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Technology management in manufacturing business: process and practical assessment

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Abstract

The role of technology as a source of competitive advantage is becoming increasingly important to manufacturing industry, as the cost and rate of technological advances increase. Effective technology management requires the integration of technical, marketing, human resource and financial functions. In addition, it is essential for strategic and operational processes to be integrated.

This paper describes the structure and application of a technology management assessment procedure, based on a five-process technology management framework (identification, selection, acquisition, exploitation and protection). The procedure provides a means of revealing and assessing the full range of technology management practices in a manufacturing firm. The method is based on a flexible top-down approach, which spans both strategic and operational issues. © 1998 Elsevier Science Ltd. All rights reserved

1. INTRODUCTION

Technology can represent a major source of competitive advantage and growth for manufacturing firms (Dussauge *et al.*, 1994). However, effectively integrating technological considerations into corporate processes is a challenging task, as this requires incorporation of multiple functions, including technical, marketing, human resource and financial functions (Gaynor, 1996). The challenges associated with technology management are compounded by a number of factors (Steele, 1989), including the increasing cost, complexity and pace of technology development, the diversity of technology sources, the globalisation of competition and alliances, and the impact of information technology.

Technology management concerns both strategic and operational issues; "A strategy is only of value if mechanisms for its implementation and renewal are in place" (Gregory, 1995). This requires a framework to structure the development and application of technology management processes, supported by a range of practical and robust tools and techniques (e.g. Hobday *et al.*, 1997; Probert *et al.*, 1993; Stacey and Ashton, 1990; De Piante Henriksen, 1997; Chiesa *et al.*, 1996; Tipping *et al.*, 1995; Groenenveld, 1997).

Gregory (1995) has proposed a framework for technology management, comprising five generic processes (see Fig. 1):

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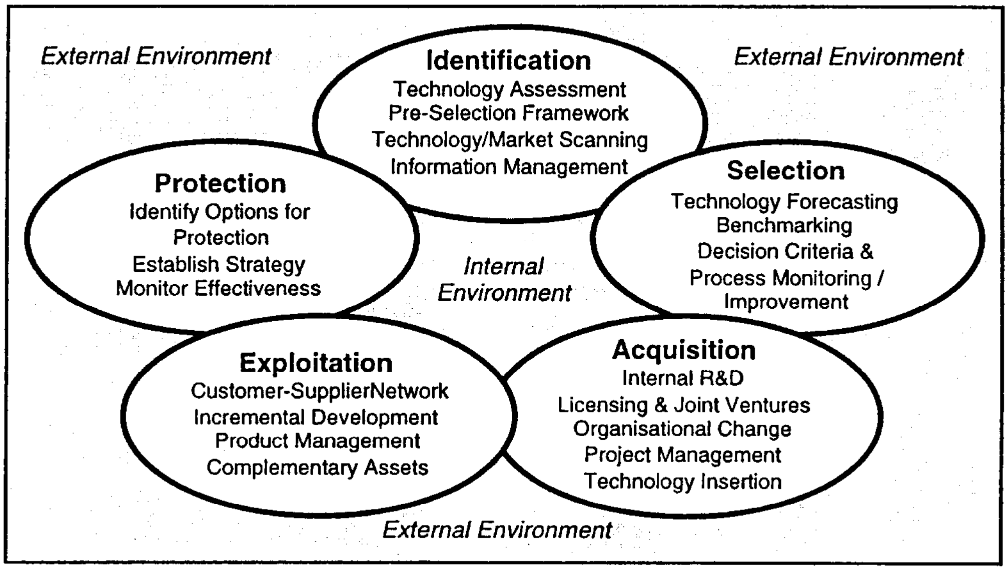

Fig. 1. Five-process technology management framework, showing example activities.

- *Identification* of technologies which are (or may be) of importance to the business. Example processes include scanning, monitoring, benchmarking and data collection.
- *Selection* of technologies that should be supported by the organisation. For instance, forecasting, portfolio analysis and scenario analysis are associated with selection of technology.
- *Acquisition* and assimilation of selected technologies. Example processes include technology transfer, research and development, corporate mergers and acquisitions.
- *Exploitation* of technologies to generate profit, or other benefits. Example processes include licensing, new product development, incremental developments, process improvements, and supply chain management.
- *Protection* of knowledge and expertise embedded in products and manufacturing systems. These processes include patenting, risk assessment, security management and staff retention.

Skilbeck and Cruickshank (1997) have extended Gregory's five-process model, linking the framework to business activities within a systems context, and identifying three levels within the organisation where technology management processes apply:

- *Corporate level* (network view): how to manage technology across a diverse range of businesses.
- *Business level* (external view): how to gain competitive advantage through technology.
- *Operational level* (internal view): how to optimise internal processes to manage technology effectively.

A procedure has been developed to assess technology management processes in manufacturing firms, based on the five-process model. The procedure has been developed in close collaboration with industrial partners, and is currently being tested in a range of different organisations and industries. The aims of the technology management process assessment procedure are to:

- Provide a framework for linking technology with business needs.
- Identify critical technology management issues in the firm.
- Map and evaluate important technology management processes in the area of interest.
- Identify areas of strength and weakness, and hence areas of best practice for transfer, and areas for improvement.
- Lead to recommendations for action plans which have cross-functional support and can be clearly justified.

Details of the background and development of this procedure are described elsewhere (Paterson *et al.*, 1997); this paper focuses on providing a detailed description of the structure of the procedure, together with a summary of its industrial application during the development and testing of the method.

