

Technology Transfer

David J. Teece

Classification: learning and adaptation; multinational enterprise/international business; technology issues

Definition

Technology transfer is the act of conveying product- or process-related “industrial” knowledge (technical and organizational) from one organization to another, either between separate entities or within a single firm.

Abstract

Technology transfer is the act of conveying product- or process-related “industrial” knowledge from one organization or sub-unit to another. It requires a series of activities and leads to learning by the recipient organization. Transfer is often costly in terms of financial and other resources. The cost is likely to be higher when the knowledge involved is more tacit than codified, where the know-how is less (rather than well) understood by both the transferor and the transferee, and when the transfer occurs between firms rather than between units of a single firm. Between firms, transfer of proprietary know-how is complicated because monitoring is necessary to avoid leakage of technology beyond what is required by the agreements governing the transfer.

Keywords: absorptive capacity, business unit, codified knowledge, licensing, multinational enterprise, organizational learning, outsourcing, tacit knowledge, technological know-how

Teece, David. J. *The Palgrave Encyclopedia of Strategic Management*, 2014. Palgrave Macmillan reproduced with permission of Palgrave Macmillan'

Technology transfer is the act of conveying knowledge from one organization or sub-unit to another. The knowledge will relate to a product or process, but it can be anything from a precise formula for a molecule to an unwritten set of heuristics useful for keeping a complex process within required tolerances.

Technology transfer is itself generally a process rather than an event. Teece (1977a) identified four stages: 1) pre-engineering technological exchanges; 2) transfer of process design and associated process engineering for process innovation; product design and production engineering for product innovation; 3) use of R&D to adapt and troubleshoot the technology; 4) pre-startup training and process debugging costs. Szulanski (1996) similarly characterized it as a four-stage sequence: initiation, implementation, ramp-up, and integration.

An implicit precursor to technology transfer is the identification of valuable know-how. In large firms, the identification of exchange or transfer opportunities can be quite difficult (Teece, 2000).

Because the technology is ultimately absorbed and adapted into a new organizational context, the subject of technology transfer is increasingly studied as an aspect of the broader topic of organizational learning (Argote, 1999). A special case is international technology transfer, which is often studied in terms of its impact on a foreign subsidiary

Teece. David. J. *The Palgrave Encyclopedia of Strategic Management*, 2014. Palgrave Macmillan reproduced with permission of Palgrave Macmillan'

of a multinational enterprise (Teece 1977a) or on the recipient country's economic development (e.g., Reddy and Zhou, 1990).

Transfers entail costs that vary with the nature of the technology. The transfer will be least costly, in terms of both financial and other resources, when the technology is fully codified (e.g., a chemical formula) or fully embodied in machinery (Teece, 1977a, 1981b). Other factors that affect the cost of transfer are the number of times the technology has been applied in the past, and how well the technology is understood (Teece, 1977a). Put differently, there is a steep learning curve associated with technology transfer itself because each transfer is another observation of the factors that impact the performance of the technology, at least for process technology. Not surprisingly, the total cost has also been shown to increase with the desired speed of transfer, especially when the technology is relatively new (Teece, 1977b).

Many elements of a technology may start out tacit but are later codified. For example, a company may determine that there are sufficient benefits to warrant the time and expense of making tacit know-how explicit. Codification, however, can increase the risk of unintentional leakage to rivals because codified knowledge is easier to copy.

Nevertheless, codification may be economically worthwhile because of the greater ease of replication, the greater ease of scaling, and the reduced dependence on specific knowledgeable individuals, or improved communication with customers.

Teece. David. J. *The Palgrave Encyclopedia of Strategic Management*, 2014. Palgrave Macmillan reproduced with permission of Palgrave Macmillan'

Even well-documented technologies will usually involve some knowledge that is tacit, accessible only by observing or interviewing those who have actually used it. These tacit aspects of a technology can only be transferred to other organizations (whether internal or external to the firm) by sending knowledgeable people (a scarce, valuable resource) for direct instruction and demonstration (Teece, 1981a). Identifying the right people to convey the knowledge and oversee the transfer can itself be a demanding task (Teece, 2000: 39). Furthermore, the ability of employees to transfer knowledge may be limited by contextual or social factors that differentiate the sending and receiving organizations (Argote and Ingram, 2000). And when the transfer occurs between firms, any contract governing the loan or “secondment” of employees is likely to be incomplete, so maximum flexibility is needed (Teece, 1986: 30).

In general, the cost of technology transfer is less between business units within a firm than between separate firms (Teece, 1976). The enterprise form of organization is very efficient for the development, internal transfer, and orchestration of differentiated organizational and technological capabilities relative to an equivalent group of separate companies linked only by market-based contracts. When transferred across separate companies, proprietary technology would need to be assigned a price, restrictions on certain uses by the recipients would need to be specified, transfer efforts would need to be spelled out in as much detail as possible, and contract (license) performance would need to be carefully monitored.

