Cormican, K. and O Connor, M. (2007) Technology transfer model. Proceedings of the 8th European Conference for Knowledge Management, 6th -7th September, Barcelona, Spain.

Technology Transfer in the Medical Device Industry (ECKM)
Methodology for Technology Transfer
Technology Transfer Model for Product Life Cycle Extension

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The current economic environment is characterised by a phenomenal rate of technical advances coupled with intense global competition. New products and technologies are being developed at increasingly rapid rates. In some cases, market leaders are losing their dominant positions to competitors and new, sometimes unknown, market entrants. Products become obsolete more quickly than ever before. Product life cycles are becoming shorter, a phenomenon observed by authors such as Browne, et al (1996) and Lawton Smith (2000). This puts pressure on companies to innovate and bring new products to market faster, cheaper, smarter and better than their competitors.

Organisations need to plan for the introduction of new products. Leaving new product introduction to chance is a recipe for ruin. Companies have a choice when starting to develop new products. They can develop products internally through research and development or they can purchase technology externally using mechanisms such as acquisition, joint venture or license agreements, transfer it to their organisation and combine it with existing technology to develop new products. Obtaining technology externally can reduce the uncertainty of the outcome of internal development. It can also reduce the time and cost of new product development. Transferring technology from such external sources to a company is termed technology transfer.

According to Burgleman and Maidique (1998) the ability to undertake technology transfer is a key capability for an organisation. It enables them to extend their product life cycles when older technologies mature. Technology transfer can enable 'technology followers' become 'technology leaders' (Forbes and Wield, 2000) making the company more competitive in the global marketplace and more capable of innovation.

However technology transfer is a complex activity and companies face many problems in this regard. Factors such as the nature of the technology, the stage that the technology is at in its life cycle, the absorptive capacity of the receiver, geographic distance and cultural differences between the parties receiving and transmitting the technology can affect the process. The availability of suppliers, customers and complimentary innovators are other factors that impact the technology transfer process. Organisations must understand how to transfer the technology to their facility so that they can operate it and supply it to the market or combine it with existing technologies for use in future innovations. In order to do this they must attempt to identify and capture critical knowledge and information from workers in the transferring site, move it to the receiving site and embed it there so that it is not forgotten or lost.

Published literature does not currently outline mechanisms for planning, managing and executing such a technology transfer. In particular there are no guidelines that deal with the logistical and operational issues that are encountered during this process. This paper seeks to address this deficit. It presents a model for technology transfer based on best

practice and designed to overcome some of the problems outlined above. It incorporates a set of tools for managers and decision makers to use to organise successful transfer of technology from one location to another. The model outlines how to plan, schedule and execute a technology transfer to ensure that:

- The roles of individuals involved are clearly defined
- The time frame for the transfer is determined
- The cost of the transfer is established
- Comprehensive training is undertaken
- Validation of process and product is completed
- All aspects of information are transferred i.e. codified and tacit
- Supply to market is maintained
- Equipment is transferred in a controlled and planned manner.

The model is considered suitable for multi-national companies such as medical device and pharmaceutical manufacturers to plan international technology transfers. These companies grow by acquisition, have overseas subsidiaries and are bound to adhere to Food and Drug Administration (FDA) regulations. The model can also be used by other industry sectors. It can be used to extend product life cycle through the transfer of manufacturing operations to low cost economies and in selling technology to developing countries.

Product Innovation

Research suggests that new products seldom begin from scratch but rather each new development is built from an existing product or platform (Ettlie, 2000; Song and Montoya Weiss, 1998; Wheelwright and Clark, 1992). Many organisations such as healthcare multinationals use commercial arrangements such as licensing, acquisition or joint venture to obtain new technologies which they transfer to and integrate with their existing technologies to generate new products. These companies need to bring new products to market under severe time constraints. Therefore technologies obtained externally need to be transferred to the receiving company in a timely and cost effective manner if they are to be used in launching new products. Technology acquired externally can become a corporate liability if the company fails to transfer it and use it in new products and gain reward from having purchased it in the first place. Like technology developed internally there is a window within which it must be used, otherwise it is of no benefit to the company.