2. STRUCTURE OF THE ASSESSMENT APPROACH

The technology management process assessment procedure comprises three main stages (see Fig. 2), described in detail in subsequent sections:

(1) The *Strategic Overview* defines a framework for linking technology with business objectives, and enables selection of area/s for more detailed appraisal.
(2) The *Process Overview* focuses on the business–technology area/s selected in stage 1, mapping and assessing technology management activities in terms of the five-process framework (Fig. 1), leading to the identification of specific processes for more detailed assessment.
(3) The *Process Investigation* focuses on mapping and assessment of specific process areas identified during stage 2.

The procedures are largely workshop-based, and so a skilled facilitator is required. The facilitator must be familiar with the procedure, with an understanding of technology management theory and practice. It is also important for the facilitator to have some appreciation of the product and process technologies in the business unit being assessed, together with the market issues facing the organisation.

2.1 Strategic overview (SO)

The focus of technology management research in the past 15 years has been directed towards strategic issues (Drejer, 1997)—that is, how to integrate technology strategy with marketing and other corporate strategies. For example, Mitchell (1985) has developed a simple matrix linking strategic technology areas (STAs) to business areas. Ranking the value of each STA to each business area, and comparing the strength of each STA with competitors, provides a framework within which a technology strategy can be developed. This type of approach has been proposed by de Wet (1996), who has developed an expanded two-dimensional matrix, linking markets, products, processes and technologies, thus enabling market-focused technology planning.

The concepts of Mitchell and de Wet have been extended to develop the Strategic Overview procedure, which comprises five steps (see Fig. 2), as described below:

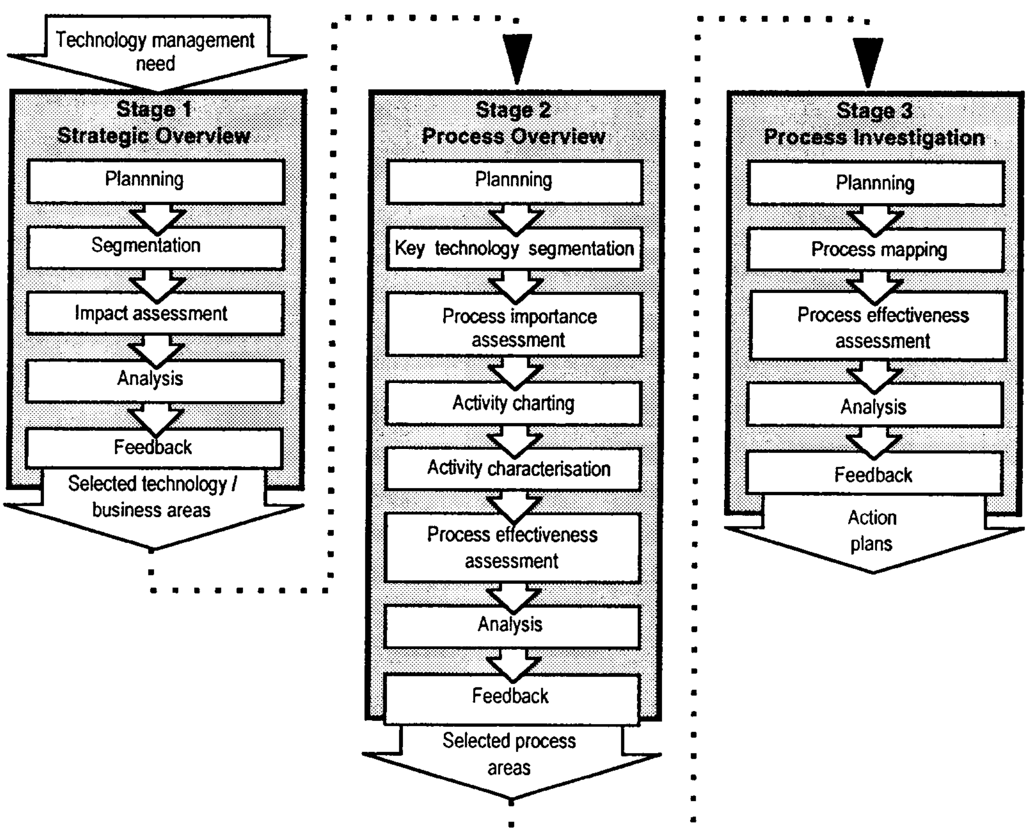

Fig. 2. Technology management process assessment procedure.

2.1.1 Step SO 1—planning

The initial step of the strategic overview procedure is planning, which includes the following considerations:

- An "internal champion" must be identified. This is usually a senior manager in the organisation, with general or specific technology management responsibilities.
- Typically there are concurrent processes under way in the company which dictate the focus of the assessment procedure, and it is vital to understand and clearly articulate these at the start of the procedure (e.g. technology/product planning, capital expenditure appraisals, R & D management activities, etc.).
- Based on the above considerations the *unit of analysis* must be identified. This may be a functional area, a business unit, or a group of business units.
- Resource and timing requirements for the application of the procedure must be considered. Workshop participants need be identified, and the workshops scheduled. The mix of participants should include staff with knowledge of the key technology and business functions of the unit being assessed (i.e. multi-disciplinary). Typically 5–7 participants are ideal, although more or less can be involved if appropriate.

2.1.2 Step SO 2—segmentation

This step is usually conducted in the format of a 2–3-hour workshop, to segment the unit in terms of technology and business areas, to form the two axes of the matrix shown in Fig. 3. The definition of what constitutes a business or technology area is not prescriptive, as part of the process is to discuss the meaning of these terms in the context of the particular company.

The definition of business areas may be based on market, customer, product or functional views. It is important that the segmentation strategy employed leads to technological differentiation in the resulting business areas (i.e. the various business areas should depend on a different combinations of technologies). Typical examples of business areas are: software systems, electro-optics, prime contractors, communication systems, etc.

