

## TECHNOLOGY TRANSFER AND COMPETITIVE OPERATIONS: THE VALUATION AND COLLABORATION QUESTION

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### ABSTRACT

*To improve competitiveness and find new markets companies are extending their operations through collaborations involving technology transfer. However, such collaborations have often been based on ad hoc agreements resulting from negotiations in which each side has been inadequately equipped with information about the other's motivations and expectations. As a result there has been a gap in the 'value' attached to the technology, leading to delays or even failure in reaching an agreement. To address this problem a technology valuation and collaboration model has been developed using empirical data gathered from various points along the UK-China value chain for machine tool technology*

### INTRODUCTION

It has become common for companies to improve their competitiveness and find new markets by extending their operations through strategic alliances and technological collaborations. This has generated an increase in the rate of technology transfer, especially between industrialised and developing countries where access to local markets can be exchanged for a share of the transferred technology. Technology transfer potentially can generate benefit for both suppliers and acquirers but, at the same time, each party incurs costs and bears risks. 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 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.

The fundamental questions concerning international technology collaborations are, therefore, how to generate greater joint benefit through a collaborative venture and how to share this between the two parties. From an operations management perspective the key issues are to determine a form of collaboration that best uses the partners' respective strengths and ensures their objectives are realised in order to sustain commitment. Elsewhere we have discussed the framework for a 'technology valuation' model (Bennett et al, 1997a). The focus of this model is on how to determine a value for technology and a collaboration form that takes full account of the owner's and acquirer's perspective. This paper assesses the interactions of each partner's objectives, share of benefits, cost, risk and transfer arrangement, together with their effects of technology valuation and collaboration and their strategic implications for collaborative operations management.

## **METHODOLOGY**

The development of the technology valuation and collaboration model is based on an analysis of empirical data gathered from three groups: machine tool manufacturers in the UK; machine tool manufacturers in China; machine tool users in China. Case study data have been gathered from companies in each of the above groups and three questionnaire surveys have been conducted: i) a survey of UK (and UK based) machine tool companies who have transferred, or are going to transfer, technology to China or sell machines in China, ii) a survey of Chinese machine tool manufacturers covering most of the key enterprises who have imported, or plan to import, technology through various forms of collaboration, iii) a survey in China of automotive and machinery companies where both Chinese and foreign machine tools are used.

The results reported here are based largely on the questionnaire returns from the UK and Chinese machine tool companies. Altogether there were 69 respondents, comprising 11 UK companies (from 34 mailed-out) and 58 Chinese companies (from 100 mailed-out). The responses provided details of 84 technology transfer experiences. Some of the reported results are complemented by the findings from case studies. The questionnaire focus is on transfer objectives, benefits, costs, risks and forms of collaboration influencing the value of technology. The degree of 'importance' of factors, the 'suitability' of transfer arrangements and the 'satisfaction' with transfer results have been scaled, with a score of 6 meaning *imperative, entirely suitable and completely satisfied*, and 1 meaning *not important, not suitable and not at all satisfied (or irrelevant)*. Scores in-between refer to varying degrees of these measures.

## **MATCHING OF OBJECTIVES FOR TECHNOLOGY TRANSFER**

The selection of an appropriate collaboration form for technology transfer that can meet both parties' requirements depends on each partner's objectives and strategies. Defining the objectives is therefore a crucial requirement when establishing a technology transfer arrangement. Among the objectives the convergent ones need first to be identified since they form the basis for a successful collaboration. Table 1 summarises the results of an earlier study involving several industries in the UK and China and shows the financial, technical and strategic objectives of both suppliers and acquirers (Bennett et al, 1997b). It can be seen that some objectives are convergent (e.g. *increase of local market sale*) and some objectives may lead to convergence in the future (e.g. the suppliers' objective of *developing the local supply chain* and the acquirers' objective of *gaining access to the world market*).

Although some objectives may not appear to converge at all (e.g. the technical objectives of the two sides), they may still be realised for both parties depending on the type of technology being transferred and form of collaboration. Therefore it is crucial to define the convergent objectives and to maximise the scope of convergence by establishing an appropriate partnership. The extent to which a specific form of collaboration can match both sides' objectives is vital for the success of the collaborative operation.