- Problems/urgency
- Requirements
- Goal

A key problem to be overcome in the transfer of an established product is ensuring continuity of supply during the transfer period. Companies cannot risk allowing customers move to competitors' products during this period. As the technology is being

obtained to generate new products it will have to be transferred within a pre-defined time period to ensure product launch dates are not compromised. The roles of individuals involved in the transfer have to be clearly defined to avoid duplication or failure to transfer any part of the process. Companies involved in technology transfer need to plan for training of their staff. Staff at the transmitting plant must be retained in their positions in order to carry out this training.

In addition to overcoming time, cost and training constraints which apply to any industry, medical device manufacturers need to plan for validation work to be undertaken in order to satisfy Food and Drug Administration (FDA) regulations which require companies manufacturing medical devices to demonstrate that product produced after a change of manufacturing site complies with their regulations. Companies undertaking transfers of technologies need to address time, cost, training and validation requirements.

Therefore in light of this The product and process must be transferred in a timely and cost effective manner without any changes.

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- The roles of individuals involved are clearly defined
- Comprehensive training is undertaken
- Validation of process and product is completed
- All aspects of information are transferred i.e. codified and tacit
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- Equipment is transferred in a controlled and planned manner.

Requirement/need

Published literature is general in nature and does not specifically address operational issues relating to technology transfer from one organization to another or from one country to another.

Technology Transfer

Product Innovation

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Research suggests that new products seldom begin from scratch but rather each new development is built from an existing product or platform (Ettlie, 2000; Song and Montoya Weiss, 1998; Wheelwright and Clark, 1992). Companies have the choice to 'make or buy' new products to replace products going into decline (Lawton Smith, 2000, Afuah, 1998, Muir, 1997, Martin, 1994). In other words, they can develop new products internally through research and development or acquire them externally under commercial arrangement such as venture capital licensing, acquisition or joint venture (see Figure 1).

Figure 1 Sources of New Products (Afuah, 1998)

Lawton-Smith, (2000) describes the move by companies to use external sources of innovation as the 'externalization of innovation'. New product development is complex and expensive process and that no firm can develop all the technologies it wishes to acquire and remain competitive. The reasons why a company may decide to acquire a technology externally include (Lawton-Smith, 2000; Lowe, 1995)

- Rapid changes in technology
- High costs of research and development
- Risk of research and development failure
- Lack of qualified/experienced technical people

Moreover the acquisition of designs, specifications, process know-how and sample products simplifies the product launch and allows a quicker market entry. Consequently, technology transfer has become part of many organisations' business strategy.

Research & Development Contracts	Licensing	Joint Venture	Venture Capital	Acquisition	Internal Development Entrepreneurship

Research approach

An action research methodology was employed in this study as it has been found to be particularly useful when examining innovation, change, growth and transformation of organisations (Wilson-Evered and Hartel, 2001).

Here the organisation in question is a community that has identified a problem i.e. the need to transfer technology from one organisation to another. In order to resolve the problem the stakeholders must be involved in designing the solution. This involves aspects of action research (Greenwood and Levin 1998) where the affected community is involved in resolving their problem, which they have identified.

It has been suggested that in-depth inductive innovation studies should be conducted to safeguard against the premature adoption of a rigid framework which may limit the scope of inquiry (Dyer and Page, 1988; Van de Ven, Argle & Poole, 1989). Within the action research framework, qualitative research techniques (including in-depth interviews and case-based interventions) were adopted to uncover the richness of data likely to be embedded in both the explicit and tacit knowledge of key industry stakeholders and participants. Qualitative analysis helps researchers to understand and explain why people have different experiences.

The mixed methods approach is one in which the researcher bases knowledge claims on pragmatic groups (Creswell 2003, Hair et al 2003). In this case, a problem is identified for which there may be a range of possible solutions and the most advantageous must be determined. …… In this case, a problem is identified for which there may be a range of possible solutions and the most advantageous must be determined. The mixed methods approach adopts strategies of enquiry that involve the collection of data in order to understand the situation that exists. Here data collection involves capturing numeric as well as textual information. In other words, both quantitative and qualitative methods are employed.