Teece. David. J. *The Palgrave Encyclopedia of Strategic Management*, 2014. Palgrave Macmillan reproduced with permission of Palgrave Macmillan'

The complexity of such arrangements is one reason the multinational corporation remains a common channel for technology to be transferred across national borders (Teece, 1981a). A comparison by Bloom et al. (2012: 12) of the diffusion of best management practices across twenty countries found that multinational affiliates as a group were always better managed than domestic, non-multinational firms. They also found that information about even the existence of best practices wasn't known by managers in local firms (Bloom et al., 2013). The management practice gap was widest in countries where competitive forces were weakest, which suggests that multinationals are generally very successful at transferring their know-how regardless of local conditions.

There are other reasons for the persistence of multinational corporations even in an era when many of the frictions affecting cross-border alliances, such as communication and travel, have been significantly reduced. One such is that careful oversight of transfers between firms is required to ensure that no sensitive information is divulged beyond what is needed to complete the task at hand, yet the monitoring procedures must not unduly impede the desired transfer. Between units of a single firm, disclosure problems are greatly reduced.

However, even within a single firm, technology transfer is a complex undertaking. Szulanski (1996) found that the greatest barriers to the successful transfer of best practices between units of a firm are weak understanding about the practice itself, poor absorptive capacity of the recipient unit, and communication difficulties between units.

Teece, David. J. *The Palgrave Encyclopedia of Strategic Management*, 2014. Palgrave Macmillan reproduced with permission of Palgrave Macmillan'

The licensing or sale of technology is a type of interfirm technology transfer that involves still another difficulty. These transactions include the added problem of the paradox of markets for information: the buyer or licensor cannot fully evaluate the technology until after it has been transferred (Arrow, 1962: 615). As a result, some types of information cannot be easily traded. Quite simply, where nondisclosure agreements are difficult to enforce, the market for know-how may not function very well, and technology transfer between unaffected entities might simply fail to take place.

A well-studied example of such transfers is the effort by U.S. universities to license technologies developed by faculty to the private sector for further development. In this situation, there is a clearly demarcated gatekeeper, the university's technology transfer office (TTO), a role that would be played by a legal or similar department in a private firm. Siegel et al. (2003) found that the effectiveness of TTOs was impeded by various institutional problems, including weak incentives for inventors to participate in the licensing process, a poor understanding of technology by those in charge of negotiating with potential licensing partners, and cumbersome procedures that make it difficult to complete a licensing agreement. Each of these could also impede technology transfer by a private firm to licensees.

See also absorptive capacity; FDI and economic development; information and knowledge; licensing; multinational corporations; organizational learning; outsourcing;

Teece, David. J. *The Palgrave Encyclopedia of Strategic Management*, 2014. Palgrave Macmillan reproduced with permission of Palgrave Macmillan'

strategic business unit; tacit knowledge; technology

References

- Argote, L. 1999. *Organizational learning : creating, retaining, and transferring knowledge*. Boston: Kluwer Academic.
- Argote, L., & Ingram, P. 2000. Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes*, 82(1), 150–169.
- Arrow, K. J. 1962. Economic Welfare and the Allocation of Resources of Invention. In *The Rate and Direction of Inventive Activity: Economic and Social Factors*, ed. National Bureau of Economic Research. Princeton, NJ: Princeton University Press, 609–625.
- Bloom, N., Genakos, C., Sadun, R., & Van Reenen, J. 2012. Management practices across firms and countries. *Academy of Management Perspectives*, 20(1), 12–33.
- Bloom, N., Eifert, B., Mahajan, A., McKenzie, D., & Roberts, J.. 2013. Does management matter? evidence from India. *Quarterly Journal of Economics*, 128(1), 1–51.
- Reddy, N. M., and Zhao, L. 1990. International technology transfer: A review. *Research Policy*, 19(4), 285–307.
- Siegel, D. S., Waldman, D., and Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Research Policy*, 32(1), 27–48.
- Teece. David. J. *The Palgrave Encyclopedia of Strategic Management*, 2014. Palgrave Macmillan reproduced with permission of Palgrave Macmillan'

Szulanski, G. 1996. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17(Winter special issue), 27–43.

Teece, D. J. 1977a. Technology transfer by multinational firms: the resource cost of transferring technological know-how. *Economic Journal*, 87(346): 242–261.

Teece, D. J. 1977b. Time-cost tradeoffs-elasticity and determinants for international technology transfer projects. *Management Science*, 23(8): 830–837.

Teece, D. J. 1981a. The multinational enterprise: Market failure and market power considerations. *Sloan Management Review*, 22(3), 3–17.

Teece, D. J. 1981b. The market for know-how and the efficient international transfer of technology. *Annals of the Academy of Political and Social Science*, 458(1), 81–96.

Teece, D. J. 1986. Transaction cost economics and the multinational enterprise: an assessment. *Journal of Economic Behavior and Organization*, 7(1), 21–45.

Teece, D. J. 2000. Strategies for managing knowledge assets: the role of firm structure and industrial context. *Long range planning*, 33(1), 35–54.

Teece, D.J. The Palgrave Encyclopedia of Strategic Management, 2013 Palgrave Macmillan, reproduced with permission of Palgrave Macmillan

Teece, David. J. *The Palgrave Encyclopedia of Strategic Management*, 2014. Palgrave Macmillan reproduced with permission of Palgrave Macmillan'