment)

Firm G manufactures tea processing equipment and also designs complete processing plants. In addition it supplies grain drying equipment. This subsidiary is an unusual case in that the parent has ceased to produce this equipment in Britain and it has recently (18 months ago) centered its tea equipment manufacture in Kenya because of its proximity to the market and the lower costs of production. As a consequence it exports a relatively high proportion of its output (about 15%)in comparison to other manufacturing firms in Kenya. It is the smallest firm in the sample and has an annual turnover of almost £450,000 and employs only 36 people. However it is one of the more dynamic firms in our sample in that it is growing rapidly (all profits are at present reinvested) and has managed to generate some new technology locally. The share of equity owned by the parent is 61.4%. The firm operates in a competitive market and supplies just over half of the local output in this sector.

TABLE I

FIRMS	A	B	C	D
	Tea and allied products	Pharmeceu- tical: etc	Pharmeceu- ticals	Cement
Turnover	17,650,000	937,399	3,000,000 (a)	5,082,353
Issued (£) Capital	10,000,000	108,235	705,882	1,764,706
Issued Capital + Reserves (£)	12,105,960	196,470	1,000,000	1,800,706
Before Tax Profit (£)	3,500,759	51,625	(a) 1,110,000	368,905
Before Tax Profit as % Capital + Reserves	28.9	26.3	111(h)	20.5
Dividends	1,650,000	(d)	(d)	300,000
Fixed Capital a machinery :	(b) 2,962,929	194,248		3,001,113
Original cost written down cost (£)	1,761,769	103,241	145,882	1,580,784
Employment	14,000	132	200	380
Capacity Utilisation (%)	100	75 (a)	100	75 (f)
Products	Tea, coffee growing & Processing. Instant tea Cinchona. Tea bark.	Cough Tables/ Sweets. Baby Foods Pharmeceu-	Cosmetics and toil- etries. Pharmeceut- icals and agro-chem-	Portland Cement.

Vehicle assembly	Refri	Price To machinery	
2,403,947	682,353.	470,588	
36,471	130,588	52,160	
55,833	182,586	(d)	
70,179	37,037	23,529	
125.6	20.3		
0 (e)		0	
12,387	13,214 4,518	9,412 2,000	
125	115	38	
75 (a)	100	100	

Vehicle Assembly	Design & Installation of refrigeration and air-condition	Tea handling drying & conveying equipment. Factory design. Grain drying Equipment

(TABLE I Contd.)

Share of Market.(%)	27	60 Cough Sweets 15 Baby foods 3 Pharmeceuticals	40 Cosmetics to toiletries	50	80 Buses 17 Trucks 60 fwd cars	50	50-75
Exports as % of sales	80	10	30	0	2	30	15
Direct Imports as % sales	13	40	35 + (a)	7	35	40	60
Equity of Parent (%)	88.75	100	100	14	45	74	61.4
(g) Est of Value Added. (£)	3,825,457	483,128	510,000	174,057	48,098	182,674	74,508
Value added/ Employee	273	3660	2,550	458	385	1509	1962

(a) Estimate (b) Much of this firm's fixed investment was in land. The 1974 value of this was £12,621,060. (c) This newly constituted firm has only been in operation for 3 months (d) not available (e) No intention of issuing dividend for next three years. (f) This firm constrained from working at full capacity due to shortage of rolling stock on railways. (g) Value added derived by adding wages and all other expenses. It is obviously an approximate figure. Profits are excluded in this figure. (h) In process of revaluing assets.

A number of points emerge from Table 1. The three consumer goods industries (tea and pharmeceuticals) all export some of their output, with the share being particularly high for the tea producer. All three are characterised by a high parent share of equity (100%, 100% and 88.75%) - it is not clear why this should be the case, but it may be related to the relative simplicity of these firm's operations which means that equity-holdings is a relatively important control-mechanism for the parent[18] (By extension the same should occur in the case of the vehicle assembly operation, which is another relatively simple operation - in this case, however, the government has enforced a local shareholding in negotiations to set up the new assembly plant). The two pharmeceutical firms have similar import content, but differ in size and propensity to export.

The two intermediate good firms (cement and vehicle assembly) are similar in a number of areas. Neither exports any output, both have a relatively low value added per employee both have a relatively high turnover and a low share of parent equity. The main difference between these two firms arises with respect to their propensity to import - the vehicle assembler has the highest and the cement manufacturer the lowest propensity to import of all the firms in the sample.

The two capital goods firms are characterised by smallness of size - they have the lowest turnover, the lowest employment and the smallest fixed capital of the sample. They do have a greater tendency to export and a high share of parent equity. This latter factor is a little surprising in that because of the specialised nature of their skills the parents of these subsidiaries do probably not need to have equity as a control mechanism. The most striking thing about these firms is their high level of value added per employee in spite of their small fixed capital - this suggests that disembodied technology is an important input in their operations.

Since we are interested to some extent in the production technology used by each of these subsidiaries, it would be useful to have some indicator of the capital-intensity of each subsidiary. The measure which is chosen to reflect this capital intensity is the

value of fixed capital (machinery and equipment) per employee. This is the best indicator available, the main problem being that it only reflects embodied technology. This works to the disadvantage of Firm D and, to a lesser extent, of Firm C, both of which have invested resources into human capital. Another disadvantage of this measure is that it works to the disadvantage of firms with an old stock of capital - that is Firms C and F.

Table 2.

Fixed Capital per Employee

	A Tea etc.	B Pharmeceuticals	C Pharmeceuticals	D Cement	E Vehicle Assembly	F Engineering Design	G Tea Machinery
Original value	211	1,471	-	7,898	-	115	24
Written Down value.	127	782	729	4,160	99	39	5

The cement producer D emerges as the most capital intensive firm in the sample. It is followed by the two pharmeceutical firms. The similarity of the ratio for these two firms represents the similarity of their operations (mixing ingredients, pressing pills and packaging). The low figure represented for the vehicle assembler reflects the fact that this subsidiary only assembles at the simplest level (there exist various degrees of assembly of which this subsidiary operates at the most simple level). The tea producer also appears to be labour intensive, despite the fact that the value of its fixed capital in aggregate terms is the largest of all the firms in the sample - this partly reflects the labour intensity of tea and coffee cultivation and partly the fact that much of its capital is held in the form of land, rather than machinery. The two capital goods producers are the most labour intensive firms in the sample. This is not unexpected and, as already mentioned, leads to the observation that the disembodied technological input for these firms is probably high.

III

The Orientation of Technical Change

Each of the subsidiaries were asked to describe the main reasons inducing them to introduce new technology and also which spheres of technology/which most concerned them with respect to technical change. As we have seen there are three spheres in which change can take place and frequently links arise between these spheres so that changes in one may lead to changes in another. The subsidiaries were further asked whether government regulations or pressures or other factors were an inducement to technical change. The purpose of these enquiries was to establish whether there exist any common patterns which might suggest that certain types of firms are more concerned with change in a particular sphere of technology.

Production Technology and Technical Change

The main concern with regard to production technology lies in the reduction of unit costs. Two of the subsidiaries, tea producing and tea processing machinery were very concerned with the reduction of unit costs. One other subsidiary - cement was moderately concerned and the other four subsidiaries did not consider that reduction of unit costs was an important consideration for them. The main points are summarised in table 3.

(i)Strong inducement to reduce unit costs.

Tea. The reasons for this strong desire to save unit costs in this subsidiary are clear. Firstly it is difficult to differentiate either tea or coffee by changes in product and in any case this subsidiary has a joint marketing agreement with most other tea producers to market tea in the local market. There is therefore little scope for the sort of product differentiation which would enable the firm to increase or maintain profit margins in a competitive market without reducing unit costs. Secondly the Kenyan subsidiary is operating in a competitive market and is squeezed at both ends. International competition is intense from other firms and from other subsidiaries in the Group. Locally the subsidiary is also under some pressure as Africanisation of the economy is largely focussed on the agricultural sector and small-holder tea cultivation is expanding with government support. The subsidiary is therefore forced to concern itself with cost reduction in order to maintain its margins.

III

The main bias of this cost reduction is the saving of inputs such as fertiliser, herbicides and fuel. The subsidiary is not focussing its attention on saving labour costs, partly because of the political consequences involved, partly because labour is abundant and relatively cheap and partly because no suitable labour-saving method of plucking has been developed. In addition to this focus on the saving of inputs, the subsidiary is concerned to increase the productivity of its capital. In this case capital is held in the form of land, rather than machinery and equipment and considerable increases in output per acre have been achieved over the years through land intensification practices.

This cost reduction has been achieved by a combination of efforts. The introduction of herbicides and fertilizers has come with the assistance of multinational agro-chemical firms operating in Kenya. To some extent cost savings also result from the subsidiary's own efforts - new strains of tea trees and vegetative production tea bushes were developed in trial programmes and some benefit has also arisen from disembodied technical change in the subsidiary such as the introduction of better supervision over tea pluckers. Other subsidiaries in the group have also been of assistance and there has been the transfer of growing, cultivating and processing practices from other subsidiaries of the group in South Asia.

Tea processing machinery. Cost saving has been the main motivation for this subsidiary to introduce new technology. Indeed it is partly for this reason that the firm moved its tea-equipment manufacture from the U.K. to Kenya. The dominant activity of this firm is the fabrication of machinery and, because demand is too small to allow for production line assembly, the production technology is labour intensive. Technical progress in production is predominantly disembodied and as the labour force has increased in skill, unit costs of production (in real terms) have decreased.

(ii) Moderate Inducement to reduce unit costs.

Cement. This subsidiary appears to have little capability to change the core technology ('materials processing' in Pack's terms) which it uses although there is some cost saving associated with small tasks such as cleaning where labour has been substituted for the machinery

which would be used in a high-wage economy. Their main concern is thereduction of energy costs and they are giving some thought, in collaboration with the parent, to burning waste materials as a source of energy - there is no sign that this has yet led to specific measures. Changes in production technology basically arise from improvements introduced by machinery suppliers, but once again this does not refer to the core technology as there have been no changes made to the original core process and there are no plans for expansion.

(iii) Weak inducement to reduce costs.

Pharmeceuticals. Neither of these two subsidiaries is particularly concerned with cost reduction. Both have made some attempt to substitute labour for capital in packaging. In the case of B, the growth of the market has led to the introduction of new machinery for making pills and in the case of C to new tube-filling machinery. Economies of scale arise in both of these activities.

Vehicle assembly. This subsidiary assembles vehicles from knocked-down kits. There has been little scope for cost reduction in the past as scale (2,700 units per year) has been too small to allow for assembly line operations. They are however in the process of building a larger plant with increased capacity (4,000 units a year) and the introduction of an assembly line should lead to a marginal reduction in unit costs. This technical change is obviously of the firm-disembodied kind. There is also some aim that the move to the new plant will be associated with the use of new production techniques which are more capital intensive (eg pneumatic rivet guns will be used), and this change, too, should be associated with marginal savings in unit costs.

Engineering Design. In the case of engineering design activities there is little scope for cost reduction, and the main savings are to be made in installation. The main cost savings in installation result from changes of a disembodied nature such as the shift from site to workshop assembly in order to save labour by making supervision more effective. Although there is not much scope for changes in production technology, there is evidence that this subsidiary does have, and has used its own technological capability. One example of this concerns a large contract for about £200,000. The original intention was to

install Westinghouse air conditioners made in America. On visiting the Westinghouse plant in the U.S., however, it became clear that the equipment to be installed was of a simple nature. The firm therefore bought two of these air-conditioners, and took them to pieces to understand the principles of manufacture. They then imported some parts and fabricated 1000 units themselves. The motivation was cost-saving and the saving realised was about £50,000.

Product Technology and Technical Change

There are three types of technical change in the sphere of product technology - product innovation, product differentiation and product adaptation. Both extremes are represented in the sample of subsidiaries. - In the case of the two pharmeceutical subsidiaries product technology is of primary importance, while in the case of the cement producer there is no sign of product innovation, differentiation or adaptation. The other subsidiaries are all concerned to some extent with product technology.

(i) Product innovation.

Pharmeceuticals. For these two subsidiaries, the introduction of new products is an important weapon in their competitive armoury. D, for example was established in Kenya with a range of four products - at present it produces twenty-two different products. Its competitor, too, has introduced new products since its takeover of a Kenyan firm five years ago.