Definition of Technology Transfer

The term technology transfer is used in several different ways in the literature. It can be defined as 'the process of bringing new products to commercialization' (Muir, 1997; Dakin and Lindsey, 1991). Jones et al (1997) define technology transfer as the acquisition, absorption and dissemination of technology.
Gee (1981) defines technology transfer as 'the application of technology to a new use or user for economic or productivity gains'.

Gruber and Marquis (1969) define technology transfer as 'a process by which expertise or knowledge related to some aspect of technology is passed from one user to another for the purpose of economic gain'.

Afuah (1998) speaks of 'innovation transfer' and outlines three types of transfer. These include (a) transfer within an organization from research to commercialization, (b) transfer from another company, and (c) transfer between countries. Similarly, Lowe (1995) classifies technology transfer into three categories. These are (a) transfer from research establishments and universities to industrial companies, (b) transfer between firms in advanced industrial countries and (c) transfer from an advanced country to a developing country. Howells (1998) notes that technology can be transferred in terms of; (a) tangible assets such as new products, plants and equipment, (b) intangible forms through formal mechanisms such as patents and licenses, and (c) informally through knowledge and information flows. Bonomo et al (1998) propose that technology can be transferred through four broadly defined market mechanisms. These are (a) sales of products that embody the technology, (b) contractual arrangements, including licensing, cooperation and sharing among firms as part of strategic alliances, and (c) acquisition. Kim (1997) classifies Technology Transfers as being (a) market and (b) non-market meditated. These definitions relate to the presence or absence of formal arrangements in the transfer of technology. For example, organisations in developing countries have may to acquire foreign technology without transaction costs if they have the absorptive capacity e.g. When technology is simple and mature and patents have already expired, these firms can reverse engineer foreign products.

Factors affecting Transfer Effectiveness

Afuah (1998) notes that the effectiveness of technology transfers depends on five factors:

- The nature of the innovation i.e. level of technological complexity
- The timing of the transfer, i.e. stage in the product life cycle
- The difference in the cultures of the receiving and transmitting entities i.e. organisational and cultural differences
- The absorptive and transmission capacities of the receiving and transmitting organisations i.e. capabilities of the transmitters and receivers
- The differences between the extended value chain players across national boundaries i.e. difference between customers, suppliers and other collaborators

Howells (1998) notes that in the traditional top down transfer of products or processes within a multinational company that the parent company reserved the most advanced lines for the home market. The focus of such transfers was in the form of embodied knowledge, plant and equipment or codified knowledge such as drawings, blue prints etc. These transfers are about moving the results of innovation rather than delivering mechanisms that would result in innovation. The barriers associated with such transfers

of existing technologies should not be underestimated. They may not be new to the firm but they are new to the overseas operation. Even embodied or codified technologies which are relatively mature involve the development of new organizational and technical skills that allow the assimilation and adapting of imported technologies.

1. Preparation (Cross functional transfer team)

A cross-functional team is formed to undertake the technology transfer. The team comprises a project manager, manufacturing and quality engineer(s), production supervisor, process technicians and operators as well as representatives from training and information technology. The team visit the plant from which the technology is to be transferred. Ideally this group travels together so that they all view the same activities simultaneously.

The team view the physical size of the operation, the number and type of machines involved and the number of people in the operation and get an initial impression of the complexity of the task to be undertaken. They can at this stage develop a comparison between the operation being transferred and their existing manufacturing operations. The team should review information such as yield analysis and failure data in order to establish what type of problems occur during the operation and how they are resolved. Production information such as cost and lead times should also be evaluated at this stage.

The transfer of electronic information must also be considered and evaluated at the earliest possible stage in the technology transfer. Companies will have their operating procedures, routings and bills of materials, yield data, fault analysis data and labelling programmes stored electronically. Ideally for the receiving plant this information should be compatible with their existing databases as this guarantees no issues with supplying of the product.