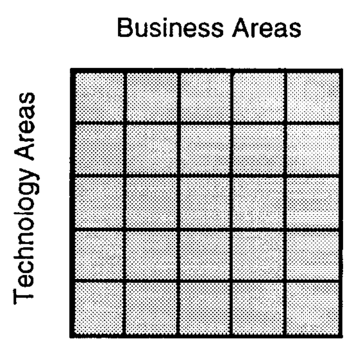

Fig. 3. Strategic overview segmentation grid.

Technology areas are groupings of the main technologies which are either integrated into products, or are key in enabling products to be made and markets exploited. The categorisation can be made both top down (broad view of which technology areas the company is working with) or bottom up, by listing the individual technologies which are under research, designed into products, used in manufacture, or support the business processes of the firm. Matching the results of the two approaches is a useful check on the completeness of the analysis, and ensures that the definition of the technologies is clearly defined (in terms of a technological hierarchy). Typical examples of technology areas are: software engineering, mechanical engineering, systems integration, project management systems, design for manufacture, etc.

2.1.3 Step SO 3—impact assessment

This step is usually conducted in the format of a 2–3-hour workshop, where the impact of each technology area on each business area is assessed. This is done by considering the *value*, *effort* and *risk* associated with each technology/business area intersection. Part of the workshop process is to consider the meaning of these terms for the particular unit under review, but in outline they are as follows:

- *Value* provides a relative measure of the competitive advantage derived from each technology for the benefit of each business area, in terms of the value provided to the customer. The perceived contribution that the technology area provides to profit margins, growth or market share may be relevant.
- *Effort* provides a measure of the relative investment in each technology area for the benefit of each business area, in terms of research and development, capital investment, labour, training, etc.
- *Risk* provides a measure of the relative difficulty in achieving the desired outcome when applying each technology area to each business area. The assessment of risk includes an appraisal of the probability and consequences of failure, and may include both technical difficulty and perceived market risks.

The ranking procedure is straightforward, with each of the above parameters ranked for the entire grid in turn. Each business area is considered individually, and each technology area is sorted into high, medium, low and not-significant categories. The aim is to seek consensus within the group; where this is not possible the reasons and different rankings are noted. The discussions which are associated with the workshop are an important part of the process, and key comments are recorded. The outputs from the workshop are largely subjective in nature, representing the views of the management team. It is generally recommended to calibrate the outputs subsequently (i.e. financial data, competitor intelligence, etc.).

2.1.4 Step SO 4—analysis

The output from the second workshop is a completed Strategic Overview grid, with rankings for value, effort and risk in each cell (see Fig. 4, where the main features of the grid are shown).

Generally, there is expected to be a correlation between the rankings for value, effort and risk. That is, a technology area of high value to a particular business area would generally merit high effort and be of high risk (difficult to do). If this were not the case then competitors would be achieving the same result and there would be little advantage to be obtained from investing effort in the area.

The completed Strategic Overview grid contains a lot of information, and it is necessary to distinguish trends or patterns in the data in this format. *Impact*, *realised value* and *commensurate effort* grids can constructed to identify these trends. The grids are derived by comparing the rankings for value, effort and risk for each cell of the Strategic Overview grid. The number of instances of value–effort, value–risk and risk–effort data pairs are counted, with the number then included in the appropriate cells of the grids, as shown in Fig. 5. These grids can be constructed for the full set of Strategic Overview data (i.e. all technology and business areas), or for specific technology or business areas (i.e. horizontal or vertical “slices” of the grid). The reader is referred to Phaal *et al.* (1997b) for examples of these grids.

2.1.5 Step SO 5–feedback

An essential part of the assessment procedure is to provide feedback to the workshop participants and internal champion, as interpretation of the results in the context of the organisation is important.

In addition to providing specific benefits to the company, the aim is to select a technology–business area (or areas) for more detailed assessment of technology management practices. Areas of high value and significant mismatch between value, effort and/or risk are usually selected for further more detailed investigation in the next stages of the process. These may be areas which exhibit particular strengths or weaknesses in terms of their technology/business interaction. This usually implies an area where insufficient effort is being invested in technologies which are perceived to have high value to the business.

2.2 Process overview (PO)

The first stage of the technology management assessment procedure, the Strategic Overview, provides a technology–business framework within which areas of interest can be identified for more detailed