Tea. This subsidiary is attempting to diversify its product mix by introducing new products. This is a policy of the parent as well, and the decision to produce instant tea partly reflects this - Kenya has been chosen by the Group as the site of the instant tea plant. Other products introduced in Kenya are related to tea and coffee cultivation, such as cinchona and tara which are both products derived from agricultural products. It is the general policy of the firm to try and extend the range of these products and they are searching for other possibilities, particularly in the area of intermediate, rather than consumption products.

Vehicle Assembly. This subsidiary has recently introduced a new luxury four-wheel drive vehicle on to the local market, but this is the only sign of product innovation in recent years. In fact, in line with its parent's policy in Britain, the subsidiary is in the process of removing certain types of vehicle from its output mix, as the mix is too diversified to allow for scale economies.

(ii) Product differentiation.

Pharmeceuticals. The two pharmeceutical firms, in line with their strong orientation on product technology, both differentiate some of their product lines. The extent of differentiation is small relative to the parents' operations in Britain and their main concern with differentiation is to build-up brand name loyalty, rather than to introduce more than one brand of any particular product. Advertising expenditure is high as one would expect.[19]

(iii) Product Adaptation.

Pharmeceuticals. Product adaptation is of great importance in the pharmeceutical industry, both for technical and market reasons. Because of the difference in climate between Britain and Kenya, some changes have to be made to products to ensure their 'stability' in local climatic conditions. Changes also have to be made in the product to reflect the taste of the market. For example, Firm [illegible] we have seen holds approximately 60% of the market for cough sweets and tablets. The reason for this dominance is that when the product was formulated ten years ago, it was recognised that the local market liked to feel the 'strength' of the product and so a high content of menthol was added to a product which therapeutically is no different to other products on the local market. Nearly all of the products sold by the two subsidiaries are adapted to local conditions.

Tea processing machinery. Product adaptation is an important factor for e firm and is a source of its success in the local market. Constant changes e made in product to satisfy the needs of individual customers and seldom are o identical machines produced. This adaptation to local conditions does not wever lead to changes in production technology as the method of production by e subsidiary remains constant. The main change introduced by this subsidiary e designed to simplify equipment to reduce the need for skilled maintenance aff by the user.

Engineering Design, as in the case of tea machinery, implies adapting the specific needs of customers. The subsidiary works from established neering principles, and then designs to meet the customer's needs. In some es the adptation required is of minor importance, while in others nificant changes have to be made to designs which had been used in the t. The main changes introduced by this subsidiary in its designs are aimed reduce the need for skilled maintenance labour and to reduce capital costs is even occurs at the expense of high recurrent costs as (government tenders awarded on the basis of lowest capital cost irrespective of recurrent costs).

erials Technology and Technical Change.

The nature of the inputs available in Kenya has been a factor in nical change in the case of two of the subsidiaries in the sample. The tea lucing subsidiary has pioneered the use of Simozine and Gramoxone weed rol herbicides in conjunction with a subsidiary of another multinational in a. This has had an effect, on the production technology used by the firm. cement producer has had to make its choice of equipment contingent upon nature of the raw materials available in Kenya, which are different to those lable in Europe. Although this has meant a choice of specialised equipment, has been readily obtainable and no new advances in production technology been required.

In the case of the two pharmeceutical firms, the sugar obtainable in Kenya not been refined to the same extent as that which is used by the parents in ain. Initially the Kenyan government pressured these two subsidiaries to local sugar, but this met with protests from the firms that the local sugar not enable them to maintain the quality standards for product appearance fied by the parents. The government of Kenya subsecquently backed down. is a case when differences in material inputs (however small these rences) might have led to some change in product and possibly production olem, but the bargaining power of the firms appears to have been ciently strong to avoid the need for these changes.

Other inducements to technical change

Surprisingly, there were few other inducements to technical change reported by the sample firms. In the case of one of the pharmeceutical subsidiaries (3), the decision to expand the portfolio of products from four to twenty-two resulted to some extent from the imposition of tariffs by the government. The same firm has been induced to reformulate one of its products by the different market taste in an export market.[20] One other inducement was reported by the cement producer. In its case the long lead-time on deliveries from Europe sometimes forced it to make minor adaptations itself or to approach the foundry at the Railways Workshops to fabricate spares. This is not a frequent occurrence.

Clearly these different aspects of technical change are not isolated from each other and changes in product and materials technology have often led to changes in production technology. Instant tea production is a good example of this where a product innovation has led to the development of a complex production technology.[21] On the materials side, the availability of new pesticides has had some effect in changing the cultivating practices of the same subsidiary. There are however many cases when changes in product and materials have little impact upon production technology. The tea processing machinery subsidiary for example has made some adaptations to its products over the years, but this cannot be said to have led to any changes in its production or materials technology.

Table 3.

The Orientation of Technical Change

	A Tea and allied products	B Pharmec- euticals etc	C Pharmec- euticals etc	D Cement	E Vehicle- assembly	F Engineer ing design	G Tea machine
ODUCTIO' TECH- OLOGY duction in unit sts.	Strong	Weak	Weak	Moderate	Weak	Weak	Strong
CDUCT CHNOLOGY) Product novation	Strong	Strong	Strong	None	Weak	None	None
i) Product Differentia- tion	None	Strong	Strong	None	None	None	None
ii) Product adaptation	None	Strong	Strong	None	None	Strong	Moderat
TERIALS CHNOLOGY	Moderate	None	None	Moderate	None	None	None
ER	None	Tariffs Export markets	None	Lead- time in spares delivery	None	None	None

Table 3 summarises the orientation of technical change for the en subsidiaries. It is clear that while all of the subsidiaries are cerned with cost reduction, this is only an important consideration for of them - tea production, which is very competitive and in which there sts little scope for product differentiation as a substitute for cost uction; and tea processing machinery which has situated its subsidiary Kenya largely because of cost factors.

The pharmeceutical industry is characterised by non price petition at the global level and this is reflected in the operations of the Kenyan subsidiaries who both register a strong response to all three form product technology. The only form of product technology relevant to the oth

consumer good subsidiary (tea) is the introduction of new products and this reflects the aim of the firm to diversify out of its dependence on tea.

The two capital goods firms (engineering design and tea machinery) have a common orientation on adaptation of products. This is probably a factor common to the capital goods industry at both the Kenyan and the global level where there exist few economies of scale.[22] and production is invariably tailored to the needs of customers. There exist no common factors specific to the two intermedi goods firms.

Another interesting point which emerges from this table is that there is little evidence of material input or any other factors inducing technical change. As we have seen in the case of the two pharmeceutical subsidiaries there is a prospect of technical change arising from the use of local sugar but the two firms have managed to pursuade the government to allow them to import rather than use local sugar.

IV

Technical Change Generated Within the Subsidiary.

Given the orientation of technical change in each of the subsidiaries as discussed in the previous section, it is of interest to establish the means which these subsidiaries use in generating new technology. Technical change . . . arises from the application of science and technology to production and the more complex the technology the greater the input of science and technology which is required. However the nature of the operations of the seven subsidiaries in the sample makes its unlikely that there will be significantly large input of this formalised Research and Development and it is more likely that technical change will result from marginal changes to existing production techniques products and inputs.

'Research and Development' is an aggregative concept which masks a number of different types of activity. Since we are focussing on the operations of particular subsidaries, there is some point in trying to disaggregate this set of ideas. One attempt has been made by the OECD[23]... which although it is addressed to the compilation of macro-economic statistics on Research and Development, does provide a useful framework for this disaggregation. The OECD Manual defines three relevant concepts - Basic Research, Applied Research and Experimental Development.

(a) Basic Research. "Basic Research is original investigation undertaken in order to gain new scientific knowledge and understanding. It is not primarily directed towards any specific aim or application....The results of basic research are generally non-negotiable and are usually published in scientific journals and circulated to interested colleagues" (p 9/10)." In pure basic research the organisation employing the investigator will normally direct his work towards a field of present or potential scientific, economic or social interest "(p 10)

(b) Applied Research "Applied research is also original investigation undertaken in order to gain new scientific or technical knowledge. It is, however, directed primarily towards a specific practical aim or objective "(P9)". "The results of applied research are intended primarily to be valid for a single or limited number of products, methods or systems. Applied research develop ideas into operational form "(p10)

(c) Experimental Development "Experimental development is the use of scientific knowledge in order to produce new or substantially improved materials, devices, products processes, systems or services...(it) is sytematic work, drawing on exisiting knowledge gained from research and /or practical experience ...Although not all development activity is of an experimental nature, experimentation is a dominant characteristic of this phase of development" (p 10).

The Frascatti manual recognises that the delineation between these three categories is not always clear and arbitrary decisions in this respect may have to be made in classifying certain activities. In addition to these three activities, there are a number of borderline case in which the activities of a firm/institution may not be easily classifiable. Tha main ambiguities arise in the case of prototypes, pilot plants and trial production runs.

(d) Quality Control

There is one further type of activity within the operations of these subsidiaries which may lead to technical change and this is Quality Control. Most these subsidiary operate to product specifications laid down by the parents and quality control is undertaken to ensure that these standards are met. If these standards are not met changes may have to be made in product technology (eg reformulations), production technology (eg (eg new packing machinery) or Matrials technology (eg imported sugar). Technical change may well result then from Quality Control and it is the case that for some of the subsidiaries there is no form of established Experimental Development or Adaptative activities, and the only source of technical change may be [illegible] through Quality Control activities.

Basic Research.

It is not suprising that none of the Kenyan subsidiaries showed any sign of undertaking any Basic Research, because even at the global scale it is unlikely that any multinationals would undertake either pure, or oriented Basic Research. In terms of the international division of scientific effort, most Basic Research is undertaken by Government bodies, universities and other research institutes. Much of the output of Basic Research is non-proprietary in nature and this is perhaps one of the factors which leads to the abstention of multinationals in undertaking Basic Research.

Applied Research.

Given the operating conditions of the seven subsidiaries in the sample there no reason to expect any of them to undertake Applied Research. (24) Even in the case of the parents of these subsidiaries, size is an important constraint and not all of the firms are large enough to undertake Applied Research. For example, the tea firm in our sample has worldwide sales of over £379m and since 1963 has undertaken some Applied Research at a cost of about £750,000 per year. It has recently decided to bring this research programme to an end.

Experimental Development.

The conceptual borderline between Experimental Development and Adaptation to local environment and market conditions is difficult to define. In some cases Adaptation may require Experimental Development at a complex technological level, while in other cases (as for example in the product reformulations by the two pharmeceutical firms) little technological complexity may be involved. In any case, all Adaptation will to some extent require Experimental Development, if only to see whether the product is acceptable to consumers. It has been decided, therefore, to include Adaptative activities within the concept of Experimental Development, particularly when discussing the commitment in manpower and finance by the firm. This is because the same personnel are generally involved in Adaptation and Experimental Development and it is difficult to differentiate between these two aspects of their activities. Where possible in the discussion, the distinction will be drawn between those activities which are Experimental Development proper and those which involve relatively simple Adaptations. NB, //Of the seven subsidiaries only four undertook any form of Experimental Development. The subsidiaries without this activity were one of the pharmeceutical firms (B), the cement producer and the vehicle assembler. In the case of the cement firm, the technology appears to have been too 'complex' for their limited technical skills while in the case of the vehicle assembling subsidiary, the nature of the assembly operations appears to have been too 'simple' to have allowed for Experimental Development. The pharmeceutical firm in question stands in contrast to its competitor (C) which did undertake some Experimental Development, with much the same product mix as B.

Tea. Until recently, this subsidiary was involved in industry-wide research on hail suppression (running at a cost of about £1.1m per year), but this programme has been halted because of lack of results. This firm is also involved in the development of agricultural techniques such as herbicide-use as well as the use of a computer to establish optimal fertiliser patterns but this is done in collaboration with subsidiaries of other multinational chemical firms. Firm A does have a small laboratory and most of its work concerns experimental introduction and analysis of new strains of plants.

As we have seen this firm is in the process of comissioning an instant tea plant. The technology for this tea plant is complex and follows on ten years of Applied Research and Experimental Development. Even now the technology is not satisfactory and the investment is predominantly a defensive one so that the Group as a whole will not be left behind in the generation of instant tea technology and will be able to supply the product to satisfy their

consumers, (instant tea is predominantly used by vending machines and is not a particularly well-selling product). The parent began to build a plant in Wales in the mid 1960's, but the present plant is of a completely different technology. All the applied research and experimental development has been undertaken by the parent and most of it has been done in the U.K. The responsibility for building and commissioning the new instant tea plant has been that of the parent, and the Kenyan subsidiary will only be involved in managing the plant once it has been satisfactorily setup.