The initial visit to the facility from which the operation will be transferred transfer will involve hands-on, person-to-person contact in order for the transfer team to understand the process, its intricacies and complexities and also for them to compare and contrast it with their existing operations. After this initial visit, the following activities should be undertaken:

- **A process flow chart** should be generated listing all manufacturing operations and quality inspections which make up the manufacturing operation. The number, models/types of machines and pieces of test equipment should be established and documented. This will assist in determining the sequence in which the transfer of equipment will be undertaken and if there are similarities with existing equipment.

- **A layout drawing** for the equipment in its new plant should be generated. It should include all equipment which is being transferred from the transmitting plant and equipment which is being purchased externally. The drawing should be posted in the manufacturing area and can be used to monitor progress of the transfer.

The transfer team must meet on a regular, pre-determined basis to plan the transfer. They should arrange to speak to their counterparts in the transmitting plant at regular intervals via conference calls. There should be clear and frequent written communication between the parties using e-mail. On return from the initial visit, a process flow chart and proposed plant layout drawing are generated. The team should then direct its efforts towards the generation of the three plans which place key roles in transfer.

2. Generate Training Plan

A training plan must be generated to include details of training to be undertaken by operators, inspectors, technicians and engineers. Training is undertaken at the transmitting company in advance of transferring equipment. It is preferable to use lead operators at the transmitting company to carry out this training. The plan must also allow training to be undertaken by the same personnel overseen by the same lead operators from the transmitting plant after the equipment has been transferred. The expected start and finish dates of training on each piece of equipment in both plants must be determined, coupled with the cost of air fares, accommodation and living expenses. Also, if production operators are to be out of the plant or out of the country training, provision must be made for cover for the activities which they generally carry out. The training plan must also identify if new people need to be hired to operate new equipment post transfer.

3. Generate Validation Plan

The objective of a transfer of technology is to be able to make a product after the transfer in the same way that it was manufactured in advance of the transfer. Companies must be able to demonstrate to themselves and their customers that there is no impact on product quality or performance arising from a technology transfer. For that reason one of the first steps undertaken in advance of transfer of a line from one location to another is to establish what process validations have to be undertaken to ensure process output is repeatable, how long this will take and what resources are required in order to undertake this work. This will impact the time required for the transfer to be completed. Validation activities specific to the manufacture of medical devices are as follows:

1. Installation qualification/ software validation: an initial assessment of the equipment used and the services and software required to operate that equipment.

2. Operational qualification: a demonstration that the process will produce acceptable product at the limits (worst case scenario) of the process parameters.

3. Process qualification: confirmation of long-term process stability,

4. Product qualification: confirmation that the product produced on the installed equipment as per established process procedures meets product performance specifications.

4. Generate Transfer Project Plan

The duration of the technology transfer will impact its cost, the amount of inventory which must be built up in order to cover the transfer period, and the amount of time people are working on the transfer. It is therefore important to predict in advance how long the transfer will take. This can be established by determining the time it will take to transfer each piece of equipment and what down time will be encountered.

The time required to train operators, transfer and modify equipment and validate it in its new location are the main elements of the time required to transfer each item of equipment in the transfer. Training activities do not necessarily contribute to down time in the transfer process. Training can be undertaken at the transmitting plant pre-transfer before any equipment is taken out of operation. This period of training can be used as part of the inventory generation in advance of the transfer. Therefore it is important that personnel at the transmitting company are retained until completion of the transfer. Continuity of supply can also be ensured by having product part made at the transmitter's site and finished at the receptor's site. During the transfer neither site will contain a full complement of machines or equipment so it is important to organise the transfer of machines in such a way that continuity of supply is ensured.

Determine sequence of transfer

In the case of a non-regulated industry such as textiles or cutting tool manufacture the most logical manner in which to schedule the transfer of machinery from the transmitter to the receptor is to move equipment from the end of the process first and work back to the start of the process. This ensures that product manufactured during the transfer period can begin to be processed at the transmitter and can be finished at the receptor without any need for any additional movement between the two centres. This concept is shown in Table 1.