Table 1 Suppliers' and acquirers' objectives for technology transfer

	Suppliers' objectives	Acquirers' objectives
<b>Financial objectives</b>	<ul style="list-style-type: none"> <li>access to local market</li> <li>increased sales in local market</li> </ul>	<ul style="list-style-type: none"> <li>increased sales in local market</li> <li>sales to external markets</li> </ul>
<b>Technical objectives</b>	<ul style="list-style-type: none"> <li>cost reduction</li> </ul>	<ul style="list-style-type: none"> <li>upgrading technological level of the product</li> <li>improved quality of product</li> <li>development of technical capability</li> </ul>
<b>Strategic objectives</b>	<ul style="list-style-type: none"> <li>market share and strategic position in local market</li> <li>development of local supply chain</li> </ul>	<ul style="list-style-type: none"> <li>technological competitiveness in local industry</li> <li>access to the world market</li> </ul>

## ASSESSING AND SHARING BENEFITS

Generating and capturing greater joint benefit is the basic motivation for technology collaboration. Table 2 shows suppliers' and acquirers' expected benefits and their assessment of importance together with the actual results from previous transfer experiences compared with expectations.

Table 2 Importance of transfer benefits and actual results from previous transfer experiences compared with expectations

	Importance	Actual results
<b><i>Suppliers' expected transfer benefits</i></b>		
market entry or increased sales	5.30	2.67
enhancement of strategic position locally	5.00	3.00
reduction in production costs	4.40	1.67
meeting local customers' requirements	4.20	2.33
improvement of after sale service	4.10	3.00
acquisition of low cost local components	3.40	1.67
<b><i>Acquirers' expected transfer benefits</i></b>		
product level (technological) can be upgraded	5.18	4.68
product quality can be improved	5.13	4.46
technical development capability can be improved	4.96	4.18
domestic market sale can be increased	4.24	3.70
company/product image can be improved	4.15	4.10
exports can be increased	3.87	3.26
the existing product range can be enlarged	3.58	4.24
production costs can be reduced	3.24	2.82
production management can be improved	3.21	3.36

The table shows that each side's benefits may not be achieved to the same degree of satisfaction. It also suggests that they may not be derived at the same stage in the process of transfer, particularly in respect of the technical and strategic objectives. For example, transferred product technology could immediately upgrade the technological level of the acquirer's product as well as improving quality compared with existing products. However, it requires a longer time to achieve a reduction in production costs and increase local market sales, so the supplier's objectives may not be immediately satisfied. This in turn often results in a gap between their perceived value of the transferred technology.

The worse result of this from among the case studies was the complete severing of a partnership when the official contract ended. Therefore, in order to judge the value of technology there should be an assessment of transfer benefits focusing on the shared joint benefits from the whole process of transfer in relation to their relative importance to each party.

## ASSESSING AND SHARING COSTS AND RISKS

Technology transfer incurs costs both to suppliers and acquirers. From a supplier's point of view these are mainly associated with technology development, manufacturing, distribution and the activities associated with transfer. They can often form the main basis of the contract price, which is a substantial part of the total acquisition cost to the acquirer (normally over 70%). Apart from this there are usually some additional (consequential) costs associated with acquisition as shown in Table 3.

*Table 3* Structure of costs associated with technology transfer

<b>Supplier's costs</b>	<b>Acquirer's costs</b>
<ul style="list-style-type: none"> <li>• proportion of development cost</li> <li>• manufacturing cost</li> <li>• distribution cost</li> <li>• transfer cost (e.g. training and technical supervision etc.)</li> </ul>	<ul style="list-style-type: none"> <li>• contract price               <ul style="list-style-type: none"> <li>- cost of purchasing equipment</li> <li>- cost of purchasing drawings</li> <li>- cost of purchasing parts</li> <li>- cost of training</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>• consequential costs               <ul style="list-style-type: none"> <li>- technology updating costs</li> <li>- further investment</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• consequential costs               <ul style="list-style-type: none"> <li>- purchase of fitting equipment and spare parts</li> <li>- marketing cost</li> <li>- organisational change cost</li> </ul> </li> </ul>

The major difference concerning costs between suppliers and acquirers is that the substantial part of an acquirer's cost (i.e. the contract price) is actually the supplier's immediate financial return if the whole contract price is paid 'up-front'. In such cases acquirers would need to pay a high financial price and bear a high risk for the acquisition of technology. If the price and risk are too high acquirers may doubt the *worth* of acquiring the technology or may be uncertain about the payment being covered by their captured future benefits from the transfer. Acquirers may therefore prefer a greater sharing of financial costs and risks with suppliers through other forms of payment arrangement. Suppliers, on the other hand, may have a different preference depending on their perceptions of local market potential and the acquirer's capability as well as their overall strategy for technology collaboration. Table 4 shows suppliers' and acquirers' assessments of the suitability of different terms of payment and indicates their relative preference for sharing costs and risks. Table 5 shows an assessment of the main risks associated with technology collaboration. The case studies suggested that many technical risks can be reduced through a solid collaboration with more technical support provided by the supplier. Market risk is the greatest concern of both sides. Suppliers and acquirers both need to be aware that the amount of risk sharing must be related to the sharing of future benefits.