The conclusion, therefore, is that while the Kenyan subsidiary of this firm is involved in some Experimental Development, this is limited to the development of new growing and cultivating techniques, activities which could not by their nature be undertaken in Britain. The more complex processing technology is the responsibility of the parent and/or machinery suppliers.

Tea Processing Machinery. This subsidiary was included in the sample because it proved to be unusual case of an equipment supplier manufacturing in Kenya. It undertakes no Basic or Applied Research. It is involved in Experimental Development, albeit at a relatively unsophisticated level. The basic design for tea processing equipment has been stable for many years, and the subsidiary is constantly making small changes and improvements to satisfy the needs of specific customers and local conditions. There is one exception to this and that concerns the development of a new "hot-feeder" which has taken place in the Kenyan susidiary. This is a new development in the industry and is not patented because this would enable competitors to copy, without duplicating the technology. In order to protect this process technology the subsidiary enforces strict control over entry to the plant and there have been attempts at industrial espionage by agents of Indian and Sir Lankan competitors.

The development of this hot-feeder" is the limit of the subsidiary's Experimental Development. It is also 'associated' with an experiment in the use of heatregeneration (i.e. raising the temperature of air passing through the machine which may lead to a fuel saving of 40-45%) which is taking place in Rwanda, but this does not involve a heavy committment of money or manpower. An indication of the limits of its Experimental Development operations is that the subsidiary has made no attempt to penetrate the technology for the manufacture of instant tea, although it has supplied standard design boilers, conveyors, elevators etc for the new instant tea plant of Firm A.

Engineering Design Of all the firms in the sample, this subsidiary is involved in experimental development at the most "complex" technological level. The nature of its operations are primarily engineering design, which

implies the adaptation of existing scientific principles in designing a system to meet the specific needs of a customer. Generally this does not lead to "substantially improved" (Frascatti p 10) systems, but in some cases it does. For example, the firm received a contract to provide air-conditioning for one of the largest buildings in Nairobi. It was decided that the most suitable system was unique to Kenya, and in fact there was only one other example of the systems use in Africa. The problem was that the existing 'body of knowledge' had been developed in North America and Europe and the standard text-book tables on solar-weightings stopped at 20° from the Equator (Nairobi is almost on the equator). The subsidiary therefore had to go back to basic scientific principles and generate the necessary data themselves in order to complete the job. This constitutes experimental development at a relatively high level compared to the other subsidiaries in the sample.

Pharmeceuticals. Firm C provides an interesting contrast with its competitor, B. As we have senn the two firms produce a similar range of products, yet while B undertakes no Experimental Development itself, C does. Thus C reformulates all products for the local market itself, although it does refer these formulations to the parent for its approval. All reformulations in the case of B are undertaken by the parent. In addition, in the sphere of production technology C has decided to design its own tin-filling machinery in collaboration with a local engineer who will manufacture it. Even though this is the first time local machinery has been procured it does represent, to a limited extent, a capability in Experimental Development which is not displayed by its competitor.

Table 4. Summarise the activities of the subsidiaries in the sphere of Research and Development.

The most striking fact which emerges from table 4 is the absence of Research and Development activities amongst the seven subsidiaries. None of the firms are involved in either Basic Research (neither Pure nor Oriented) or Applied Research..Indeed, given the size of the operations of the subsidiaries in Kenya the absence of these two types of research is not suprising. What is somewhat suprising (to the author at any rate!) is the limit of Experimental Development activities. Here three of the subsidiaries, with respective annual turnovers of £937,399(Pharmeceutials -B) £5,082,353 (Cement) and £2,403,947 (Vehicle assembly) have no Experimental Development activities at all. In the case of the four firms with these activities, the expenditure in the case of two of them (Phameceuticals-C- and tea machinery) is negligble.

Table 4.

Expenditure on Research and Development.

Nature of activities / Firms	A Tea and allied products	B Pharmaceuticals etc	C Pharmaceuticals etc	D Cement	E Vehicle assembly	F Engineering design	G Tea machinery
BASIC RESEARCH Pure	No	No	No	No	No	No	No
Oriented	No	No	No	No	No	No	No
APPLIED RESEARCH	No	No	No	No	No	No	No
EXPERIMENTAL DEVELOPMENT	Yes	No	Yes	No	No	Yes	Yes
MANPOWER.	1 Research manager 1 food technologist and 3 food technicians (all full time)	-	2 Chemists 1 laboratory technician (all part time)	-	-	3 design engineers 7 draughtsmen (all full time)	1 Chief engineer production controller 1 draughtsman (all part-time)
COST	£35,294	-	£1,177	-	-	£47,058 (a)	£4,118
as % of Value added	0.92%	-	0.23%	-	-	25.76%	5.52%
How long have thes activities taken place	10 years	-	1½ years	-	-	15 years	10-15 years (a)

(a) Estimate. This figure covers the cost of all the firms design activities, not all of which would necessarily lead to the generation of technical change.

Only two of the seven subsidiaries have Experimental Development expenditures of any size. In the case of the tea producer, this is understandable because some of the firm's activities such as developing new strains of tea and cinchona bush cannot be undertaken by the parent and there is no option but for these activities to be undertaken by the Kenyan subsidiary. Where the firm is able to undertake Experimental Development in Britain, as in the case of instant tea, it does so and the participation of the Kenyan subsidiary in the development of this technology has been negligble. The other subsidiary with a sizeable expenditure in this respect is the enginecring design firm. This would tend to support the point made earlier that it is in the nature of engineering design firms that they do adapt to local surroundings by applying engineering principles to meet the needs of specific customer. (There is some degree of overestimation of expenditure on Experimental Development, because not all of its design activities necessarily lead to technical change. Most do, however, in the sense that the "product"differs between designs).

Suprise at the absence of Experimental Development activities does not lead to a conspiracy-theory with regard to the operations of these firms in Kenya. Their activities follow logically from the position they find themselves in and the dominant characteristics in this respect are the small size of their operations, the absence of a welldeveloped capital goods sector in Kenya, the nature of their operations (eg. assembly, or minimal value added, as in the case of the pharmeceutical firms) and the interest of the multinational in the parent assimilating technical change and using this as a control mechanism over the operations of the subsidiary.[25] Only in one (pharmeceutical) where we can see a contrast between two broadly similar firms, is there a suggestion that the absence of Research and Development arises from the deliberate policy of the parent. But even here the smallness of the C's Experimental Development expenditure cautions against drawing firm conclusions.

Quality Control.

A distinction has been drawn between production, product and materials technology in our study of technical change in the seven subsidiaries. There are grounds to suppose that quality control activities by these subsidiaries may in fact lead to technical change if products are found to be of sub-standard quality and this leads to changes in product design production technology or material inputs.

All of the firms have some form of control over quality. In the case of the two pharmeceutical and the cement subsidiaries, not only are the quality standards used those of the parent, but the parent is also actively involved

In each of these three cases the subsidiaries argued that it is essential that the parents standards be used to ensure the safety of those who use the products. While this may be true in the case of ethical medicines, it is not the case with regard to other products such as cosmetics and toiletries. Here we find quality control hindering, rather than accelerating adaptation to local conditions (as in the use of local sugar). The tea producing and the vehicle assembling firms work to the same standards as their parents even though the parents are not involved in the control of quality.

In only two cases do the subsidiaries set quality control standards independetly of those of the parent. It is probably no coincidence that these two firms - tea machinery and engineering design - are capital goods firms. Capital goods firms, as we have seen, work to the specifications of individual customers so it is difficult for the parent to generalise quality control specifications to all designs.

The real interest with regard to quality control activities by these firms lies in the link with technical change. To take each of these in turn:-

(a) Product technology. In the case of both of the pharmeceutical firms there is a strong link between quality control and product formulation. Before any new product is marketed it is checked for 'stability' to see whether it stands up to local climatic conditions to the satisfaction of the parents. If not, new formulations are made. The difference between the two subsidiaries is that in the case of C the original reformulation is madeby the subsidiary itself whereas in the case of B the parent is completely responsible for this reformulation.

Quality control is also linked to product technology in the case of the two capital goods firms, tea machinery and engineering design. Here the acceptability of a particular design to a customer will affect whether the design or a changed one will be used again. The lessons of quality control in both cases are internalised within the subsidiary and not the parent.

(b) Production technology. The link between quality control and production technology is strongest in the case of the vehicle assembler the tea producer, the tea machinery producer and one of the pharmeceutical firms (C). In all of these cases the acceptability of the final product will influence the production technology. For example in the case of thepharmeceutical firms, quality control staff noticed a variation in the quality in tube filling and this was traced back to labour intensity in this packaging operation. As a consequence the subsidiary has decided to introduce new, semi-automated tube-filling machinery.

(d) Materials Technology. The strongest link between quality control and materials technology probably arises in the case of the cement producer where the suitability of the inputs will determine whether the final product matches up to the British Standard specifications. As we have seen, it also occurs in a 'negative' way in the case of the pharmeceutical firms where quality control standard inhibit the use of local sugar.

All of the firms have had some form of quality control since the inception of operations, although in two cases Pharmeceuticals (C) and tea machinery this control has only recently been set aside from production. For example, B used to have quality control as part of the production technology - they found however that it was necessary to set up an independent quality control unit responsible to the general manager and not to the production manager, if they were to have effective control over quality.

The cost of the quality control operations (see table 5) varied considerably between the firms and bears little relationship to firm size or operation. The greatest expenditure on quality control in aggregate terms is undoubtedly that of the cement producer, although no estimate was available. It however possessed a well-equipped laboratory and employed a number of skilled and semi-skilled staff (one M.A. graduate and a number of technicians). Samples of inputs and outputs are regularly sent to the UK for the parent's approval. The expenditure by (one of the phemeceutical firms (C) is almost certainly an overestimate, for its staff are the same number as its competitor (B) and perform a similar function. Relatively speaking, the greatest expenditure on quality control is by the vehicle assembling subsidiary, but this is probably due to the fact that in its case quality control is integrated with production. The assembly of vehicles, especially custom-made ones, requires constant checking to ensure that the vehicle is put together corectly. No figure on expenditure is available for the cement producer, but as mentioned it is probably high. Therefore with the exception of the tea producer, quality control expenditure is fairly high for all subsidiaries particularly in comparison with expenditure on Experimental Development and Adaptation (cf table 4) . Since there do exist links between control and technical change it may well be that quality control activities are more important than formalised Experimental Development and Adaptation expenditure in the generation of technical change in these subsidiaries.

Some caution should however be exercised in discussing the link between quality control and technical change. The caution is not to dispute the links which do arise, but rather in the interpretation of the policy conclusions which result. The main problem lies in the specification of quality standards. Does it really matter if product finish 'suffers' from the use of local sugar? Perhaps of greater importance is the case of the engineering design firm. Is air-conditioning necessary in Nairobi, and if it is, does it need to be sophisticated? For example, an earlier point was made with reference to a building in Nairobi which had air-conditioning installed through a system unique to Africa (with one other exception)

which supplied a constant temperature without variation. Perhaps a more 'appropriate' set of standards would have been one design to adjust temperature at 'steps' of 10°, thus perhaps cutting the cost of the system installed. The question of the transfer of taste patterns is one to which we shall have to return at a later stage.

Table 5.

The Link between Quality Control and Technical Change.

	A Tea & allied prod-ucts.	B Pharmec-euticals	C Pharmec-euticals	D Cement	E Vehicle assembly	F Engineer-ing design	G Tea machinery
ose standard quality Control ?	Parents	Parents	Parents	Parents	Parents	Subsi-' iary	Subsidiary
le of parent in ality control	None	Active	Active	None	None	None	None
w long have ey had quality ntrol ?	Since incep-ption	five years	2 years	Since incep-tion	Since incep-tion	Since local design	1½ years
npower in ality control	No sepe-rate staff	4	4	12	18	No sepe-rate staff	Senior production staff
nual cost of ality control % of value led)	No sepe-rate cost	£5,294 (1.1%)	£25,000 (4.9%)	(a) (-)	£10,941 22.8%)	£9,412 5.15%)	£2,354 (3.2%)
k with tech-ol Change . duct tech - ogy	No	Yes	Yes	No	No	Yes	Yes
duction hnology	Yes	No	Yes	No	Yes	No	Yes
erials hnology	No	Yes	Yes	Yes	No	No	No

Technical Change from Sources External to the Subsidiary

The seven subsidiaries all rely on external sources for technical change (as little is generated by themselves) although the extent of course varies between them. Associated with the reliance on external sources is the question of the participation of the parent in supplying this technology. This important point concerns the 'independence' of subsidiaries, for while it may be true that most subsidiaries are 'dependent' upon external sources for technical change, some may be more 'independent' than others from their parents in the acquisition of this new technology. The question of who is responsible for the actual choice if thus important; but so, too, is the question of the ability of the subsidiaries to make the choice themselves.

