

Technology transfer

The commercialization process involves getting technology to where it can be used most profitably, and this often involves the transfer of technology. Technology transfer can be defined as the movement of technological capability—typically a package of artefacts, information, rights, and services—from supplier(s) to potential user(s). It is therefore a broader concept than the sale of IPR. These transfers can occur internally between two organizations under the same financial control, quasi-internally between joint venture and alliance partners, and externally between independent buyers and sellers. Here we focus on a simple means by which firms and research organizations can analyze and manage the transfer of their technology and some methods by which firms can import technology from international sources.

JOLLY'S COMMERCIALIZATION MAP

A large number of tools and techniques are used to assist firms and research organizations in analyzing and managing the process of technology transfer for commercialization.

Jolly's (1997) 'Commercialization Map' illustrates some important general principles, suggesting that there are five key stages in the commercialization of technologies—imagining, incubating, demonstrating, promoting, and sustaining. Each of these has a definable transfer gap—in interest, technology transfer, market, and diffusion—through which the technology must pass if it is to be commercialized. The stages involve finding solutions to a variety of technological, production, or marketing problems, and the 'bridges' between the stages involve the mobilization of resources to deal with them:

Imagining. Conceiving of the technology and linking it to a market need. A vision is created (with colleagues and partners), a concept is proved, and patent protection is sought. If there is sufficient interest in the idea, in developing it, funding it, and buying it, the technology progresses through the interest gap.

Incubating. The idea is fully demonstrated, technically, and in a business sense, often with customer involvement. If the research originated in a public-sector institute, this stage usually represents the end of its involvement. If the process is complete, it moves to a product development process and it has progressed through the technology transfer gap.

Demonstrating. The first commercial quantities are produced, and suppliers and customers involved in the development are integrated into supply lines and marketing channels. Once this occurs the product has moved through the market transfer gap.

Promoting. This entails careful market positioning and targeting to ensure that the product quickly gains a profitable share of the market. If this is done successfully, the product has moved through the diffusion gap.

Sustaining. Here the aim is to entrench the product as broadly as possible in the market so as to ensure continuing long-term income streams.

This approach reveals several important principles:

- Commercialization can fail at any one of the stages or gaps in the process. The process throughout is highly uncertain and risky.
- The commercialization process is continuing. It does not end when the product reaches the market. The product itself may be subsequently improved, and the market may change. Long-term income streams depend not only on careful market entry strategies, but also on continuing market development activities.

The commercialization of technology requires high levels of organizational integration, in which human factors, such as teamwork, are critically important. Integration with external organizations is also important. Early feedback from customers and opinion-formers, sound links with suppliers and, if it is not self-funded, the procurement of suitable sources of external funds, are all required.

ACCESSING INTERNATIONAL TECHNOLOGY

Apart from actual purchase or through FDI, firms can access international technology in a number of ways:

- Reverse engineering is a very common method of technology transfer, and was instrumental in the development of Japanese industry. It involves disassembling goods, learning about how they work and are made, and developing improved versions sold under the firm's own name.
- Pirating, where replicas are sold as originals, requires analytical and manufacturing competencies to be developed.
- Original equipment manufacture(OEM), which is very common in electronics and consumer goods. OEM involves a local firm producing a finished product to the specification of a foreign buyer (commonly a large Japanese or US consumer electronics firm). The foreign firm then markets the product under its own name. OEM sometimes involves the foreign firm in the selection of capital equipment and managerial and technical training, and can involve close, long-term technological relationships. It provides a valuable learning experience in design and manufacturing and has been instrumental in assisting the technological development of Korea, Taiwan, and Singapore. There are some disadvantages to OEM inasmuch as the junior partner is subordinate and dependent upon the technology, components, and market channels of the large multinational firm (which often imposes strict conditions). Furthermore, the local firm is denied access to large post-production value-added, and cannot develop brand image and international marketing expertise.
- Turnkey plants involve the transfer of usually complex production facilities, whereby the foreign firm takes responsibility for project management, the selection of overseas and domestic suppliers, and training of plant managers and technicians.

Personnel transfer is a key aspect of technology transfer, domestically or internationally. In the USA, high job mobility moves knowledge from firm to firm. In Japan, job rotation transfers knowledge within firms. This also occurs when employees are seconded from firms to collaborative research institutions. In Korea and Taiwan large numbers of professionals returning from the USA bring important knowledge with them. Many Asian scientists and engineers have returned from the USA because of the 'glass ceiling' that can prevent movement from R & D into management positions, and this has considerably assisted the development of technology in these countries. The Indian software industry has also greatly benefited from this type of mobility of its highly qualified nationals.