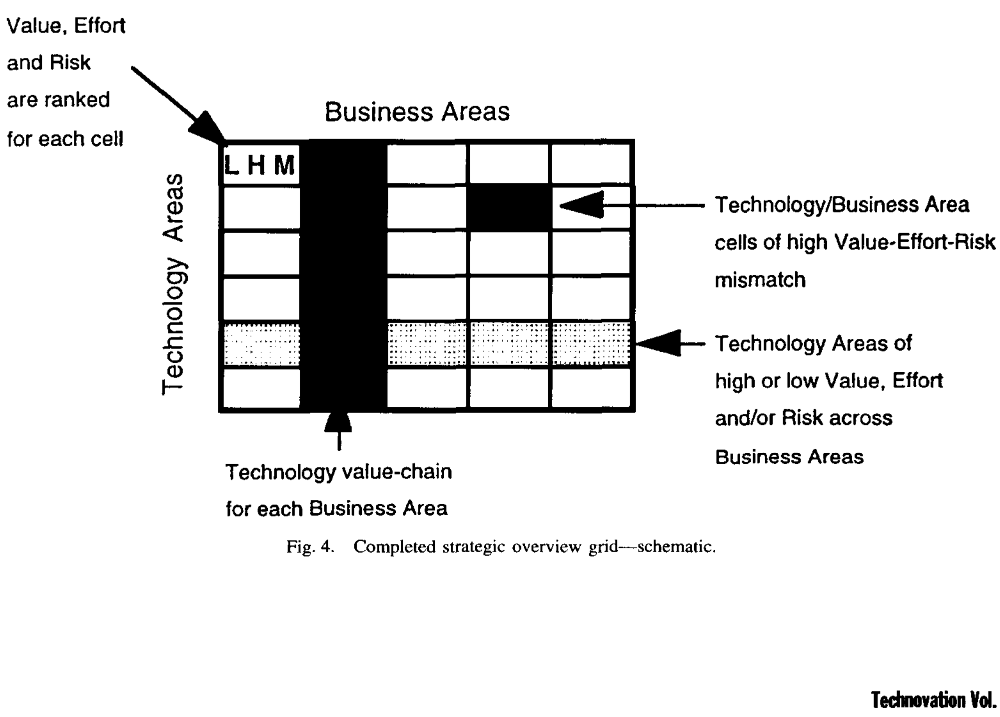

Fig. 4. Completed strategic overview grid—schematic.

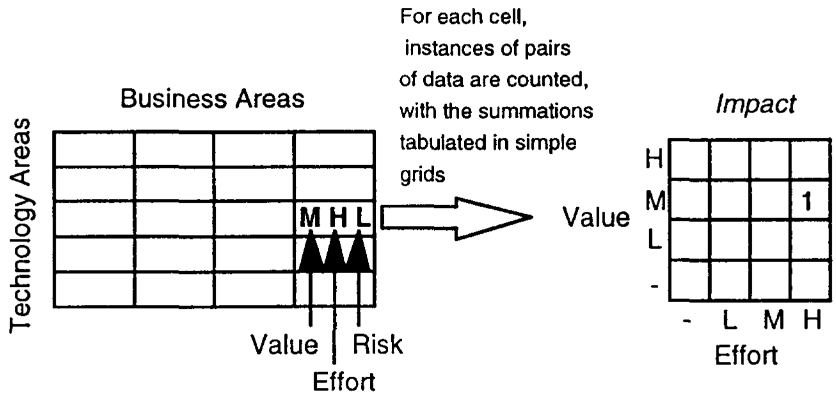

Fig. 5. Comparisons of value/effort, value/risk and effort/risk pairs—illustrated for impact (value/effort).

assessment. In the second stage, the Process Investigation, practical company activities are mapped and characterised in terms of generic technology management processes. The importance and effectiveness of these processes are ranked, as a means of identifying particular areas for more detailed assessment.

The Process Overview procedure comprises eight steps (see Fig. 2), as described below.

2.2.1 Step PO 1—planning

The Process Overview normally comprises two workshops, each of 2–3 hours duration. Resource and scheduling requirements must be considered, and workshop participants identified. The mix of participants should reflect the range of activities in the area of interest, including technical and commercial functions.

2.2.2 Step PO 2—key technology segmentation

The first Process Overview workshop starts with a presentation to the group. It is important to brief the participants fully on the Strategic Overview, so that the reasons for selecting the particular area are clearly understood.

The first group exercise in the workshop aims to segment the selected technology area into its constituent key or sub-technologies. The methods for doing this are similar to those described in Section 2.1, although an initial starting point is provided by the results from the Strategic Overview.

2.2.3 Step PO 3—process importance assessment

Having introduced the concept of the technology management process model in the introductory presentation (step PO 1), the relevance to the company and area being assessed is discussed, in the context of the key technology areas identified in step PO 2.

The aim of this step is to rank the relative importance of the five technology management processes (identification, selection, acquisition, exploitation and protection), in terms of the value they provide to the business. The methods for ranking are similar to those used in the Strategic Overview; the management processes are sorted into high, medium and low categories for the overall technology area, or for each key technology.

2.2.4 Step PO 4—activity charting

The main element of the first Process Overview workshop is a charting exercise, derived from methods developed by Mills *et al.* (1996). The aim is to gather information about practical activities in the company relating to technology identification, selection, acquisition, exploitation and protection processes. This entails a group exercise, where specific events and activities relating to the key technologies are captured on a wall chart, together with the linkages between them (see Fig. 6).

The charting method works well in a group, as the focus is on practical activities in the firm, rather than the somewhat abstract technology management process model. Also, the group derives benefit from sharing its experience of events from their different perspectives.

2.2.5 Step PO 5—activity characterisation

Two factors require consideration after completing the activity charting exercise, prior to the second workshop:

(1) How do the charted activities and events relate to business processes in the firm? For instance, important technology acquisitions may be embedded in project management processes in the R & D department of an organisation, and it is

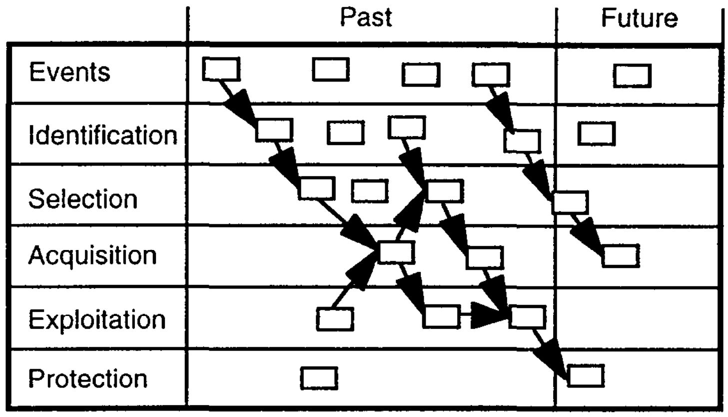

Fig. 6. Technology management activity chart (schematic).

important to ensure that technology management concerns are appropriately reflected in project management procedures.