The problem will be examined in three stages - firstly examining the rights of subsidiaries to acquire new technology independently from the parent, and then establishing whether these subsidiaries have the ability to choose this technology (table 6). Finally there will be some discussion of the mechanisms used to obtain this technology from external sources. (table 7)

(a) The rights of a Subsidiary to 'Independent' Choice[26]

The complete spectrum of independence is represented in the sample of subsidiaries. Three of them - engineering design, cement production and tea machinery - have complete autonomy of choice. Three others - tea producer and both of the pharmaceutical firms have some autonomy and are the vehicle assembler has no autonomy at all (although in this case it is not clear whether the lack of autonomy reflects a lack of ability to make independent choices).

(i) Complete Autonomy of Choice.

Engineering design. The design of products is entirely in the hands of the subsidiary. Since the parent is predominantly engage in the manufacture of heavy refrigeration machinery, as opposed to the design of air conditioning and refrigeration systems practised by the subsidiary, there is little option for the parent but to allow the subsidiary complete autonomy in this respect. The subsidiary is also independent in its choice of sources for production materials

technology, but since its parent is the 'leader' in the production of refrigeration equipment, the subsidiary does purchase these inputs from the parent (this makes up only about 20% of all their imported inputs). In theory the subsidiary is able to buy this refrigeration equipment from another source, but since this has not yet occurred there is no way of knowing how real this autonomy is.

Tea machinery. Not only does this subsidiary have complete autonomy in the choice of its technology, but it purchases none of it from the parent. This unusual case arises from the rather special circumstances surrounding the presence of this subsidiary in Kenya. Unlike any of the others in the sample (and also, to the best of the authors knowledge, unlike any other subsidiary in Kenya), the parent has moved all of its tea machinery manufacture to Kenya and produces none in the UK.

Cement Production. The substance of the parent's relationship to this subsidiary lies not so much in the form of equity (of which it holds only 1/4), but in the form of the Technical Services Agreement. At an earlier stage the Technical Services Agreement was held by another firm and all of the core equipment of the plant was provided by a third Danish multinational

Since the British parent assumed the responsibility for the Technical Service Agreement, no new core equipment has been installed. Yet in the case of all purchases of peripheral production technology and materials technology the subsidiary has had the right to independent choice. The complication which arises in this respect is that the personnel responsible for making these choices are in part supplied by the parent in terms of the Agreement; so that in fact the parent actually makes much of the choice, although nominally the subsidiary has complete autonomy.

(ii) Some Autonomy of Choice

Tea. The subsidiary has some autonomy in the purchase of new technology. In the case of materials technology it has almost complete autonomy. Since these comprise largely of agricultural inputs and packaging materials (which are made locally) This autonomy is not

surprising. In the case of production technology, this autonomy is more limited - some machinery is purchased locally (such as that produced by G) and some is acquired through the parent from firms in South Asia and Europe. In the case of the instant tea plant which comprises the most 'complex' of all production technology installed, the parent has been completely responsible for the choice of suppliers, even though some of the less 'complex' items were acquired locally from G.

Pharmeceuticals. While both of these subsidiaries possess some measure of autonomy, the degree is greater for C than for B. The latter subsidiary only has some autonomy in the acquisition of inputs.[27] All production technology is purchased through the parent, although the subsidiary is consulted about it. Product technology is the responsiblity of the parent, which involves one of its consultants in the reformulation of specific products for the local market. By contrast C has considerably more autonomy. Like B it purchases most of its inputs from non-parent sources (except for perfumes used in cosmetics which comprise about 10% of all purchased inputs). It is also involved in the acquisition of new production technology and as we have seen in the case of the tin-filling machine mentioned earlier, it is to a small extent involved in generating this another production technology locally. This subsidiary also has some autonomy in the sphere of product technology, where it undertakes all reformulations for the basic market (the parent has the right to veto these changes). These two subsidiaries, while similar in product mix, provide an interesting comparison of the effects of parent policy on subsidiaries.

(iii) No Autonomy of Choice

Vehicle Assembly. This subsidiary is completely reliant on its parent for new technology. All product technology is supplied by the parent as is almost all materials technology in the form of knocked down kits. There will be a slight change in future in that the new assembly plant will also assemble vehicles produced by a German car firm, but in this case too the subsidiary will be reliant on the German firm for both product and materials technology. In the case of production technology, the subsidiary relies on its parent. The spot welder to be introduced in the new assembly plant is to be built in

Britain to the parent's design; similarly the jigs to be used in the new plant are to be designed by the parent, although some of the more simple jigs will be built in Kenya.

(b) The Ability of the Subsidiary to Choose Independently.

Closely related to the rights of a subsidiary to choose new technology autonomously is its ability to do so, for without this ability any nominal autonomy may be useless. In cases/three the subsidiaries were 'frustrated' in that they were obliged to refer to the parent when they were able to make the decisions themselves. In three other cases the rights of the subsidiary to choose technology autonomously from the parent coincide with their ability to make this choice.

The two pharmeceutical firms particularly in the case of materials technology, were to a limited extent tied to the purchase of parent technology in spite of being able to obtain these from other sources. The tea producer routed the purchase of some of its production technology through the parent when it was almost certainly capable of making these purchases independently. The cement producer is a rather special case in that while it had the nominal autonomy to purchase new technology independently from the parent, without the participation of the parent in the operation of this subsidiary (in the form of the Technical Services Agreement) this autonomy would have been purely nominal.

The autonomy of the two capital goods subsidiaries is clear when referring to table 6. Not only do both have the right to independent choice, but they also possess the ability. In the case of the vehicle assembler there exists a coincidence between the subsidiary's rights and abilities to choose independently in that it has neither the right nor the ability to make these choices itself.

(c) Types of Technological Collaboration.

There are a variety of mechanisms open to a subsidiary in its attempt to obtain new technology, ranging from the direct purchase of equipment, through the use of licences, the purchase of blue-prints to the establishment of a Technical Service Agreement. In some cases the establishment of a subsidiary may occur in the form of a package - the parent supplies equipment, provides raw materials, supplies disembodied inputs to

Table 6

Rights and Abilities of the Subsidiaries to Choose Technology Independently

Firms	A Tea & allied products	B Pharmec-euticals etc	C Pharmec-euticals etc	D Cement	E Vehicle assembly	F Engineering design	G Tea machinery
The Right to Autonomous Choice							
(i) Production technology	Some	None	Some	Complete	None	Complete	Complete
(ii) Product technology	Some	None	Some	Complete	None	Complete	Complete
(iii) Materials technology	Complete	Some	Some	Complete	None	Complete	Complete
The Ability for Independent Choice							
(i) Production technology	Some	Some	Some	(a)	None	Complete	Complete
(ii) Product technology	Some	Some	Some	None	None	Complete	Complete
(iii) Materials technology	complete	Some	Some	(a)	None	Complete	Complete

(a) Subsidiary only has ability because of presence of parent personnel through Technical services Agreement.

ensure the maintenance and operation of the plant and the disposal of output and supervises and enforces quality as well. At the other extreme, which is generally associated with the 'independence' of a subsidiary, a subsidiary purchases capital equipment from a variety of sources, and has technological agreements with different producers etc - this situation is generally referred to as an 'unpackaged' transfer of technology.

The subsidiaries were approached in order to establish the mechanisms used to obtain new technology. Associated with this is the question of property rights. When production technology is generated by a subsidiary who obtains the property rights over this technology and the property rights over product technology (ie brand names)?

The types of technological collaboration entered into by the various firms is summarised in Table 7. The surprising conclusion from this table is the fact that most firms make no specific payment to the parent for technology: one would like to but this payment has been blocked by the Central Bank. The most probable explanation for this is that generally these technological payments are made by subsidiaries in an attempt to transfer-price profits to the parent. This fact was recognised by some of the firms - and of the pharmeceutical subsidiaries for example replied "We don't do any fiddles - there are means of getting money back to the UK ... The Americans do this sort of thing". The other pharmeceutical subsidiary made a similar observation when it replied that there was no need to double the payment for technology as account had already been taken of the parent's technological input in the payment of dividends. The ethics of the matter aside, it is clear that the subsidiaries feel no need to transfer price in this way as their is no restriction on the repatriation of dividends to the parent or because they use other channels to transfer price. One other factor inducing the use of such transfer pricing mechanisms is the existence of a joint venture. In this case it would be expected that the tea machinery, vehicle assembly and engineering design subsidiaries (where there exist substantial minority holdings) would make more attempt to make additional payments for technology, but there is no indication that transfer pricing has occurred in the form of technology payments.

None of the subsidiaries made technological payments to non-parents either. This suggests that the technology which they are using is either wholly supplied by the parent or is readily available from alternative suppliers. The latter conclusion follows from the fact that all machinery purchases are lump-sum payments and no royalties are involved. Presumably equipment suppliers would prefer to have ongoing payments as well as lump-sum payments and where they were operating in a monopolistic market they would be able to enforce the payment of royalties.

The importance of technology as a control measure by the parent over subsidiaries is suggested by the fact that in all cases parents obtain the property rights over new technology generated in the Kenyan subsidiaries and take responsibility for the registration of patents and brandnames. There is no clear pattern in the number of patents registered by each of the firms. All of the firms producing final output have registered patents, neither of the intermediate product firms (cement and vehicle assembly) holds patents and one of the capital goods firms (engineering design)also holds no patents. On the other hand the firm with the most registered patents is also a capital goods producer. The number of patents held by each firm probably reflects the individual circumstances of each firm with respect to technological complexity, the sector of operations and the policy of the parent.

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Table 7

Types of Technological Collaboration

	Firm A	Firm B	Firm C	Firm D	Firm D	Firm 7	Firm G
Technological payments to parent	Technical Service Fee (blocked)	None	None	Technical Service Agreement	None	None	None
Technological payments to non-parent.	None	None	None	None	None	None	None
Property rights over technology generated in subsidiary	Parent	Parent	Parent	Parent	Parent	Parent	Parent
Responsibility for registration of patents and brand names(a) in Kenya	Parent	Parent	Parent	Parent	Parent	Parent	Parent
Number of patents registered in Kenya.	8	5	13	0	0	0	11

(a) Due to the manner in which the Registrar General's Office stores its data, there is no way of establishing the number of brand names registered by each subsidiary, or whether patents are input implemented.

Circulation of Technology through the Firm

To some extent foreign investment occurs in Kenya because the technological capability to undertake these investments does not exist without the participation of the foreign investors. Since the presence of these foreign investors reflects this technological and organisational capability the parents are concerned to maintain property rights over technical change (see previous section). It is natural that the foreign investors will want to keep subsidiaries abreast of developments within the firm and the industry to ensure that the subsidiary's operations in Kenya reflect this technological ability. The sample subsidiaries were therefore questioned with regard to the mechanisms used by the parent to circulate technology (both parent and non - parent) through the firm.

This circulation of technology through the firm is essentially a disembodied technology. As we have seen this can be a combination of firm-disembodied and man-disembodied technology. While most of the firms had organised a system through which to transmit technical change through the corporate body, there were two exceptions - tea machinery and vehicle assembly. At the other extreme was one of the pharmeceutical subsidiaries (B) and the rest were ranged between these two extremes.

(a) Some System of circulating technology

Tea. All subsidiaries of this firm have a development committee which examines new ideas and changes in method. A similar committee exists in the parent. These new ideas are circulated through the firm via the Board, where divisional directors are expected to report on relevant changes in their subsidiaries, and at the same time to pass on changes generated in other divisions to their own subsidiaries.

Of greater importance to the subsidiaries, however, is the exchange of visits by skilled manpower. The Kenyan subsidiary is for example sending someone to Assam where the local subsidiary is having trouble with growing of coffee. They also assist small-holder production in this way in Kenya, and, via the Commonwealth Development Corporation, they are sending someone to Swaziland to assist in small-scale tea growing schemes. In all cases there is no charge for these services, but the recipient subsidiary is [illegible] to pay the cost of the visit if exchange control regulations permit this.