Summary and conclusions

The commercialization process is an essential element of MTI and the delivery of value. It is important to distinguish between social and private value from innovation, and achieving the balance between these is a continuing challenge for governments trying to maximize public good and maintain private incentives to innovate. Firms operate in different appropriability regimes, the nature of which—whether they are loose or tight—strongly influences the ways managers commercialize. Mobilizing or accessing complementary assets is key to the delivery of returns to innovation. When complementary assets are not owned in-house, there are significant challenges for firms needing to access them, especially if there is a power imbalance between small start-ups and incumbents. These difficulties are compounded by the paradox of disclosure—the knowledge you wish to buy is at the same time the knowledge needed to enable you to decide whether to buy.

Firms commercialize through the market for ideas and the market for products, each posing different tests for managers. IPRs are a means by which firms can appropriate value from their technological investments in the market for ideas. In the knowledge economy, where it is extensively traded, IPR provides the security underpinning firms' transactions. Licensing is a particular way of selling IPR, but there are difficulties in managing the sale of licences for both the licensor and licensee, particularly in respect of technology pricing. The examples of BTG and OEC show that these difficulties can be managed. Technical standards can also play an important role in the commercialization process.

Continuing input from the marketing function is critical to commercialization in the market for products and services. Marketing informs firms about the commercial potential for technological innovations, and helps direct those innovations towards meeting commercial objectives. Technology transfer in the commercialization process can be managed through the application of various analytical tools; one such was described which helps and disciplines what is often a complicated and vexatious issue for private and public-sector organizations.

Marketing technology products/downstream support

The primary means by which technology is commercialized is the production of products, components, and services, which are then sold in the marketplace. We have seen, however, that a high proportion of new products fail in the market. It is the marketing domain that has the task of reducing these high levels of failure. Marketing expertise would have made a significant difference to the biotechnology company. Whilst its technology was excellent, the company was

unaware of how best to use it, and it originally targeted the wrong market. Previous discussions have emphasized the importance of direct inputs from marketing into the broad range of firms' technological activities. The high levels of internal and external organizational integration required by MTI include close links between marketing, R&D, and operations and production, and their further integration through innovation strategy. Marketing plays an important role in the use of stage-gate systems and QFD, where it disciplines the innovation process towards considerations of market needs. We have also seen how, in the case of the Post-It notes, marketing can make some serious miscalculations, occasionally preventing firms from realizing opportunities. Poor integration of marketing and production input into the innovation process can lead to the sorts of difficulties DuPont experienced when it developed Kevlar. The original market for the product was to be tyre cord, a large market, but the company had not properly understood the costs of production, and the costs of alternatives. It took some time before the product was successfully used in other applications.

There are three major roles for marketing in the commercialization of technological investments through technology products and services. First, market definition, or posing the question: what should we make? The marketing function has an important role to play in defining what R&D to undertake, what new products and services to develop, and what sorts of operations are required. Littler (1994: 295) argues that: [Marketing's functional] role is seen to be concerned with commissioning and/or undertaking market research and analysis, and with having an active part in the development of all aspects of the offering that include pricing, advertising, promotion, service support, distribution, packaging, sales, and design. Its prime purpose should be to ensure that the offering which emerges from the development process has significant appeal to the customer segments which it has identified as having the optimum potential for the business, whilst at the same time having a perceived differentiation from its competitors with regard to those values which its customers regard as important. Customers, both industrial and individual consumers, can often be segmented into groups with specific requirements, and marketing can assist in articulating, defining, and measuring these requirements.

Second, and relatedly, marketing plays an important role in facilitating internal and external communications. According to Littler (1994: 294): The marketing function may also have a key part in gathering, analyzing, and disseminating throughout the organization intelligence on customer purchasing behaviour, satisfaction levels, attitudes towards the business and its competitors and such like, as well as contributing to the development of an overall corporate culture which not only acknowledges the central role of the existing and potential customers but also the manner in which the dynamics of the environment are continuously shaping demands, resulting in new customer priorities, with consequent implications for the development of new and existing products.

Littler argues that firms market not just a product, but rather a collection of values such as the ability to perform tasks, enhance appearance, and augment or reinforce perceived self-image. When it comes to technology products, where there is an increasing commodification of technical product features, it is the non-technical features, such as design, service quality, distribution, and technical support, which add the greatest value. He argues that there is a temptation for technology producing firms to concentrate too much on the features of the technology, and it is the role of marketing to ensure that new products satisfy the basic criterion

of presenting the customers with something that they regard as having some differentiating benefits, such as ease of use.

Third, there is a well-established field of marketing that concentrates on relationships between firms and their management (Hakansson 1982). We have seen that close customer–supplier relationships are important in the development of new products, inasmuch as longer-term, more intimate relationships engender the trust required to exchange sensitive and valuable information. The loss of a major relationship with a customer in such circumstances can be very difficult, so it is important in such cases for the marketing department to be involved in the conduct of the relationship. It is also important to ensure that firms do not become too attached to particular clients, and have the capacity to diversify their sources of information about customer needs (Hakansson and Snehota 1995).