Stage	***Transmitter***	***Receptor***
1	*Product produced at Transmitter Process 1, Process2, Process3*	*Product not produced at Receptor*
2	*Start of Transfer: Process 1, Process2*	*Process 3 transferred to Receptor Process3*
3	*Process 1*	*Process 2 transferred to Receptor Process2, Process3*
4	*End of Transfer Product not Produced at Transmitter*	*Product Produced at Receptor. Process 1, Process2, Process3*

Table 1 Sequence of Transfer for Non Regulated Industry

In the case of an industry regulated by for example the FDA the transfer cannot be undertaken in such a manner. Product cannot be part manufactured at one site and finished at another without validations being undertaken and approval being granted by

the regulatory body e.g. FDA. Each site which is involved in the manufacture of a product applies for a license of its own to manufacture the product. Therefore if the manufacture of a product is being transferred from one location to another (from transmitter to receptor) it is generally the case that sufficient inventory is built at the transmitter to ensure continuity of supply during the transfer. This differs significantly from the example of a non-regulated company outlined above.

In the transfer of a product such as a Medical Device there is no advantage in transferring the process in the sequence outlined above. In order to ensure that product is not part manufactured at both sites it is best practice to move equipment from the start of the process and progress sequentially through the process to the last operation as outlined diagrammatically in Table 2.

Stage	***Transmitter***	***Receptor***
1	*Product produced at Transmitter* *Process 1, Process2, Process3*	*Product not produced at Receptor*
2	*Start of Transfer:* *Process 2, Process 3*	*Process 1 transferred to Receptor* *Process 1*
3	*Process 3*	*Process 2 transferred to Receptor* *Process 1, Process 2*
4	*End of Transfer* *Product not Produced at Transmitter*	*Product Produced at Receptor.* *Process 1, Process2, Process3*

Table 02 Sequence of Transfer for Regulated Industry

The next step is to generate a budget for the transfer outlining what expenses will be incurred and when they will be incurred. Expenses likely to accrue during the transfer include:

1. Purchase of machinery, equipment, jigs and fixtures
2. Freight charges for movement of equipment
3. Air fares, hotels and living expenses for training and installation at both sites and any additional travel required by the Transfer Team
4. Labour costs of all Transfer Team members (full-time and part-time)
5. Costs of modifying machines as required
6. Cost of validation product builds
7. Contingencies

The project plans for a technology transfer must include a full list of all activities involved in the transfer of all equipment and information from the transmitting plant to the receiving plant and for the commissioning of equipment purchased from machine manufacturers. The plan will have two key elements:

1. Transfer of information
2. Transfer of equipment

5. Transfer Information and Equipment

Information can be transferred orally, in writing, or in a graphic. Moreover, the transfer of written and graphic material can take place in hardcopy or softcopy formats, using many different media and technologies. Transfer of information can be undertaken in one block of activity as it is not dependent on the sequence in which equipment is transferred. Care must be taken to ensure tacit information, i.e. information relating to the process which is not easily documented and which is generally held by trained operators with years of experience, is related to personnel from the receptor during the transfer. This transfer of information can be undertaken effectively during the training period when personnel relocate temporarily.

A company which strategically decides to grow by acquisition must have in place a Product Data Management Database in which the following items are located:

1. Operating Procedures
2. Bills of Materials
3. Product Routings
4. Manufacturing Lead Times
5. Product Specifications
6. Change Requests

An audit of documented procedures is advisable to ensure that all information required to start, set-up, operate and shut down each piece of equipment is documented. Any omissions must be documented in advance of deciding to transfer the piece of equipment.