The Kenyan subsidiary has also received assistance in this way. When they were contemplating building an instant coffee plant in Kenya, they turned to one of the other subsidiaries whose growth had largely followed from their success with instant coffee. Frequent visits were made to this subsidiary by high level manpower from the Kenyan subsidiary and drawings were obtained, as well as advice on the best methods of processing to use.

Following the closing down of their Research and Development section, the Group has established a Technical Services Division, which acts independently from the Board. It scrutinises monthly reports sent in by subsidiaries, and evaluate whether it has any specialised services to offer. Where it has, it makes direct contact with the subsidiary to offers advice and this frequently results in the dispatch of skilled manpower to the subsidiary.

With respect to obtaining non-parent proprietary technology the operations of the Kenyan subsidiary must be seen in relation to the Group's decision to give-up all Research and Development and to buy in new technology from other firms. Some non-parent proprietary technology therefore comes through the parent. The Kenayn subsidiaries of other multinationals are another source of non-parent proprietary technology and have been particularly important in enabling the subsidiary to keep abreast of developments in herbicides and fertilisers.

Pharmeceuticals. (B)

As we have seen, this subsidiary undertakes no expenditure on either Research and Development or on Adaptation. It relies completely on the parent for new technology. The Kenyan subsidiary relates to three Divisions in the parent in this respect.

(i) Technical Services Division. Once the Kenyan subsidiary specifies a need for certain equipment the actual choice is made by the Technical Service Division of the parent, which will suggest its choice to the Kenyan subsidiary. In the unlikely event of continued disagreement (as capital expenditure of more than UK £1,177 is discussed three years in advance) Technical Services will send someone out to discuss the

problem, or the discussion will take place on the manager's annual visit to the parent. The full instructions for operating the plant, as well as precise instructions for mixing any new formulations are supplied by Technical Services.

Technical Services is responsible for quality control and sets out the required standards. It is also responsible for the design of new buildings, scaffolding and platforms. These designs are undertaken in London by the parent of another British construction firm which has a subsidiary in Kenya, and the design follows discussions by the two parent firms in London.

If there is any difficulty in operating the plant Technical Services will assist. For example the Kenyan subsidiary is experiencing difficulties in the quality control section and technical services are sending a consultant out for six weeks.

(ii) New Products Division. In most cases the Kenyan subsidiary identifies a need for a new product. The formulation of this product is undertaken by the New Products Division of the parent. In some cases the Kenyan subsidiary will be instructed to either produce or market a new product developed elsewhere in the firm. The New Products Division circulates a quarterly list of new products to all subsidiaries, but hitherto this has not provided the Kenyan subsidiary with any new products.

(iii) Marketing Services Division. This division is responsible for marketing and advertising. Since marketing conditions vary throughout the firm's subsidiaries, the activities of this division are confined to the realm of new ideas rather than of specific marketing techniques.

Pharmeceuticals (C) The subsidiary has contact with two Divisions of the parent.

(i) The Marketing Services Division. This division is mainly concerned with training, advertising, and marketing. It sends circulars at monthly intervals to all subsidiaries, but there is also direct contact with the Kenyan subsidiary on specific problems. This division is also responsible for the circulation of new formulations.

(ii) The Technical Services Division. The main concern of this division is with regard to the purchase and operation of production technology. The Kenyan subsidiary clears all machinery purchases with this division and goes to it for advice on specific problems where necessary.

Subsidiaries are also able to contact each other directly without going through the parent. Advice may be sought from a subsidiary operating in similar conditions with regard to product formulations as well as production technology. Access to non-parent technology is made through the parent and the Technical Services Division keeps the subsidiary informed of developments which it considers to be relevant.

Cement.

. The main link between the parent and the Kenyan subsidiary of Firm D is not through equity (where the parent only holds 14%), but through a technology agreement. It was not possible to obtain details of this technology agreement, but the broad outline is that the parent supplies a Technical General Manager, a Works Manager and an Electrical Engineer. It also gives the subsidiary access to new developments in Technology and assists with specific problems which arise. Occassionally the parent is asked for advice with regard to the purchase of new equipment, but since there have been no major purchases for some years, few problems have arisen. Monthly reports on production are sent to the parent.

The circulation of manpower is another way in which the parent assists the Kenyan subsidiary. Two or three times a year, they are visited by someone from the parent. He informs them of advances made elsewhere in the firm and considers specific problems of the Kenyan subsidiary in the light of his experience in other subsidiaries. Should he not be able to offer advice on the spot (he only stays for a few days), he will consult with colleagues in London and write back with their views.

Engineering design. In earlier years the parent sent manpower out from the U.K. to fulfill specific contracts, but since the Kenyan subsidiary begun to undertake its own designs, this has become much more infrecuent, and it seldom occurs now that the local subsidiary has generated its own design expertise. However use is made of visits to the parent and the Managing Director and General Manager make annual visits to the parent, and senior design staff make bi-annual visits, or visits on particular problems. This is an important channel for the Kenyan subsidiary in its attempts to keep abreast of parent technology. Circulation of lower level through the firm is an important mechanism and personnel are sent to the UK on courses or to spend some time working in the parent's operations.

The Kenyan subsidiary may write to the parent on specific problems. Where the parent has this technology readily available, it will be freely offered, but where it recuires specific work by the parent, the subsidiary will be expected to bear the costs. The Managing Director is on the circulation list for confidential design manuals of the Group's activities, and this is an important method of keeping abreast of the parent's activities - until recently he was the European Marketing Manager for the parent firm, so this too assists in the Kenyan subsidiary's ability to keep abreast of parent technology.

The activities of the Kenyan subsidiary are broader than those of the parent. The parent concentrates its activities in refrigeration technology, while the local subsidiary complements this with work on air-conditioning. It is important therefore for the Kenyan subsidiary that it keeps abreast of non-parent technological developments. This is done in three ways. The first is through trade journals which informs them of developments by machinery manufacturers. The second is by visits from the main non-parent suppliers and the third is through visits to the suppliers. The Managing Director visits one supplier in Israel (manufacturing under licence from the U.S.) twice a year and visits the main U.S. supplier approximately once a year.

(b) No System of Circulating Technology

Tea Machinery. The Kenyan subsidiary is completely responsible for the manufacture of tea processing equipment and is autonomous from the parent in this respect. As a consequence the contact between the parent and the Kenyan subsidiary is limited to financial matters. The subsidiary maintains its access to non-parent technology through trade journals, but since it is a basically a capital goods firm the relevant technology is mainly simple machine tools.

Vehicle assembly. This subsidiary operates at a simple technological level, as we have seen. The main input of the parent is to design drawings for jigs used in the assembly of vehicles, and in the case of the new assembly plant, to design a new spot welder. There is little contact with the parent, therefore, with regard to technology. Were the Kenyan subsidiary to have problems it would go to the parent, but there is no occasion when this has happened. The limits of their technological problem concern, for example, a blown motor, and this can be easily solved by purchasing an (imported) replacement in Kenya.

Table 8 summarises the system used to circulate technology throuth the firms. It can be seen from the table that five out of the seven firms have a firm-disembodied technology (ie a specific division catering for the needs of subsidiaries) for communicating technical change to subsidiaries. The exceptions are vehicle assembly, where the technology used in 'simple' and the main objective of the parent is the sale of knocked-down kits, and tea machinery where the subsidiary, for reasons which have already been explained, has a large measure of independence from the parent.

In the case of three firms - engineering design and the two pharmeceutical firms- a regular system of circulars exists to keep subsidiaries informed of technical change. In only one of these cases, however, (that of engineering design) do any of the subsidiaries consider this to be an effective form of transmission. A more effective form of transmission is that of the transfer of personnel (ie man-disembodied) from parent to subsidiary and vice - versa - three of the firms have regular visits organised, but all of

the subsidiaries benefit when skilled personnel are seconded from the parent or another subsidiary for a number of years.

Keeping in mind the earlier discussion of property rights over technical change there is a clear indication that the majority of these firms use this 'property' by recycling it around the firm. The function of this recycling is probably as a way of maintaining the dependence of the subsidiaries on the parent. This is true even for the engineering design subsidiary which probably has a greater 'command' over the technology it uses than any other subsidiary with the exception of the tea machinery firm.

The two firms which are exceptions do not really undermine the argument of technology and control. In the case of the vehicle assembler, there is little scope for maintaining dependence through control over production technology as the technology used by the subsidiary is predominantly product and materials technology, given the specificity of its output, there is little scope for the subsidiary to break its dependence on the parent. The tea machinery subsidiary is a slightly different case and this partly follows from the rather special circumstances which surroung its presence in Kenya. It probably also reflects the smallness of the subsidiary (it has by far the smallest turnover of any of the subsidiaries in the sample - see Table 1) as well as the fact that it is personally managed by one of the Directors of the parent.

Table 8

Circulation of Technology through the Firm

Firm	A Tea & allied products	B Pharmec-euticals etc	C Pharmec-euticals etc	D Vehicle assembly	E Engineering design	F Tea machinery
Parent Division catering to needs of subsidiaries	Technical Services Division	Technical Services, New Prod-ucts, Marketing divisions	Technical Services, Marketing divisions	Technical Services Agreement	No	No specific division	No
Use of regular circulars	No	Yes	Yes	No	No	Yes	No
Visits from parent for purpose of transmitting technology	No	Yes	No	Yes	No	No	No
Regular visits to parent for purpose of obtaining technology	No	Yes	No	No	No	Yes	No
Access to non-parent techno-logy through parent	Yes	Yes	Yes	Yes	No	Yes	No
Access to non-parent techno-logy independently	No	No	No	Yes	No	Yes	Yes

VII

Linkages

One of the arguments used to justify the presence of multinationals in an underdeveloped economy such as Kenya is that their presence may lead to industrial linkages and thereby stimulate further industrial development. There are two forms which these linkages may take. They may be forward in the sense that the product technology of the multinational provides an opportunity for new investment which is founded on the use of these products. Or they may be backward in the sense that investment results from the supply of capital goods (production technology), or the supply of intermediate goods (materials technology) to these subsidiaries.

The existence of these linkages is of considerable importance to continued industrial development in Kenya. The precise importance is affected by a number of factors, not the least of which concerns the nature of entrepreneurship which is stimulated. If the new enteprises which are established are controlled by multinationals, this will almost certainly have different implications for the economy than enterprises which are wholly-owned and or controlled by Kenyan citizens.

The seven subsidiaries were therefore questioned in an attempt to establish the nature of the linkages which have arisen from their operations in Kenya, and some attempt was made to determine whether these new enterprises were locally - or foreign-owned (as an indication of control)

(a) Forward Linkages

The discussion of forward linkages is complicated to some extent by the fact that although new firms may exist which utilise the output of some of the subsidiaries in the sample, it is not possible to determine whether these new firms would not have come into existence without the local production of their inputs by using imported alternatives. This difficulty aside, there are four cases in which it could be said that new investment was 'stimulated' by the presence of output emanating one, or more, of the multinationals in our sample.

Tea machinery. This subsidiary produces tea machinery for the local market. Processed tea is one of the major agricultural based industries in Kenya (A for example, which produces tea, is the largest private employer in Kenya), and although the processing costs are only a small proportion of unit tea costs, it is a necessary stage in the production and export of tea. Even without the presence of this subsidiary in Kenya, tea production and processing would have continued in Kenya. In this respect it could not be said that forward linkages have arisen as a consequence of the presence of this subsidiary in Kenya. Nevertheless it is clear that the output of this subsidiary is a necessary input in tea production and it therefore does qualify as a 'sort of' forward linkage.

Cement. The availability of cement locally allows the construction sector to operate in Kenya and even now, when there exists a temporary shortage of cement in the country, building activity is slowed by its non-availability. Once again, as with most of the forward linkages, it is feasable that the construction sector could have operated independently of the presence of this subsidiary, but this does not negate the function of the cement producers in enabling continued industrial activity in the construction sector.

Vehicle assembly. The availability of transport for both goods and people is an important factor in the industrial development of Kenya. To the extent that this transport is made possible by the presence of this subsidiary in Kenya, it could be said that forward linkages have arisen from its activities.