(2) How do the charted activities and events relate to the five-process technology management model? How are the activities distributed between the five processes? Are there areas where little activity is apparent, in comparison with the importance of the process, as ranked in the workshop?

The aim is to characterise activities captured during the charting exercise in terms of generic technology management processes, in the context of the business processes within which they occur. For example, technology acquisition in the context of R & D project management should be distinguished from corporate technology acquisitions. Each characterised process is positioned with respect to whether it is driven by external events (i.e. reactive), or by internal impetus (i.e. proactive). Characterising the technology management processes in the business context has the benefit of being able to benchmark processes across departments, firms and industries, and thus to facilitate transfer of best practice. A tabular guide has been developed to structure the characterisation of technology management processes.

2.2.6 Step PO 6—process effectiveness assessment

The second Process Overview workshop starts with a presentation, summarising the progress to date. This is followed by a group activity to rank the effectiveness of each characterised process (i.e. high, medium or low), in terms of the simple process model shown in Fig. 7: clarity of requirements, process management and the exploitation of results. For each of the these factors, a series of questions have been developed to prompt the facilitator, in each of the five technology management process areas. Specific strengths or weaknesses which are highlighted during the group discussions are noted.

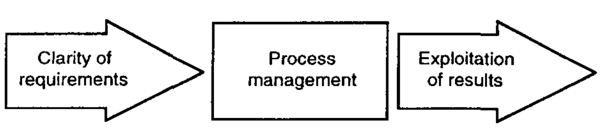

Fig. 7. Effectiveness criteria for technology management processes.

2.2.7 Step PO 7—analysis

By comparing the effectiveness of each technology management process with its perceived importance enables process areas to the identified with are potentially under- or over-performing (see Fig. 8). In addition, the distribution of apparent activity can be compared to the perceived importance of each process area, and the balance between proactive and reactive activity can be assessed. Consideration of these issues is supported by the discussion points which are captured during the workshops, together with the strengths and weakness which are identified.

2.2.8 Step PO 8—feedback

The results of the workshops and analysis are normally presented back to the participants of both the Process and Strategic Overview stages. It is important for participants to discuss and review the output and

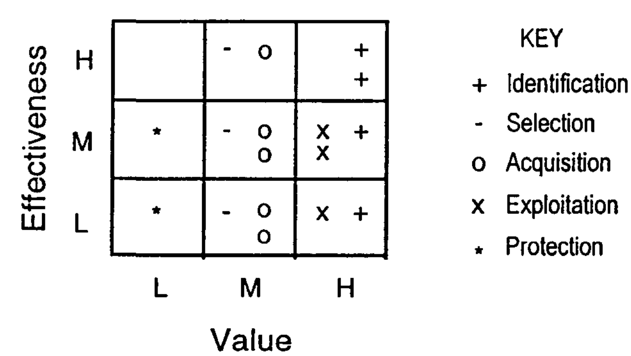

Fig. 8. Value–effectiveness grid for characterised technology management processes (schematic).

analysis, to ensure that the results of the assessment are correctly interpreted. Again, it is helpful to record pertinent comments from participants during feedback sessions, to ensure that the context of the assessment results is captured.

On the basis of the results from the Process Overview, and the feedback discussions, specific technology management process areas of strength and weakness can be selected for further, more detailed evaluation in the Process Investigation. Areas may be selected because they require improvement, or because they are considered to be examples of best practice.

2.3 Process investigation (PI)

The third stage of the technology management assessment procedure, the Process Investigation, provides methods for mapping and assessing the effectiveness of specific technology management processes, by comparison with generic process models. In this way the various components of the process can be identified, their performance appraised, and appropriate action plans developed for process improvement.

The Process Investigation comprises five steps (see Fig. 2), as described below.

2.3.1 Step PI 1—planning

The Process Overview typically comprises one workshop of 2–3 hours duration, for each process areas selected. Additional workshops may be required if the procedure leads to further work to implement improvement plans. Resource and scheduling requirements must be considered, and workshop participants identified. The mix of participants should reflect the range of activities in the process area of interest.

2.3.2 Step PI 2—process mapping

The Process Investigation workshop aims to map the activities, events and associated factors for selected activities within the process area under consideration. The starting point for this is the activity chart which was produced during the Process Overview stage. Informal mapping techniques are used, with the aim of capturing as many of the factors which influence the process as possible, including cross-functional relationships and links to formal company processes. A series of prompting questions for each of the five process areas has been developed for the facilitator to ensure that essential issues are captured.

The output from the mapping activity is then considered in terms of a generic model for the technology management process of interest, to define system boundaries, inputs and outputs, control functions, information flows, management and transformation processes. This is illustrated in Fig. 9, which shows the generic process model developed for technology acquisition, based on a review of the literature in this area (e.g. Mansfield, 1988; Sen and Rubenstein, 1990; Radnor, 1991; Cutler, 1991; Granstand *et al.*, 1992; Thomas *et al.*, 1994).

2.3.3 Step PI 3—process effectiveness assessment

Once the process has been mapped and system elements defined, the group considers the effectiveness of the process, in terms of its generic components. A series of prompting questions have been developed for each generic process for the facilitator to support this process.

2.3.4 Step PI 4—analysis

After the Process Investigation the results from the workshop should be considered carefully prior to feedback. Areas of strength and weakness need to be identified, and recommendations for improvement need to be established. The technology management assessment procedure has been designed to provide a structured justification for such recommendations.

The detailed nature of the improvement plans are outside the scope of the procedure, as these tend to be specific to the particular process area and organisation, and could encompass any one of many process areas contained in the five process technology management model.