Transfer Equipment

Before a machine can be used in the receptor's plant the following sequence of events must be undertaken. The following list of activities applies in the situation where transfer is being undertaken across national borders:

1. A machine operator must be identified to train on the machine pre-shipment
2. The operator must spend appropriate time in transmitter's plant for training
3. Inventory must be built as required,
4. A crate must be ordered for the machine to be shipped in
5. Supplies of electricity, compressed air, gas and water must be disconnected as appropriate
6. The machine must be sent to the warehouse or shipment depot for shipment
7. The Shipping Department organise purchase order for shipment
8. Customs clearance must be organised in order to avoid un-necessary delays at port of entry which could compromise project time lines and product supply
9. The machine must be collected at port of entry and transported to receiving plant
10. Rewiring of equipment may be undertaken if required. Occurs if operating voltage is different in new location relative to country of origin
11. Machine safety features may need to be modified in order to adhere to local health and safety regulations
12. The machine must be placed in pre-designated location as per plant layout drawing

13. Training is completed if required
14. Validation must be undertaken

This sequence of events is repeated for all pieces of equipment in the manufacturing process. When all equipment has been transferred and all validations have been undertaken it is advisable for the transfer team to review their three plans, i.e. training , validation and transfer project plan to ensure that all activities have been undertaken as planned. At this stage the equipment is available to be used by the receptor to supply product or to be incorporated into future innovations.

Discussion and lessons Learned/ guidelines to help overcome some problems identified

As mentioned earlier factors such as the nature of the technology, the stage that the technology is at in its life cycle, the absorptive capacity of the receiver, geographic distance and cultural differences between the parties receiving and transmitting the technology can affect the process.

The technology transfer model outlined in this paper addresses the generic problems associated with technology transfer outlined in this list, as follows:

Problems arising from *the nature of the technology* to be transferred can be overcome by the selection of appropriate personnel for the transfer team. If a technology is similar to the existing technologies of the receptor then it should be relatively easy to transfer. The amount of time that personnel from the receiving plant spend at the transmitting plant will also help overcome problems associated with the nature of the technology.

The *stage of the technology or product in the product life cycle* will determine how much information there is relating to its design, development and maturity. In general, the less mature the process, the less established information there will be, and vice versa. The less that is written down about the process the more personal intervention will be required to collect all relevant detail in a transfer situation. Such a technology transfer will invariably require more emphasis on training. Hence the emphasis on generation of a training plan in the technology transfer model outlined above.

The relocation of personnel from the receptor to the transmitter and vice versa is essential in ensuring that *information is absorbed and understood* by the receptor. This contact arises from the generation of the training plan and results in staff of all levels from the receptor spending time at the transmitting plant in advance of transfer taking place.

The personal contact which arises from plant visits and from staff from the receptor and transmitter spending time in their respective plants undertaking training or validations will help in *overcoming cultural differences* which are present. People get to know each other on a personal basis and build working relationships. They get to know how to deal with each other and how to communicate information effectively to each other.

Issues relating to *geographic distance* between the receptor and transmitter can to some extent be overcome by travel, temporary relocation and communications. Successful technology transfer model requires the holding of regular meetings and conference calls to include the transfer team and their counterparts in the transmitting company.

The operational difficulties encountered in planning a technology transfer listed in Section 6 above are overcome by the technology transfer model as follows:

- In order to ensure that the roles of individuals involved are clearly defined a cross functional transfer team is established from the outset. These teams incorporate representatives from all the relevant functions in the process and can ensure that problems can be anticipated in advance.

- Organisations need to know how long transfer will take as product launch date may be impacted. Therefore the model recommends that transfer lead times are calculated and that a transfer plan is developed to help guide and control critical activities.

- The model also recommends that costs associated with the transfer are identified and specified. To do this the transfer lead time (which ultimately will have an impact on the overall cost) is established and re-location costs for people and equipment are determined and validation expenses are considered.

- A training plan is produced which includes details of training to be undertaken, location of training and duration. This is done to ensure that that the technology can be operated when moved to the receiving plant.

- Validation plans are also produced which includes details of product builds, time required and validations to be undertaken.

- Training plans detailing the nature of training to be undertaken as well as the location and duration of these sessions together with personal contact at site visits ensures that both tacit and documented or codified information is shared among the transmitters and receivers. Furthermore comparative analysis of procedures and practices are also encouraged.

- Establishing transfer lead time enables required inventory cover to be calculated. Furthermore, determining the appropriate sequence of transfer ensures that everything is done to ensure that supply to market is maintained.