Engineering design. This is the only subsidiary in the sample where there is an strong presumption that the presence of this firm has led to forward linkages in the economy. Its presence does allow other investment to take place as for example in the case of a Danish firm which has set up a subsidiary to export flowers to Europe. Without the existence of this engineering design subsidiary in Kenya it would not have proved feasable for the Danish firm to cultivate flowers on a scale sufficient to make its operations rewarding.

(b) Backward Linkages

There are two forms which these backward linkages may take. They may be in the sphere of production technology in which case the linkages will concern capital good firms, or they may be in the sphere of materials technology in which case the firms concerned will be intermediate goods firms. In the case of five out of the seven subsidiaries it can be said that backward linkages have arisen (i) Backward linkages in production technology.

Tea. The presence of the tea machinery subsidiary in Kenya is a concrete sign that backward linkages have arisen in part from the operations of this subsidiary in Kenya. It would be a mistake to over estimate this contribution because much of this subsidiary's production technology is still imported.

Engineering design. To a limited extent the operations of this subsidiary have led to backward linkages in production technology, but these linkages have been internal to the subsidiary. Recently the subsidiary has begun to manufacture its own panels by injecting polystyrene into wooden frames and on a previous occassion (as we have seen [illegible]) the subsidiary engaged in 'reverse engineering' and fabricated 1,000 air-conditioning units to meet its own needs.

Pharmeceuticals (C) As we have seen [illegible] this subsidiary is engaging in its first purchase of locally manufactured production technology. In association with a local engineer they are designing and building a tin-filling machine to meet the increased scale of production.

Vehicle Assembly. This subsidiary has had a few pieces of equipment manufactured locally. The jigs for the new assembly plant as well as the existing paint-shop have been constructed locally to the design of the parent.

(ii) Backward linkages in materials technology.

The tea subsidiary meets all of its packaging requirements from local producers, while the two pharmeceutical firms still import a proportion of their needs. The link between their product technology and this importation is strong as the only reason for not using local inputs is the product differentiation which they practise in common with their parent. For example, bottles are produced locally and are used by both subsidiaries - yet some products which manufacturers

(eg hand cream) are marketed in a bottle of a specific shape which is not produced locally. Therefore these bottles are imported.

One other subsidiary whose presence has led to backward linkages in materials technology is the vehicle assembler. A concerted attempt has been made to introduce some locally-manufactured parts into the assembly operations in the new plant. This has led to the projected inclusion of locally manufactured batteries, tyres, soft-trimmings, canvas and oil and air filters. The major linkage arises from the local fabrication of all bus and lorry bodies - this has led to significant activity by a large number of locally - owned firms.

The position with regard to the linkages in summarised in Table 9. By definition there are no forward linkages which would arise from the use of the output of consumer good firms. Forward linkages can therefore only arise from the presence of both the capital and both the intermediate goods firms. The ownership of these linkages are largely local in the case of the two intermediate goods subsidiaries and largely foreign in the case of the capital goods subsidiaries. In the latter case this is probably a common pattern in that much of industrial investment in Kenya is foreign owned. However in the case of the two intermediate firms, the local ownership follows from the specific nature of these two industries - other intermediate products (eg packaging) are almost certainly widely used in the foreign dominated manufacturing sector.

In the case of backward linkages there is little evidence of major linkages arising with regard to production technology, with the possible exception of the tea producer, in whose case the existence of the tea machinery subsidiary is a visible testament to the existence of such a backward linkage/ and vehicle assembly. Generally the other production-technology linkages are insignificant. This no doubt reflects the absence of a well-developed capital goods sector in Kenya. What does exist is split between the locally-owned small scale workshops (eg manufacturing jigs, and containers/ and vehicle bodies) and the larger foreign owned subsidiaries (eg the two capital goods firms in our sample).

Table 9

Linkages	Firms	A Tea and allied products	B Pharmeceuticals etc
FORWARD LINKAGES		None	None
BACKWARD LINKAGES			
(i) Production technology		Tea machinery (manufactured by G)	None
(ii) Materials technology		Packaging	Packaging
Ownership of firms resulting from backward linkages		Foreign	Largely Foreign
Ownership of firms resulting from forward linkages		-	-

Linkages

C Pharmaceuticals etc	D Cement	I Vehicle assembly	F Engineering design	G Tea machinery
None -	Used in construction sector	Used in transport sector	Used in manufacturing sector	Used in tea industry
Packing machinery (partly self-manufacture)	None	Jigs, paint-shop.	Frames, (self-manufacture)	None
Packaging	None	bodies Batteries, tyres, canvas, filters, soft-trimmings	None	None
Production technology - local Materials technology largely foreign	- -	Production technology - local. Materials technology- largely foreign, some local	Foreign	-
-	Largely local	largely local	largely foreign	local / foreign

The major backward linkage in the sphere of materials technology occurs with regard to packaging, where a Canadian-owned subsidiary dominates the field. All the consumer good firms in our sample purchase local packaging materials and this is to be expected, given the product-technology orientation of their activities in Kenya. The only other case of backward likages in materials technology is the provision of inputs into the vehicle assembly plant and these firms are largely foreign owned. In the case of the locally owned suppliers, the vehicle assembler had to exert a great deal of pressure before they were able to stimulate these local producers.

On balance the evidence of linkages arising from the presence of the seven subsidiaries is limited. Where they do arise, the larger firms are invariably foreign owned, while the local firms are of a much smaller scale and in industries where there are few technological barriers to entry. This follows from the general nature of the industrial sector in Kenya which is only at the earliest stage of development, and which is largely dominated by foreign owned firms.

In another study undertaken on over seventy multinationals operating in the Kenyan economy, Langdon[28] found a similar absence of linkages arising from the presence of these foreign-owned firms in Kenya. In the case of production technology linkages, he found that the "linkages are so limited that variations among different sorts of subsidiaries are of little relevance; the whole sector performed poorly" (page 21). Materials technology linkages were also very limited, although not to such a marked extent. Statistical analysis of his data suggests that three factors are associated with the low level of linkages - "parent firm integration", capital intensity and product differentiating activities (measured by relative advertising expenditure.) Langdon explains this absence of linkages in the following terms. 'Overall, though, the qualitative evidence suggests clearly that the indirect linkage impact of subsidiaries in Kenya is limited by the nature of the mnc package - its product/taste transfer implications, its capital intensive choice of technique, its integration of subsidiaries into co-ordinated world [illegible], and its product-differentiating style of business' (page 32).[29]

While we may not agree with all of Langdons conclusions (for example, his analysis is a little 'condemnatory' in style. Infact the multinationals are following the logic imposed upon them by accumulation in a global context and are faced with an underdeveloped industrial sector in Kenya), his more detailed evidence supports the conclusions which have emerged from this study. Broadly speaking, both sets of research have found an absence of linkages, and where these arise they are generally undertaken by subsidiaries of other multinationals.

VIII

CONCLUSIONS

In this study we have concentrated on the generation and acquisition of technical change by the subsidiaries of seven British-owned subsidiaries in Kenya. Three spheres of technical change have been distinguished - changes in production technology, product technology and material technology. These changes may be of an embodied or disembodied type and may either be of a proprietary or non proprietary nature. The technical change may be generated within the subsidiaries or it may be acquired from parent or non-parent suppliers.

The major problem with this study has been the smallness of the sample of subsidiaries. This has not made it possible to systematically explore a set of hypotheses, and although this is regretable, it is believed that the absence of research in this field[30] justifies such a tentative approach. The research must inevitably be seen in the context of the generation hypotheses with regard to the behaviour of subsidiaries in underdeveloped economies, rather than in drawing definitive conclusions in this respect. One further problem has been the absence of detailed quantitative data on the Research and Development expenditure of the firms in the sample. The problem here has been that it is unlikely that the detailed information required (e.g on the breakdown of expenditure) can be obtained in the context of interviews with senior management. Without exception the subsidiaries did not have readily at hand precise estimates of expenditure which are relevant to this study - short of detailed research in each subsidiary (requiring the cooperation of each subsidiary and a great deal of time) there has therefore been no alternative but to sidestep the problem of quantitative data and to concentrate instead on a qualitative approach. This has attempted to establish the nature of activities undertaken by the subsidiaries and the links which they have with their parents in the acquisition of new technology.

In the discussion on the generation and acquisition of new technology, the major interest has been in establishing the sources of variance with respect to subsidiary performance. There are a number of factors relevant here and these will each be briefly discussed with reference to the results presented earlier. It should however be stressed that there is no suggestion of culpability in these conclusions - each of these subsidiaries as well as their parents are behaving in a rational manner insofar as they perceive the problem of accumulation in the global context. The existence or absence of Research and Development expenditure in the Kenyan subsidiaries is a reflection of the environment which each of the firms perceives to exist.

Summary of Results.

Seven subsidiaries were included in the sample - one tea producer, two pharmeceutical subsidiaries, one cement producer, a vehicle assembler, one engineering design subsidiary and one tea machinery producer. The subsidiaries varied in the size of their operations, ranging from a turnover of £17.65 m to £470,000 per annum (Table 1). The cement firm was the most capital intensive and the two capital goods subsidiaries (tea machinery and engineering design) were the least capital intensive (measuring only embodied technology - table 2).

With regard to the orientation of technical change, (table 3), only two of the sample were particularly concerned with cost reduction (tea and tea machinery). The two pharmeceutical subsidiaries were predominantly concerned with product technology, and the two capital goods subsidiaries had a common interest in product adaptation (particularly with respect to 'technical adaptation').

None of the sample firms undertook any Basic or Applied research (table 4). Only two subsidiaries had a significant expenditure (as a percentage of value added) on Experimental Development and Adaptation (tea machinery and engineering design). Two other subsidiaries (tea production and one of the pharmeceutical firms) had some expenditure in these activities, but in both cases it amounted to less than 1% of value added. One of the important conclusions which emerges from the study is the importance of quality control in stimulating technical change. All of the subsidiaries had some sort of quality control and in almost all cases this expenditure exceeded that on formalised Experimental Development and Adaptation (table 5). There were links between quality control and production-, product- and materials - technology, although not all subsidiaries had links in all three spheres of technical change.

Three of the sample (cement and the two capital goods firms) had the autonomy to choose technology without the participation of the parent (table 6). By contrast the vehicle assembler and one of the pharmeceutical subsidiaries had little autonomy in this respect. Nominal autonomy aside, only the two capital goods firms had the ability to make full use of the autonomy granted to them by their parents.

With the exception of the tea producer, none of the sample made any specific payments for technology to either the parent or non-parent firms (table 7). The importance of technology in the relationship of the subsidiaries to the parents is highlighted by the fact that in all cases the property rights over technical change were obtained by the parents. In all cases the parents were also responsible for the registration of patents and brand names in Kenya

Given the importance of technology in this parent-subsidiary relationship, it is to be expected that each of the firms has a system for circulating technical change through the corporate body (table 8). The interesting result which emerges is the importance of man - disembodied technological flows through the firm.

Finally, with respect to industrial linkages stimulated by the activities of these subsidiaries in Kenya, there is little evidence of either forward or backward linkages (table 9). Where linkages have occurred, they have predominantly involved other multinational firms. The reason for this relative absence of linkages must be found in the undevelopment of the Kenyan industrial sector and the weakness of the local industrial bourgeoisie, particularly African industrialists.

Sources of Variance in the Generation and Acquisition of Technical Change.

There are a variety of factors which explain the behaviour of each of the subsidiaries in the generation and acquisition of technical change. The problem in understanding their behaviour and making generalisations on the basis of this understanding is that there exist multi-causal factors and it is difficult to isolate particular ones in any one case. To some extent this problem will be alleviated by comparative study,[26] but even then the problem of indeterminacy will arise. The approach to be followed here will be to list each of the sources of variance and to discuss them in the light of the evidence gathered from the subsidiaries.

(a) County Specific Factors.

Kenya is a relatively underpopulated country with a population of about 12 million living in an area of 225,000 square miles. While it is considered to be a relatively highly-industrialised economy in relation to its neighbours, this is more a reflection of the degree of industrial undevelopment of the neighbours than of its own industrial development.

Much of industrial activity is dominated by multinational firms or non-citizen industrialists, who predominantly produce import substitutes for final consumption at a relatively 'low level' of value added.[31] For example, the vehicle assembling subsidiary in the sample assembles from knocked-down kits at the most simple level of assembly, and the only locally manufactured inputs to be included when the new plant under construction is completed will be batteries, tyres, some soft-trim and canvas and filters. Similarly the pharmeceutical subsidiaries in the sample confine their activities to mixing imported inputs, forming them into pills and packing.

