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INTERNATIONAL MANUFACTURING STRATEGIES AND THE TRANSFER OF TECHNOLOGY

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Abstract

Technology is at the core of both products and processes, so to improve competitiveness and access markets it must be acquired, absorbed and developed. Moreover, as manufacturing has become more globalised, technology is also increasingly being transferred as part of collaborations between companies and has therefore effectively become a commodity in itself. It can be sold for a direct financial return or exchanged for a share in the local market, for example when being transferred through foreign direct investment from developed to the newly developing economies. This paper describes the concept of a "technology valuation and collaboration" model that has been developed using empirical data gathered from along the UK-China value chain for machine tool technology. It can be used to assist the negotiations and ongoing technology transfer arrangements of manufacturing companies that are supplying or acquiring technology.

Introduction

As manufacturing has become more globalised, technology is increasingly being transferred as part of collaborations and strategic alliances between companies (de Bruijn and Jia, 1997) and to access new markets this transfer in often through foreign direct investment into the newly developing economies (Lan, 1996). Transferring manufacturing through a collaborative arrangement potentially can generate greater benefit for both suppliers and acquirers but, at the same time, each party incurs costs and bears risks (Zhao et. al., 1998). Failed transfers are as common as successful ones, due to each side being inadequately equipped with information about the other side's motivations and expectations. This in turn has led to two principal causes of failure:

i) The 'value' of the technology not having been adequately determined.
ii) The form of technology transfer collaboration not having been properly considered.

To assist companies with their negotiations and ongoing technology transfer arrangements a "technology valuation and collaboration" model has been developed by the authors using empirical data gathered from along the UK-China value chain for machine tool technology. UK and Chinese machine tool companies with mixed experiences of technology transfer have participated in the research that underlies the model development. As well as case studies, the other data sources for the research have included surveys of users in China as well as machine tool manufacturers in both countries

Technology transfer in the machine tool industry

China has one of the largest machine tool industries in the world in terms of volume. It has an output of around 300,000 machines per year but its world ranking in terms of value is only 7th, its current share being 4.6% and decreasing. This difference in volume and value is a

result of China's production being mainly of simple, low cost, machines. For example, the unit price of foreign milling machines being imported into China is more than 6 times than that of exported Chinese milling machines - and for boring machines it is more than 30 times. Since the early 1990s China's consumption of machine tools has increased to meet the requirements of its major customers in, for example, the emerging automotive industry. However these industries, which are often Sino-foreign joint ventures, demand high quality CNC machines that are produced to international standards. But since Chinese companies cannot supply such high quality machines this demand is being met largely by foreign imports. The result of this increase in imports has seen the domestic market share of Chinese machine tools being halved in just seven years.

The Chinese machine tool industry's principal objective, therefore, is to develop the capability to produce high-technology CNC machines of sufficiently good quality and reliability to meet the rapidly growing domestic demand for high performance production equipment. The Chinese government is discouraging the import of machine tools by imposing tariffs on types of machines that are already available in China and trying to upgrade domestic production through the transfer of technology to Chinese firms. As a result there is considerable interest among machine tool manufacturers in establishing technology collaborations with Chinese partners.

The technology valuation and collaboration problem

From our case studies and interviews with various organisations in China, and surveys conducted in earlier research, we have identified 5 basic reasons why suppliers and acquirers often do not agree on the value of the technology being transferred (Bennett et al, 1997).

i) The supplier's and acquirer's motivations may not be the same when technology is being transferred internationally. Therefore there are differences in the perceived strategic and commercial importance of the technology.

ii) The distribution of costs, risks and benefits varies between types of arrangements as well as the specifics of agreements, which may substantially affect the value of technology to the provider and the recipient. So differences in the form of collaboration are a factor.

iii) The size of the gap between foreign and domestic technologies is likely to be evaluated differently by foreign suppliers and Chinese acquirers, which in turn would yield differences in the value of a particular technology.

iv) Chinese enterprises may have different standards or requirements, which are considered by suppliers to be a reason for the value of technology being only partly appreciated by the acquirer. Differences in perception of product standards are therefore a reason for disagreement on value.

v) China's machine tool enterprises manufacture most of the parts for their products in-house so the effect of the local production processes on the quality and reliability of the end products made using the transferred technology would also influence the value of the technology.