- Finally the technology plan listing timelines for transfer of information and equipment ensured that all equipment is transferred in a timely and co-ordinated way.

Effects of Technology Transfer

Apart from its use in the innovation process, the technology transfer model can be used by organisations to extend the product life cycle of its products. Companies can improve the cost performance ratio of their product and consequently generate additional demand for products by transferring their manufacturing operations to low-cost economies (Zangwill (1993), Rosenthal (1992), and Sheth and Ram (1987)).DeGarmo, Black and Kohser (1999)

Companies can also use the technology transfer model to sell technology to less developed countries in order to generate substantial cash rewards. Dussauge, Hart and Ramanantsoa (1994) term this activity as '*external exploitation*' of technology. It is a strategy which can be used by companies which have exploited a technology internally through design, development and manufacture of products itself and when these products come to the decline stage of their product life cycle the company can sell the technology to developing companies and countries in developing regions. The emphasis in such organisations changes from manufacturing activities to research and development of new products and technologies to sustain industrial activity into the future.

Griffiths and Wall (1989) outlines the evolution of multi-national companies which sees manufacturing operations move from the innovating country to less developed countries. The result is that the innovating country becomes in time an importer rather than and exporter of the product which was innovated there. This is shown diagrammatically in Figure 6.

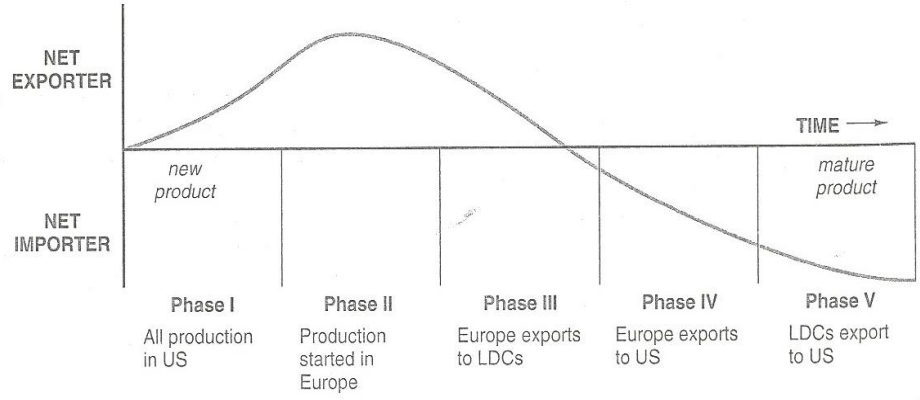

Figure 6. Evolution of a Multi-National Company
Source: Griffiths and Wall (1989)

Many researchers contend that technological advance in catching-up countries stems largely from the acquisition, assimilation and improvement of foreign technology (Forbes and Wield 2002; Kim, 1997). The effect of technology transfers to low cost economies is increased economic activity in those regions. Therefore technology transfer is crucial to the economic development of these countries. Companies and countries can use imported technology to generate economic activity and commence their progression up the technological ladder as outlined by Bell (1999) and Mac Laughlin (1999).

Conclusions

In the current economic environment it is imperative for companies to plan the development and introduction of new products. Increasingly rapid rates of technical innovation coupled with intense global competition means that in order to survive companies must have a continuous supply of new products and technologies to bring to market. One option for a company seeking new technology is to acquire it externally and transfer it to their organisation.

In order to benefit from the time and money spent in obtaining technologies externally, companies need to be able to transfer them and all associated knowledge to their own operation. This paper outlines a model to guide such a technology transfer. The model aims to assist companies to plan, manage and execute produce transfers successfully. The model was first implemented within the medical device industry, but use of the model is not restricted to the manufacture of healthcare or medical devices. Likewise the model is not for use only within the innovation process. It can be used by companies to transfer manufacturing operations to low cost economies, thereby reducing manufacturing costs and stimulating demand.

The technology transfer model can also be used to transfer the technology after sale to developing companies or countries. Therefore, technology transfer can be used in both the innovation process and extending product life cycle. It is clear that the ability to undertake such a transfer is an important capability for a company to possess.