2.3.5 Step PI 5—feedback

The results from the Process Investigation are presented back to the participants of the various stages of the procedure, as required. As before, it is important to ensure that the interpretation of the procedure outputs is reviewed to ensure appropriate conclusions are drawn.

3. COMPANY APPLICATIONS OF METHODOLOGY

The methodology has been applied in a wide range of organisations, in terms of size and industrial sector. The companies can be divided into two groups:

- *"Development" companies* participated during the early stages of the project, confirming the need to develop a practical method in an industrial context (Paterson *et al.*, 1997). These companies also participated in the development stage of the procedure,

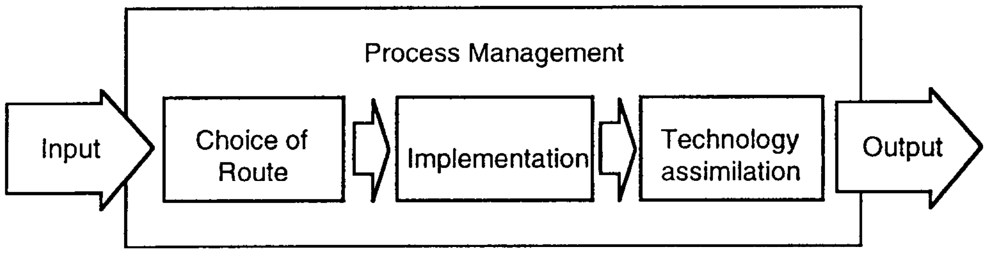

Fig. 9. Example generic process model: Acquisition.

TABLE 1. Application data: development of the procedure

	D1	D2	D3
Companies	Aerospace	Automotive	Electro-mechanical
Size[a]	Very large	Large	Large
Stages of methodology applied	1–3	1–2–3	1–2–3 (part)
Version of methodology	Version 1	Version 2	Version 3
Format	Workbooks	Interviews	Workshops

[a]Small < 200, Medium 200–499, Large 500–5000, Very large > 5000 employees.

where significant modifications to the procedure were required, based on the learning associated with each application.

- *"Testing" companies* participated during the final stages of the project, to test the full procedure and its modules (see Phaal *et al.*, 1997a). Only minor refinements to the procedure have been required during this phase, which is ongoing.

The company applications during the development and testing phases of procedure are summarised in Tables 1 and 2.

3.1 Implementation factors

The assessment procedure aims to provide a method by which manufacturing companies can reveal their technology management practices for discussion and subsequent improvement. The tool itself must be robust and the content relevant to the company involved, however additional factors which influence the successful implementation of the procedure are also crucial. The "implementation" factors that have emerged from the company applications (Paterson *et al.*, 1998) are summarised below:

- *Need.* The reasons for applying the procedure should be clearly articulated. There should be congruence between the goals of the company and the capabilities of the methodology, and a wish to take ongoing action.
- *Timing.* The procedure should fit well with company planning time scales or specific initiatives.

TABLE 2. Application data: testing of the procedure

	T1	T2	T3 (three applications)
Companies	Electrical fittings	Industrial controls	Electro-mechanical
Size*	Medium	Small	Very large
Parts of methodology	1–2–3	1 to date	1 to date
Format	Workshops	Workshops	Workshops
continued:	T4	T5	T6 (multiple applications)
Companies	Auto components	Pharmaceutical	Marine + others
Size[a]	Large	Medium	Small
Parts of methodology	1 to date	1–2 to date	1–2
Format	Workshops	Workshops	Workshops

[a]Small < 200, Medium 200–499, Large 500–5000, Very large > 5000 employees.

- *Ownership.* Close involvement of the internal company champion is required.
- *Support* and visibility of senior management is needed.
- *People.* The right mix and level of participants is important, together with availability and a willingness to share information and views.
- *Facilitation* skills are important, together with knowledge of technology management issues and familiarity with the assessment procedure.

3.2 Criteria for overall success of the methodology

Three criteria are used to assess the success of the procedure, based on previous research into the development of practical tools (Chiesa *et al.*, 1996; Platts, 1993; Neely *et al.*, 1996):

- *Usability.* Is the methodology workable? Issues include: organisation, resources and elapsed time.
- *Usefulness.* Does the procedure produce workable results? Issues include: short term perception of value, medium term actions/changes, and long term significance to the company.
- *Functionality.* Do the procedure and its modules achieve their aims? Issues include: degree of congruence between the goals of the company and the capabilities of the procedure; flexibility and facilitation.

These criteria are used to determine the overall success of the methodology, based on post-assessment questionnaires provided to participants. The questionnaires were designed to include assessment of the various implementation factors, and hence the success criteria. The overall response for each criterion is summarised in Table 3, for the applications which have been completed. Although limited data are currently available, the indications are that the procedure is achieving acceptable performance levels. The development and testing of the procedure have raised the following issues:

- It is important to test prototype procedure modules at an early stage, as several iterations may be required to ensure that the methodology is successful in the industrial context, in terms of the above criteria.
- It is important to try to measure the success of such procedures, although this may be difficult owing to the "soft" nature of many technology management issues, and the subjective nature of the outputs. The judgement of the participant companies on the usefulness of the procedure was is the most important measure, supported by evidence of change in the organisation attributed to the application of the procedure.
- Ideally, the testing of such procedures would entail a much larger test programme than is feasible, bearing in mind resource limitations and issues of company access. Thus, the results from a limited test programme must be carefully considered, in order to achieve maximum benefit.

3.3 Company comments

In addition to ranking issues of usability, usefulness and functionality, the post-assessment questionnaires capture associated comments. A selection of these company quotes are given below.