*Table 4* Preference for terms of payment by suppliers and acquirers

<b>Terms of payment</b>	<b>Assessment by UK companies</b>	<b>Assessment by Chinese companies</b>
<i>No sharing</i> - one-off payment	3.67	2.41
<i>Part sharing</i> : - initial payment plus royalty	4.50	2.82
- instalment	4.67	4.00
<i>Greater sharing</i> - payment for key components	4.00	3.57
- share of return from sales	3.00	4.42

*Table 5* Assessment of technical, market and collaboration risks based on actual transfer experiences (Note: risk assessments are based on the gap between actual experience and complete satisfaction, i.e. the higher the percentage the greater the risk)

	<b>Assessment by UK companies</b>	<b>Assessment by Chinese companies</b>
<b>Suppliers' specific risks:</b>		
control of the technology being transferred	29%	
cost advantage for the transferred product	56%	
partner's ability to win orders	56%	
partner's absorption of technology	33%	
<b>Acquirers' specific risks:</b>		
absorption of technology		31%
effective use of technology		31%
supply of key components		45%
solution to technical problems		39%
<b>Common risks:</b>		
quality of end-product	58%	29%
competitive product (quality & price)	54%	50%
customer's confidence (quality & reliability)	44%	34%
meeting customers' needs (performance)	39%	34%
market sales of the end-product	56%	36%
'goodness' of collaboration	29%	41%
financial stability of partner	38%	35%

## **TRANSFER ARRANGEMENTS**

Table 6 shows the UK and Chinese companies' assessments of the suitability of different forms of collaboration. The value of technology is not only dependent on the upstream costs of production and distribution but also on the future gains to be derived by using the technology to add value further downstream. The total gain to be shared from the transferred technology is therefore dependent on the effectiveness of use of the technology and its realisation in local and other markets. There are a number of important technology and contributory features that can influence effective use, which in turn depend on different transfer arrangements. Potentially, more advanced technological knowledge and training as well as supervision can be provided, and consequently more suppliers' advantages can be shared, if there is a close form of collaboration. Arguably this leads to a higher degree of effectiveness in using and realising transferred technology. Therefore acquirers in general are in favour of collaborations with higher commitment and more technical support from their partners.

Table 6 Suitability of forms of collaboration assessed by the experienced companies

	Assessment by UK companies	Assessment by Chinese companies
One-off purchase of technology	3.67	3.22
Licensing agreement	3.50	3.49
Subcontracting	3.00	4.36
Co-production	3.75	4.39
Equity joint venture	3.00	4.58

On the other hand, Table 6 also shows that suppliers consider it less suitable to have such a close arrangement and this is borne out in many of the case studies. From the supplier's point of view the preference for a particular transfer arrangement appears to depend on their willingness to release control of the technology, which is determined by their strategies, perceptions on local market potential, characteristics of the technology and the local partner's competence. On one hand, arrangements that involve less sharing will reduce their costs and risks; however, on the other hand, they may reduce the opportunity of creating greater joint value as a result of making more effective use of the technology.

## CONCLUSIONS

The advantages from technology collaboration are derived from the enhancement of opportunities for generating greater joint benefits and an improvement in each party's capability to capture the benefits created. The value of the technology being transferred is dependent on the owners' and acquirers' viewpoint so technology valuation should be based on a broad perspective by considering *joint* value and how it is *shared* between partners. This has proved to be the fundamental basis for a successful collaboration. Defining the objectives and maximising the scope for convergence are crucial for the success of technology collaboration. An appropriate transfer arrangement is the key to effectively using and realising technology in the market and, as a consequence, has substantial influence on creating the total amount of joint value as well as the shares of the value between partners. Sharing costs and risks need to be assessed in comparison with transfer benefits, taking into account the enhancement of opportunity for generating greater future gains.

## REFERENCES

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