Development of a model for technology valuation and collaboration

As well as being influenced by these identified differences, the value of technology cannot be separated from the type of transfer arrangement between the partners. Any model for valuing technology and helping to find the most appropriate transfer arrangement must have a high degree of transparency that will enable each side to recognise and make a calculated assessment of the other's motivations and expectations.

The basic framework of the model recognises that the value of technology to owners and acquirers will depend on their different perspectives. The effectiveness and value of technology are dependent on upstream factors such as cost and quality of components, processes and services required to develop and produce the technology. The technology also adds value downstream, for example, better machine tools enable more efficient manufacture of better quality, and therefore higher value, parts.

Based on these considerations, four components have been identified for incorporation into the technology valuation model. These are "owners value", "transfer value", "substitute value" and "traded value" (Figure 1).

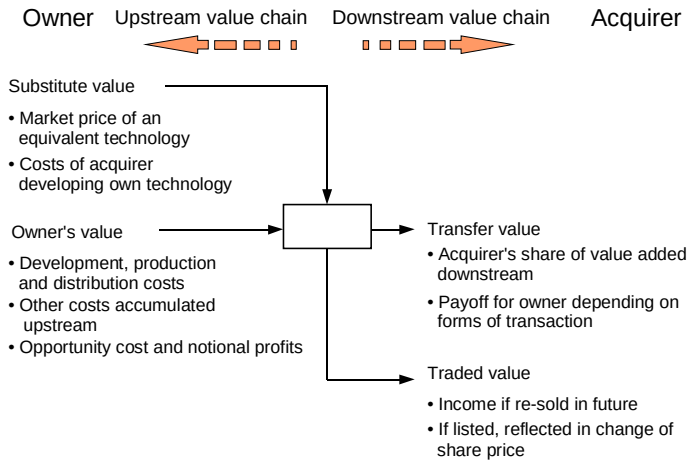

Figure 1. The four value components of transferred technology

From our in-depth investigations of the UK companies we have been able to construct a cost framework for owner's value (Figure 2). Here, the costs of the technology are separated into two types. First, there are those that are incurred internally by virtue of the fact they are linked with 'proprietary' activities. These are costs that provide scope for negotiation. Second, there are those incurred externally through buying-in various items, i.e. the 'market cost' elements. In practice it is necessary to clarify what parts of both elements are to be transferred and what additional components and know-how the acquirer may need to obtain in order to make effective use of the technology.

Know-how and skills that are embodied in the technology have been separated into two types: The innovating types such as design, development and process planning - and the operational types such as processing, sub-assembling and final assembly skills.

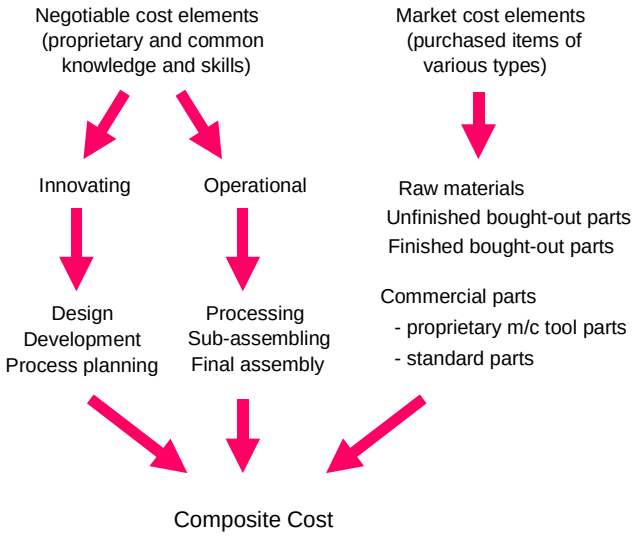

Figure 2. The cost framework for owner's value

The innovating components are 'key' to improving and updating technological capability. If the owner wishes to protect a technological advantage the emphasis will be on transferring operational capabilities only. The market cost elements - materials, parts and commercial items - would normally be provided through a network of suppliers in the mature industrialised countries. However, China does not have such a supplier network because Chinese machine tool manufacturers make most parts themselves.