Some intermediate goods are also produced locally, of which cement is one example. In this particular case almost all of the value added of this product arises from Kenyan inputs, as the raw materials which comprise a large

share of total costs are available locally. To some extent the tea producing subsidiary is in an analogous position because in its case the value of its final product (i.e. f.o.b in Mombasa and not as priced in British shops)is almost entirely of Kenyan origin - Both cement and tea production are cases of an industry environmentally specific to Kenya.

For technical progress to be generated in Kenya it is probably necessary that a local capital goods industry exists. The capital goods industry in Kenya is still in its infancy. Basically there are two forms of capital goods industry in Kenya. On the one hand there are many small scale workshops fabricating containers, vehicle bodies and some industrial machinery. Most of these firms are local in the sense that they are locally-incorporated, but in almost all cases they are enterprises set-up and run by European or Asian non-citizens. The other type of local capital goods firms are the subsidiaries of multi-national firms, of which there are two in our sample. These latter two firms do provide production technology for local industry.

The smallness of the Kenyan economy and the undevelopment of the industrial sector are probably the main reasons explaining the lack of locally generated technical change. To some degree this undevelopment is countered by the role which Kenyan industry plays in East Africa - this almost certainly explains to a large extent the nature of operations of three subsidiaries in the sample. The two capital goods subsidiaries as well as the two pharmeceutical subsidiaries supply the East and Central African market from their Kenyan plants. In all of these cases some technical change results from the need to serve these different markets.

(b) Sector- and Industry- Specific Factors.

There are a number of broad sector-specific factors which influence the behaviour of the seven subsidiaries in their generation technical change. As is to be expected in the global context of oligopolistic competition (which is closely replicated in Kenya with the major difference that the Kenyan market is generally more concentrated and less competitive than those in developed countries), the consumer goods industries are characterised by product- rather than price-competition.

The three consumer goods subsidiaries in the sample, tea and pharmeceuticals, all are characterised by this emphasis on product, rather than production technical change. Particularly in the case of the two pharmeceutical firms, this emphasis on product technology plays a major role in determining the orientation of their technical change. Production technology is however also of importance to the tea producer. In its case its operations are confined by necessity to economies such as Kenya, rather than Britain, and this is reflected in the situating of some of their Research and Development in Kenya.

By contrast intermediate products are generally not characterised to such a great extent by changes in product technology. When product technology is important it is less so in the case of product differentiation than innovation and adaptation. This is reflected in the behaviour of the cement subsidiary in particular whose major concern lies in the spheres of production and materials technology.

It is in the nature of the activities of capital goods firms that adaptations of technology are made to suit the specific needs of customers. This largely explains the fact that these two subsidiaries displayed a greater tendency than any other in the sample to generate themselves new technology. They also tended to be more independent from the control of the parent, although this may be a reflection of the specific industries chosen rather than of the capital goods sector as a whole.[32]

Aside from these broad sectoral factors (i.e. consumer, intermediate and capital goods sectors) there are a number of industry-specific factors which are relevant. The operations of the tea machinery subsidiary is a case in point, in that it is a rather unusual case where the parent has moved its operations in the manufacture of tea machinery from Britain to Kenya in order to be close to the market and to take advantage of cheap labour in a relatively labour intensive process. Another example of industry-specific factors is that of tea production, which unlike pharmeceuticals it is located in Kenya for environmental factors. This largely explains why this subsidiary engages in particular types of Research and Development such as the sue of new herbicide and fertiliser patterns and the development of new strains of tea and cinchona bushes.

(c) Firm Strategy and Market Conditions as Factors Explaining the Generation of New Technology.

In addition to country- and sector- specific factors, it is quite possible that a subsidiary's performance in respect to generating new technology also reflects the specific policy of its parent, particularly in the context of market conditions at both the global and the local level.[33]

Probably parent-policy is not as important a determinant of a subsidiary's activities as are sectoral and country factors. There is evidence that parent policy does have an effect through contrast between the two pharmeceuticals subsidiaries in the sample. The two firms produce a broadly

similar range of products, although the turnover of C is over three times that of B. In the case of C, parent policy is to give a fair amount of autonomy to the subsidiary which is involved in product adaptation as well as the development of production technology (albeit at a simple level). By contrast the lack of autonomy given to B by its parent is reflected by its almost total dependence on the parent - even designs for new buildings are commissioned by the parent to another British multinational in London which has a subsidiary in Kenya. A further example of the effects of parent policy is the decision of the tea machinery firm to situate its machinery manufacture in Kenya. But the influence of parent policy in this case merges with the effects of market and country specific factors.

Market conditions also influence the decision of a multinational to locate its subsidiary in a country and the behaviour of this subsidiary in the generation and acquisition of new technology. Thus the tea producer in our sample appears to be slowly disengaging itself from South Asia due to the policy of the Indian and Sri Lankan governments. There has been little replanting of new vegetative production tea bushes on their estates in these two countries and the introduction of new varieties of tea bush has been concentrated in their African subsidiaries. So too has the introduction of new products such as tara and cinchona.

It is also probable that the differential behaviour of the two pharmeceutical subsidiaries represents the difference in the competitive position of the parents at the global level. While the two parents are amongst the three largest pharmeceutical firms in Britain, B is a much older and more firmly established firm than C. The latter firm, as is often the case of 'followers' in an oligopolistic market, tends to be more aggressively competitive and growth oriented. To some extent this is reflected in the behaviour of their two Kenyan subsidiaries.

(d) Size, Capital Intensity and Longevity as Factors Explaining the Generation of New Technology.

Size, either in absolute terms or as a percentage of value added, is not positively correlated with the behaviour of the subsidiaries in generating new technology (table 10). Only four of the seven subsidiaries make any formal expenditure on the generation of technical change. Two of these subsidiaries are the smallest in the sample which might suggest that there exists a negative correlation between size and relative Research and Development expenditure. It is extremely doubtful however whether this coincidence is casually related.

It is doubtful, too whether longevity of operations in Kenya is related to performance in the generation of Research and Development. As is also shown in table 10, there appears to be no relationship at all in this respect. The only case where there is a clear indication that a subsidiary has increased its expenditure on Research and Development over the years is in the case of the engineering design subsidiary which has progressively expanded these activities since it began local design in the early 1960's.

The apparent inverse relationship between capital intensity and Research and Development expenditure reflects the fact that the two capital goods firms have a high disembodied input which of necessity must be internal to the subsidiary. This man-disembodied technology takes the form of design staff, particularly in the case of the engineering design subsidiary. Aside from these two labour-intensive subsidiaries there is no relationship at all between capital intensity and Research and Development expenditure.

Table 10

Relationship between size, longevity and capital intensity and expenditure on Research and Development

Firm	A Tea and allied products	B Pharmec-euticals etc.	C Pharmec euticals etc.	D Cement	E Vehicle Assembly	F Engineer-ing design	G Tea machinery
Expenditure on Research & Develop-ment.(c) (as % of value added)	£35,294 (0.92%)	-	£1,177 (0.23%)	-	-	£47,050 (25.0%) (a)	£4,118 (5.52%)
Turnover (£'000)	£17,650	£937	£3,000	£5,002	£2,404	£882	£471
When was manufactur-ing subsi-diary estab-lished in Kenya?	1920's	1964	1970 (b)	1933	1961	1960	1973
Capital intensity as measured by (written down) fixed assets per employee	£127	£702	£29	£4,160	£99	£39	£53

(a) Estimate. This figure covers the cost of all the subsidiary's design activities, not all of which would necessarily lead to the generation of technical change.

(b) Locally owned prior to this.

(c) For a discussion of what is meant by Research and Development see section IV entitled

(c) Share of Equity Held by Parent as a Factor explaining the Generation of New Technology

As can be seen from table 11, there is little evidence that the share of equity held by the parent has any effect on the level of expenditure on Research and Development. It would probably be surprising if there were to be any link of this nature as the reason for disparities in parent-shares of equity differ for most of the firms in the sample.

The two wholly-owned subsidiaries are both pharmeceutical firms whose presence in Kenya has followed the familiar pattern of import-substituting investment in a newly independent country.

The tea subsidiary is of long standing in Kenya, and its decision to sell a small share of its equity was to maintain goodwill as the government has been attempting to promote the purchase of shares by the Kenyan public. The sale of shares by the engineering design firm was occassioned by the terms of it establishing design facilities when its distributor was taken over and offered part of the equity for goodwill and stock. It its not clear why the tea machinery firm sold off part of its holding, but it is believed to have been a method used to gain capital to finance its expansion in Kenya.

The relatively low share of the vehicle assembly parent in the new assembly plant reflects the concern of the government to Africanise distributorship of vehicles (20% is held by a local firm which markets the firm's output) and the rest is held by the Treasury. This latter holding is probably partly explained by the fact that the government is anxious to maintain control over this strategic sector of the economy, and as the main interest of the parent lies in the sale of knocked down kits, it may also be anxious to involve the government in an attempt to ensure the long-term interests of the subsidiary. The low share held by the parent in the cement plant is a relatively recent phenomenon as the Treasury has only taken a majority holding in recent years. Prior to this the parent held over 20% of equity; the reason for this relatively low share-holding is probably because the parent is anxious to control the local market as it has a more substantial holding in the other cement plant in Kenya (See footnote 16).

None of these reasons given for shares of equity held by the various parents suggests that this may be a reason explaining the relative performance of the subsidiaries in generating new technology. Were the government of Kenya to be more 'active' in its holdings, or were there to exist an 'independent'

group of local industrialists, it might be expected that the lower the share of the parents the higher the relative expenditure on Research and Development. But once again there is no evidence from table 11 that such a relationship exists.

Table 11

Relationship between Equity Held by Parent and Expenditure on Research Research and Development

Firm	A Tea and allied products	B Pharmec-euticals etc	C Pharmec-euticals etc	D Cement	F Vehicle assembly	F Engineer-ing design	G Tea machinery
Equity held by parent (%)	88.75	100	100	14	45(a)	74	61.5
Expend-iture on Rese-arch and Develop-ment(b) (as % of value added)	£35,294 (0.92%)	-	£1,177(b) (0.23%)	-	-	£47,05(c) (25.8%)	£4,118 (5.52%)

(a) Share in new assembly plant under construction.

(b) For a discussion of what is meant by Research and Development, see Section IV.

(c) Estimate. This figure covers the cost of all the subsidiary's design activities, not all of which would necessarily lead to the generation of technical change.

(f) Government Policy as a Factor Explaining the Generation and Acquisition of New Technology

There has been little indication in this research that government policy has had any effect on the behaviour of the subsidiaries in their generation and acquisition of new technology. We have already seen that there has been one case when the government has failed to pursuade the two pharmeceutical firms to use local sugar.[34] In the case of one of the pharmeceutical subsidiaries, there is evidence that the imposition of tariffs by the government led the subsidiary to increase the number of products produced in Kenya - but even in the case of the pharmeceutical industry there appears to be no pattern in Government tariff policy which consistently induces subsidiaries to import raw materials and manufacture final products. It could be

argued that the government's (temporary) blocking of the Technical Service Fee by the tea producer is an attempt to induce the subsidiary to develop this technology itself - but since there is no limitation on the remission of dividends by the subsidiary it is more likely to reflect the government's desire to prevent transfer pricing and to cut the foreign exchange loss.

Other Points of Interest Arising from the Research

A number of points of interest are raised as a result of the research which do not concern the sources of variance in the behaviour of the seven subsidiaries. They do not fit into any pattern of observations so it is best to treat them individually.

(a) Core and Peripheral Activities

The first concerns the distinction between core and non-core technology used by the subsidiaries in the sample. Pack as we have seen (page 6) draws the distinction between five basic processes involved in production, of which material processing - which we have referred to as core technology - is only one. Since the ability to choose amongst different technologies is in itself a technology (page 1 it may well be that the subsidiaries do possess a technological capability, but this ability is not reflected so much in generation of technical change, but rather in the choice of more appropriate techniques. It is often argued that it is in the non-core processes that the greatest flexibility of choice arises.