- Reasons for undertaking procedure:
  "To raise the profile of technology management and associated practice, also to capitalise on other

TABLE 3. Success criteria, implementation factors and company ratings

Success criteria	Implementation factors	Application context			
		Full procedure		Strategic overview only	
		D3	T1	T2	T3
Usability	People Facilitation Ownership/support Format	M	H	M	H
Usefulness	Need Ownership/support Timing	M	M	L	H
Functionality		L	M	M	H

Key: L = low, M = medium, H = high achievement in terms of success criteria.

cross-functional efforts at the time to develop a product strategy management process".
"We wanted to improve the link between R & D programmes and the future business plans and to improve the return of investment from R & D expenditure".
"To help newly formed company groups to define critical areas of technology/business mismatch".

- Evidence of change due to the process:
"The assessment increased the general awareness and understanding across the functions and levels of groups involved. In consequence there is an emerging willingness to manage technology more effectively in the business".
"The priority given to one technology was increased following the Strategic Overview".
"A specific design area was identified as a key issue, together with several other mismatches of effort/value/risk".

- General comments:
"We clearly have a long way to go in developing technology management as a conscious practice within the company. Our effort to develop this area of management will undoubtedly incorporate the five-process model in one form or another, along with a number of the tools and concepts used in the assessment procedure".
"Overall the assessment procedure was a very useful and successful exercise. It provided a logical place to start, exposed the ways in which the company inherently managed (or not) particular technologies, and certainly helped in raising the general awareness and understanding of what technology management is about".
"Involvement in the project and assessment helped to focus attention within the company on technology management—specifically the links between R & D programmes and future business plans. There is still a long way to go, but the assessment helped us to start".

4. SUMMARY AND CONCLUSIONS

This paper has summarised the structure and application of a procedure for assessing technology management activities and processes in manufacturing firms. The top-down procedure is comprised of three stages, which start at the strategic level in the firm, and drill down to operational processes:

(1) The Strategic Overview aims to construct a framework linking technology to business objectives, and to support the selection of appropriate areas of for more detailed assessment.
(2) The Process Overview aims to capture key technology management activities and events in the area of interest, and to characterise these in terms of generic processes. The effectiveness and importance of each process area is assessed, enabling strengths and weaknesses to be identified, and appropriate areas identified for further more detailed assessment.
(3) The Process Investigation aims to map the selected process area in detail, and assess the effectiveness of the process components by comparison with generic technology management process models. In this way specific areas of strength and weakness can be identified, and requirements for improvement plans recommended.

The procedure has been developed and tested in close collaboration with a range of companies, in a number of industries, including aerospace, automotive, electrical, electronic, marine and pharmaceutical. The test programme is currently progressing in order to extend the range of applications, and to refine the associated guidelines for application of the procedure.

The five process technology management model has been found to have broad application, owing to its apparent simplicity. However, technology management processes are typically embedded within other cross-functional business processes, and understanding the relationships between these processes is a complex task. The assessment procedure provides a structured means of mapping out these processes and linkages, and assessing their effectiveness.

The technology management process assessment procedure has been designed to be flexible, in order to be able to adapt to the particular issues and concurrent processes in different firms. The core content of the procedure is generic, and can be applied to virtually any organisation. This content is then mapped onto the particular company context, by defining the meaning of key terms (e.g. technology and business areas, value, effort and risk, charting and ranking). A key component of this "adaptive interface" is feedback and facilitation of the workshop based process, and extensive guidance is included in the *process guide* for the procedure, which has a "workbook" format, and is a primary output from the research project.

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ressource la plus importante est également celle qu'elles ont le plus de difficulté à gérer.

En s'inspirant de la définition de *compétence fondamentale* de Prahalad et Hamel, on avance l'hypothèse qu'une des raisons des difficultés qu'éprouvent les sociétés pour identifier les compétences basées sur les connaissances tient à la nature tacite de ces mêmes compétences. La communication décrit un modele qui a été développé par un des auteurs (Boisot) et qui pourrait aider les entreprises à identifier et à gérer leurs compétences. Elle se penche ensuite sur l'application du modèle dans les deux sociétés suivantes: BP Exploration et Courtaulds. Elle en conclut d'une part que le modèle offrait un cadre utile pour permettre aux deux entreprises d'explorer leur propre patrimoine de connaissances, d'autre part qu'il donnait un meilleur aperçu dans les deux organisations.

Strategien zum Management von Wissensaktiva: die Geschichte zweier Firmen

Abriss

Wissensaktiva und deren Management stellen gegenwärtig sowohl eine wesentliche Quelle von wettbewerbsfähigem Vorteil für Firmen als auch ein großes Problem dar. Im weltweiten Umfeld wird zunehmend anerkannt, daß die Art und Weise, in der Firmen ihre Wissensaktiva mobilisieren und benutzen, einen bedeutenden Unterschied zwischen ihnen darstellen kann. Gleichzeitig wird jedoch anerkannt, daß die Art und Weise, in der Firmen auf ihre Wissensaktiva zugreifen und sie managen ein großes Problem sein können, so daß Firmen sich in einer Position befinden, in der ihre bedeutsamste Ressource gleichzeitig diejenige ist, deren Management die größte Herausforderung darstellt.

Auf der Grundlage von Prahalad und Hamels Definition von Schlüsselkompetenz schlagen wir vor, daß einer der Gründe für die Schwierigkeiten, die Firmen bei der Identifizierung von wissensbasierten Kompetenzen haben, in der stillschweigenden Natur dieser Kompetenzen liegt. Die Arbeit beschreibt ein Modell, das von einem der Autoren (Boisot) entwickelt wurde, und von dem wir glauben, daß es Firmen helfen könnte, ihre Kompetenzen zu identifizieren und zu managen. Anschließend wird die Anwendung des Modells auf zwei Firmen — BP Exploration und Courtaulds — erforscht. Die Schlußfolgerung besteht darin, daß das Modell beiden Firmen einen nützlichen Rahmen lieferte, um ihre Wissensaktiva zu erforschen und neue Einblicke in beide Organisationen zu liefern.