Our case study investigations in Chinese companies have similarly enabled us to establish a framework for the acquirer to assess transfer value (Figure 3).

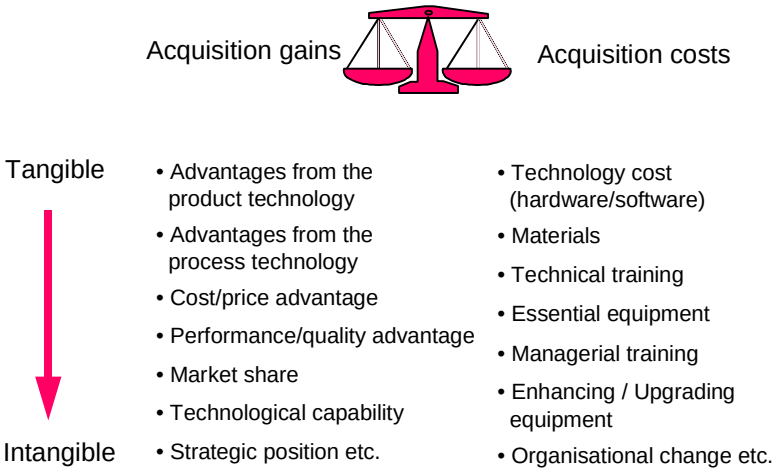

Figure 3. The framework for transfer value

The important considerations in determining transfer value are the acquisition gains, the acquisition costs and the balance between them. Both the gains and costs can be more, or less, tangible. Gains can range from the advantages of product and process technology, which enable 'better' machine tools to be offered to customers, to more long-term strategic gains that may involve moving into completely new industries or markets. Costs on the other hand

can range from the technology hardware and software costs - to the sort of organisational changes that need to be made to sluggish Chinese state enterprises if they are to effectively absorb technology. Transferring technology between countries does not necessarily guarantee that customers' perceptions of the acquirer's end product is the same as that of the supplier's, despite the fact that they may be made to identical standards and specification. For this reason it is necessary to ascertain the perceptions of different groups concerning the attributes of machine tools of different origins. This was achieved though three questionnaire surveys, one among Chinese machine tool manufacturers, another among Chinese machine tool users and the third among UK machine tool manufacturers.

Figure 4 is based on the performance scores assigned by respondents to specified product factors and shows the perceived relative advantages for machine tools of different origins with a baseline score of 1 being used for Chinese machines. It shows that foreign machines are regarded as offering greater satisfaction in meeting customers' needs in all factors, with technology transfer based machines having intermediate scores.