No systematic attempt was made in this research to establish whether the choice of more appropriate technology, particularly in peripheral activities, occurred in the subsidiaries. In part this was occassioned by the belief that the only way to establish this was by paying visits to other subsidiaries of each firm in many other parts of the world, which clearly has not been possible. It is the general impression though, that with the possible exception of the cement plant, (where the core plant is similar to that used in developed countries) all of the subsidiaries had chosen technology, core and peripheral, which was suitable to local conditions and which was not used by the parent. The most frequent factor influencing this choice was the scale of the market - this was true for both the pharmeceutical firms, the vehicle assembler, the engineering design subsidiary and possibly the tea machinery manufacturer. If a subsidiary had been interviewed which produced at a much greater scale (e.g. one of the larger consumer good firms in Kenya) a different pattern of

Unfortunately the subsidiary originally approached was not willing to cooperate in the research project.

The existence of these choice patterns, differentiating the production technology used by the subsidiaries from that used by their parents, should not be taken to imply that the choice was undertaken by the subsidiary. As we have seen in Section 5, only three of the subsidiaries (the two capital goods firms and the cement subsidiary) had the complete autonomy to choose technology, and only the former two had the ability to use this autonomy.

(b) Transfer of Taste Preferences and Standards and the Generation and Acquisition of Technology.

There are many cases when the specification of a product influences either or both of the production and materials technology which is to be used. The transfer of taste patterns across national boundaries is an accepted phenomenon and the possibility arises that this transfer will affect the propensity of subsidiaries to adapt to the local environment.[35] There is some evidence that this has occurred, particularly in the case of the two pharmeceutical firms. Here the desire of the parent to standardise product technology through the firm has led to the use of imported rather than local material inputs in a number of cases. Similarly the variability in quality resulting from the use of a labour-intensive tin-filling machine has led one of the firms to generate new production technology.

In the case of the intermediate and capital goods subsidiaries it is not so much the transfer of tastes, but that of standards which influences the behaviour of these subsidiaries. Cement is made to British Standard Specifications.(there are probably important reasons concerning safety which commend this transfer), while the engineering design firm aims to produce air-conditioning of a quality acceptable to the many expatriates working in Kenya.

In spite of these instances in which the transfer of taste patterns and standards from developed countries influences the propensity of the subsidiaries to generate new technology themselves, it would be dangerous to place too much emphasis on this phenomenon. More important factors exist which influence the behaviour of the subsidiaries in this respect.

(c) Embodied and Disembodied Technology

A distinction has been drawn in this research between embodied and disembodied (and in the latter case between man- and firm-disembodied) technology. The importance of this distinction is confirmed by the research. For the two capital goods subsidiaries particularly the disembodied technological input has been of great importance. The presence of disembodied inputs is also of importance because it is more likely that some disembodied technological inputs will be situated in an underdeveloped country than in the case of embodied technology. Obviously this depends upon the type of disembodied input which is considered - in some cases overall managerial and entrepreneurial expertise will be centered in the parent.

Another factor of importance in this respect is the role which disembodiedtechnological inputs appear to play in the circulation of technology through the firm -the circulation of technology through the circulation of manpower has turned out to be an important factor for most of the subsidiaries in the sample.

(d) Transfer Pricing

One of the more surprising results of the research has been the relative absence of overt transfer pricing practices associated with the transfer of technology by parents to the subsidiaries. This contrasts with the results of research in other countries, particularly in Latin America.[36] To some extent this is a reflection of the absence of barriers to the remission of dividends, compared to other countries such as Colombia.[37] But it also refects the fact that there may well be other channels used to transfer price profits which are not associated with the questions discussed in this research.[38] It would not be accurate therefore to conclude that no transfer pricing takes place in the operations of these subsidiaries, but at the same time there is little evidence that it occurs in association with the transfer of technology from parent to subsidiary.

(e) Quality Control as a Factor Influencing the Generation and Acquisition of New Technology

The possibility of quality control leading to the generation and acquisition of new technology has been neglected in the literature on technical change. There is however clear evidence from this investigation that there is a relatively strong link between quality control and the product, production and materials technology used by the subsidiaries. While only four of the subsidiaries spent money on Research and Development, all of the subsidiaries had some sort of quality control. Not only is it possible to point to specific instances where this link has occurred, but the orders of magnitudes involved are also of interest. In only two cases, tea machinery and engineering design did expenditure on Research and Development exceed that on quality control. These are the exceptions which are to be expected, as both these two subsidiaries had relatively large formalised Research and Development activities.

Table 12

Firms	A Tea and allied products	B Pharmec-euticals etc.	C Pharamec-euticals etc	D Cement	E Vehicle assembly	F Engineer-ing design	G Tea machinery
Expendi-ture on Research and Deve-lopment(a) (as % of value added)	£35,294 (0.92%)	-	(a) £1,177 (0.23%)	-	-	(b) £47,058 (25.0%)	£4,118 (5.52%)
Expend-iture on quality control (as % of value added)	No Separate cost	£5,294 (1.1%)	£25,000 (4.9%) (c)	(d)	£10,941 (22.8%	£9,412 (5.15%)	£2,354 (3.2%)

(a) For a discussion of what is meant by Research and Development, see Section IV.

(b) Estimate. This figure covers the cost of all the subsidiary's design activities, not all of which would necessarily lead to the generation of technical change.

(c) This figure is almost certainly an overestimate by the subsidiary.

(d) No estimate available, but large quality control section exists.

Footnotes

1. See Accumulation and the Transfer of Technology; Issues of conflict and Mechanisms for the Exercise of Control, R. Kaplinsky, World Development, forthcoming.

2. The Sussex Manifesto,

3. OECD, The Level and Structure of R & D Efforts in OECD Member Countries.

4. The seven firms were chosen with the idea that a matching study will be undertaken of the Indian subsidiaries of the same firms (where these exist). It was intended that other British multinationals be included in the sample, but some difficulty was experienced in getting them cooperation. The results of this comparative research will be made available through the OECD Development Centre.

5. Ideally more firms should have been included in the sample, but this has not been possible for a variety of reasons. This means that there is a greater element of speculation in the research findings than is desireable. The alternative however would have been to have left the subject 'unexplored'. On balance the absence of research on Research and Development activities of subsidiaries in underdeveloped countries, particularly in the African context, has been a decisive factor in the implementation of this research project.

6. See for example, W.E.G. Salter, Productivity and Technical Change, 2nd Edition, Cambridge University Press, 1969.

7. Cited in Technological Dualism in Late Industrialisers: on Theory, History and Policy, D. Felix, Washington University, mimeo, 1973.

8. In recent years these assumptions have come to be challenged. For a theoretical exposition of this see F. Stewart, Journal of Development Studies, October 1973. For a detailed empirical study on the relationship between product structure, consumption patterns and the activities of multinational corporations in Kenya, See S. Langdon. forthcoming

9. Employment and Productivity in Kenyan Manufacturing, H. Pack, Revised version of Institute of Development Studies, Discussion Paper 54, mimeo, 1972.

10. OECD,

11. Technology, Dynamic Comparative Advantages and Bargaining Power, J.M. Katz, Paper presented at Symposium on Foreign Investment and External Finance in Latin America, Cambridge, June 1974.

12. Research undertaken at the Science Policy Research Unit at the University of Sussex in particular has focussed on this question of the 'unpackaging' of technology.

13. Engineering design is not always considered as a capital goods industry. In this research a 'capital goods' industry is interpreted in the broad sense as an industry which manufactures equipment which is used by other industries to manufacture final or intermediate products.

14. All £ are sterling. This conversion has been made to facilitate comparison with the subsidiaries of the same firms in India and the operations of the parents in Britain. The exchange rate used is 17/- = £1 which was the going rate at the time the research was undertaken. The pound has been devalued recently and the going rate at the time of writing is about 15/-

15. It would be more accurate to refer to this firm as an 'associate' rather than a subsidiary. But for the purposes of our enquiry into the acquisition and generation of technology, it stands in much the same relationship to the 'parent' as some of the other subsidiaries in the sample.

16. The relationship between these two subsidiaries is as folows. The British parent and a Swiss multinational each hold 14% of the equity of the subsidiary in our sample, and the British parent holds the Technical Contract for this subsidiary. The British and Swiss parents each hold 40% of the equity of the other cement firm in Kenya, and in this case the Technical agreement as held by the Swiss parent. It is not clear what affect these interlocking link have on subsidiary operations although the subsidiary in this sample produces only for the Kenyan market (and has announced no plans for expansion) while the competitor produces predominantly for the export market and is in the process of expanding capacity to 1.25 million tons per annum, 1 million of which will be for export.

17. The buses and trucks are assembled on a one-off basis and are tailor-made to suit the requirements of particular customers. By contrast the smaller four-wheel drive vehicles are produced on a small assembly-line. However, there is no substantive difference in technology here as the adaptations required for particular customers of heavy vehicles concern the length of the chassis and the size of the engines which are to be installed - these changes do not require complex knowhow or sophisticated production technology.

18. For a discussion of the importance of equity as a control mechanism by parents over subsidiaries, see Kaplinsky, World Development, forthcoming.

19. In the USA selling and promotional expenses in the pharmeceutical industry range from three to four times the amount spent on R & D and account for about one third of the value of sales. See S Lall, The International Pharmeceutical Industry and Less Developed Countries, Oxford Bulletin of Economics and Statistics, Vol 36 No. 5, August 1974.

20. Recently the parent of Firm B decided to supply the Malaysian baby food market from Kenya, rather than from Britain. The problem has been that the taste of Kenyan cereal products is slightly different from that of British cereals, and in spite of attempts to change the formulation of the baby foods, the result has been the erosion of the firm's market position in Malaysia.

21. When the Group originally tried to develop instant tea technology, a different process was explored which required a change in tea input from the Kenyan subsidiary. This induced changes in production and materials technology in Kenya, and were this instant tea technology to have been successful, it could have been said that changes in production technology led to changes in both production and materials technology.

22. M. Todaro and H Pack, 'Technological Transfer, Labour Absorption and Economic Development,' Oxford Economic Papers, Vol. 21, No. 3, November 1969.

23. OECD,

24. For a review on the literature concerning Research and Development and size of firm See 'Market Structure and Innovation: A Survey, M I Kamien and N. L. Schwartz, Journal of Economic Literature, Vol. XIII, No. 1, March 1975.

25. This point shall be considered at a later stage in the discussion on the Circulation of Technology through the Firm. See also R. Kaplinsky, World Development, forthcoming.

26. In this discussion we are concerned with the autonomy of a subsidiary to specify itself the technology which it requires. This is not the same thing as the rights to purchase this technology independently. Control over capital expenditure is the main control mechanism exercised by parents over subsidiaries (See R. Kaplinsky op.cit) and in the case of most of them subsidiaries in this sample, the parent laid down clear rules on the maximum capital expenditure (which was usually in the region of £1,000 to £2,000), which could be undertaken independently from the parents' agreement.

27. The relative autonomy of both of these pharmeceutical subsidiaries is rather surprising when comparison is made with the same industries in other underdeveloped countries. Vaitsos, for example (Intercountry Income Distribution and Transnationall enterprises, Oxford University Press, 1974) found that the overpricing of intermediate inputs purchased from the parent was an important avenue for transfer pricing for a combination of two factors. Firstly in Colombia many of the pharmeceutical firms in question were locally-owned, while in Kenya both subsidiaries are wholly-owned by the parents - Since there are no barriers in the remission of profits, there may be little need for such forms of transfer pricing. Secondly, neither of these firms, (particularly B) were large scale producers of these inputs. In most cases the inputs such as aspirin powder are easily available in a competitive world market. This would suggest that subsidiary B is more likely to purchase inputs from the parent than C . Unfortunately no information was provided from B with regard to the amount of inputs purchased from the parent or the make-up of these inputs. In the case of C we do know that where the parent does 'monopolise' the manufacture of a specific input - perfume-the subsidiary is forced to acquire these from its parents.

28. The limitations of Taste Transfer Industrialisation, See S. Langdon, mimeo, 1975.

29. This argument has an element of circularity in that one of the definitional characteristics of 'parent firm integration' is the absence of linkages in Kenya.

30. For two exceptions, see Katz, op. cit. and 'A Comparison of Foreign and Domestic Firms in Monterrey : Performance and Source of Technology, L. Fairchild, mimeo, undated.

31. For a corroboration of this point see 'Multinational Comparatio and the Indigenisation of the Kenyan Economy : J. J. Jorgenson, in Multinational Corporations in Africa, C. Widstrand (ed), Scandinevian Institute of African Studies, Uppsala, 1975. Jorgenson estimates that in 1967, "Predominantly or totally foreign aimed firms ... contributed 71.4% of total value- added in the manufacturing sector " p.21.