Algunas estrategias para la gestión de los bienes intelectuales: un relato de dos compañías

Resumen

Los bienes intelectuales y su gestión actualmente representan para las empresas tanto un recurso importante que contribuye a la ventaja competitiva y a la vez un gran problema. En un entorno global se reconoce cada vez más que la manera en la que las empresas mobilizan y aprovechan sus bienes intelectuales igualmente define la diferencia importante que distingue a una empresa de otra. Sin embargo, se sabe también que el hecho de tener distintos modos de acceso y gestión de los bienes intelectuales disponibles a las empresas constituye un gran problema y, por tanto, las empresas se encuentran en una situación en la que el recurso más crítico supone a la vez el reto más difícil de gestionar.

Basado en la definición de Prahalad y Hamel de competencias claves, se propone que una de las razones por la que las empresas han experimentado dificultades en identificar las competencias en materia de conocimientos es la naturaleza tácita de estas competencias. El artículo describe un modelo desarrollado por uno de los autores (Boisot) que se considera útil para las empresas en la identificación y gestión de sus competencias. A continuación se comenta la aplicación del modelo en dos empresas: BP Exploration y Courtaulds. Se deduce que, en primer lugar, el modelo proporciona un marco que puede servir a las dos empresas para mejor explorar sus bienes intelectuales, y, segundo, que genera nuevas perspectivas de comprensión en las dos organizaciones.

Technology management in manufacturing business: process and practical assessment

R. Phaal, C.J. Paterson and D.R. Probert

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La gestion de la technologie dans la fabrication: évaluation des procédés et pratique

Résumé

Le rôle de la technologie comme source de supériorité sur la concurrence est de plus en plus important dans les sociétés industrielles, au fur et à mesure de l'augmentation du coût et du rythme des avances technologiques. La gestion efficace de la technologie passe par l'intégration des fonctions techniques, de marketing, financières et de personnel. En outre, il est indispensable d'intégrer également des processus stratégiques et opérationnels.

La présente communication décrit la structure et l'application d'une procédure d'évaluation de la gestion de la technologie, basée sur un cadre de gestion de la technologie à cinq niveaux (identification, sélection, acquisition, exploitation et protection). Cette procédure présente un moyen de révéler et d'évaluer l'intégralité des pratiques de gestion de technologie dans une société de fabrication. La méthode est basée sur une approche souple 'du haut en bas', qui couvre à la fois les aspects stratégiques et opérationnels.

Management von Technologie in Fertigungsunternehmen: Verfahren und praktische Beurteilung

Abriss

Die Rolle von Technologie als einer Quelle von wettbewerbsfähigen Vorteil wird zunehmend wichtiger für die Fertigungsindustrie, da die Kosten und die Geschwindigkeit des technologischen Fortschritts zunehmen. Effektives Management von Technologie erfordert die Integration von technischen Funktionen, Marketing, Personalressourcen und finanziellen Funktionen. Zusätzlich dazu ist die Integration von strategischen und betrieblichen Verfahren unabdingbar. In dieser Arbeit beschreiben wir die Struktur und Anwendung eines Beurteilungsverfahrens für Technologiemanagement — auf der Grundlage eines Rahmens zum Technologiemanagement, der aus fünf Verfahren besteht (Identifizierung, Auswahl, Erwerb, Ausschöpfung und Schutz). Diese Vorgehensweise bietet ein Mittel zur Aufdeckung und Beurteilung des vollen Umfangs von Praktiken des Technologiemanagements in einem Fertigungsunternehmen. Die Methode beruht auf einem flexiblen retrograden Ansatz, der sowohl strategische als auch betriebliche Aspekte einschließt.

La gestión de la tecnología en la fabricación: la evaluación de procesos y de la práctica

Resumen

La contribución de la tecnología a la ventaja competitiva viene a ser cada vez más importante para la industria de la fabricación, a medida que el costo y el ritmo de los avances tecnológicos aumenten. La gestión efectiva de la tecnología requiere la integración de las funciones técnicas, de marketing, de recursos humanos y financieras. Además es imprescindible que los procesos estratégicos y operacionales se integren.

Se describen la estructura y la aplicación de un procedimiento de evaluación de la gestión de la tecnología que se basa en un marco de gestión de la tecnología de cinco procesos (la identificación, la selección, la adquisición, la explotación y la protección). Este procedimiento permite revelar y evaluar la gama completa de prácticas de gestión de la tecnología en una empresa de fabricación. El método se basa en un enfoque flexible de arriba hacia abajo, que abarca temas estratégicos a la vez que operacionales.

Hotspots in complex product systems: emerging issues in innovation management

Karen Lee Hansen and Howard Rush

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"Points chauds" dans les Systèmes de Produits Complexes: les problèmes nouveaux dans la gestion de l'innovation

Résumé

Les Produits et Systèmes Complexes (CPS) jouent un rôle croissant dans les activités économiques des entreprises, des industries et des nations. Sous l'effet de l'évolution des marchés et des technologies, on relève, depuis plusieurs années, une orientation vers les CPS, en particulier dans les pays évolués. Cependant, ce n'est que récemment que l'importance des CPS a été reconnue et examinée systématiquement. La présente communication se penche sur les problèmes ou 'points chauds' que les sociétés éprouvent dans le développement et la production des CPS et tente d'identifier plusieurs tendances communes en six études de cas en profondeur menées auprès de