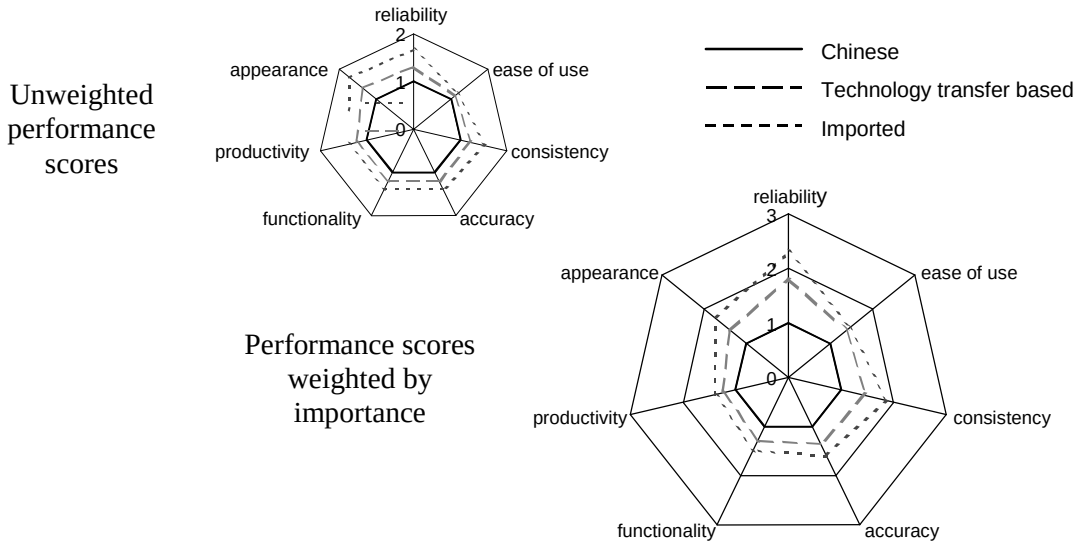

Figure 4. Relative advantages for machine tools of different origins

However, when each factor is weighted according to its perceived importance, the relative advantage of foreign machines is even more apparent. For example, the reliability of imported machines, with an already high assessment, has a weighted score 2.3 times that for Chinese machines while the weighted score for Chinese machines with foreign technology is 1.8 times. This information, together with that concerning expected price differences, is obviously of crucial importance when assessing the value of the transferred technology.

The technology valuation and collaboration model takes suppliers and acquirers through the process needed to arrive at an agreed value and appropriate transfer arrangement. Needless to say the process will, in practice, involve the gathering and analysis of large amounts of data but it will always follow the same basic steps (Figure 5). The first step is to discover and recognise the respective motivations of the supplier and acquirer and identify the costs, benefits and risks of transfer. The second step is to determine owner's value and transfer value and make an assessment of the previously identified costs, benefits and risks. Then, after the influences of substitutes and traded value have been considered, the joint value can

be determined. Finally, this must be related to the transfer arrangement, that in turn will take account of the transfer phases and forms of payment, bearing in mind that joint value and transfer arrangement are highly interdependent and cannot be separated.

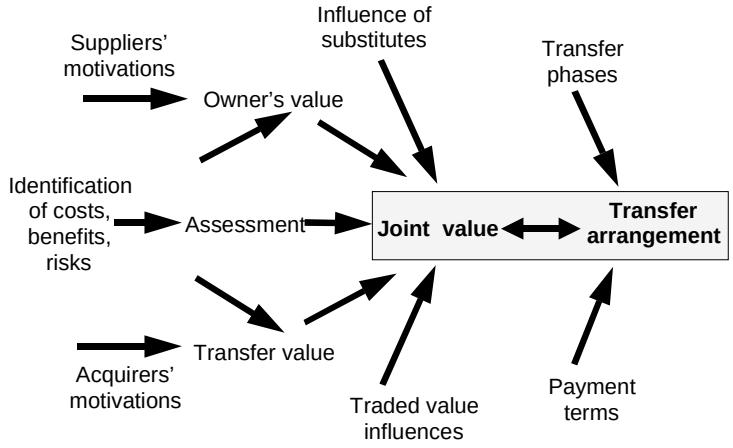

Figure 5. A framework for technology valuation and collaboration

Conclusions

Successful technology transfer depends on the potential for creating greater net benefits for both parties in terms of any technological improvement that will have a positive impact on the businesses of both supplier and acquirer. It is also dependent on the long-term strategic development that must be based on convergent objectives for transferring the technology. There must also be a willingness for suppliers and acquirers to share risks over the long term, so an appropriate form of collaboration is needed that suits both parties' strategic objectives.

The agreed value between both parties would be based on determining the value components as well as an assessment of the costs, benefits and risks. However, the joint value and form of transfer arrangement are mutually interdependent. Using the technology valuation model will help to narrow the gap between the supplier's and acquirer's perceptions that has proved to be the obstacle preventing the success of many technology transfer collaborations in the past.

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