CORPORATE STRATEGY AND TECHNOLOGY MANAGEMENT: CREATING THE INTERFACE*

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ABSTRACT

The methodology presented here was developed around a morphological construct proposed by Alan Fusfeld, linking products to technologies through the processes of value addition in an enterprise. In addition to creating an additional management perspective on the business and providing a structured means of communication between strategic management and technology management, it represents a unique means of determining which technologies, from the multitude "out there" are relevant to the particular enterprise. This helps to define technology for the enterprise and limits the amount of resources applied to monitoring and tracking of technologies. This part of the methodology is labelled a technology balance sheet, or TBS.

A first expansion on the primary TBS construct is to add an analysis of product life cycles to the right-hand side of the balance sheet, which gives a profile of product succession in the various product classes, to ensure the constant flow of new products necessary to sustain and grow the income stream to the enterprise. A second expansion to the primary TBS is to add a profile of the life cycle stages of the technologies identified on the left-hand side of the balance sheet. The construct is now referred to as the technology income statement, or TIS, since it links future income to technologies, through products and processes. It also provides a means for (especially more complex) enterprises to ensure that investment in technology to support future income, is done with due attention to the product life cycle, to ensure recovery of, and the desired return on such investment. Many useful variations on the basic concept have been found in different practical applications.

INTRODUCTION.

Corporate strategy is developed and executed in order to ensure longer term survival and growth of an enterprise. In general it is focused on the products to be supplied to customers, in an ongoing and growing relationship that provides the means of success to each customer. The main point of departure for strategy development is therefore the product/market mix of the present and the dynamics envisaged in this mix for the future. This generates alternatives of particular approaches to be followed in terms of competitive advantage, market share, synergy, leader/follower and so on, for each product-market combination. [Ansoff, 1977]

Once these elements of strategy are identified, the requirements with respect to the resources implied by the strategy, must be considered. Technology, as represented by the aggregate of knowledge, skills and tools of the organisation obviously forms one essential resource category to be considered in corporate strategy. Since strategy development is an iterative process, the initial strategy formulated in a given

cycle may express general desire or intent of top management rather than firm commitments. At least some of such desires to enter a new market or launch a new product may be subject to technological feasibility. These should thus be delegated to the technology manager for evaluation and proposal of scope and content of action, in order to achieve such desires. At the same time the technology manager may suggest new opportunities offered by technology.

In both cases this represents a vital interface between corporate strategy and the management of technology (MOT) function "lower down" in the organisational hierarchy. Appropriate communication across this interface is essential if technology is to receive its proper share of attention at corporate level and the opportunities for improvement and survival are not to be lost. [Adler & Ferdows, 1990, Wolf, 1990]

In practice this requires that technology managers have to learn to communicate in the language of corporate management. More often than not, corporate managers find it difficult, if not impossible to translate MOT-jargon into their particular perspective. It would thus seem desirable that at least some of the concepts used to convey information from the technology area into the corporate environment, should contain words and notions familiar to members of that level. This is illustrated in the discussion below.

THE TECHNOLOGY BALANCE SHEET

Introduction
The Product/Market mix, is usually presented as a morphology as shown below:

<table>
<thead>
<tr>
<th>PRODUCTS</th>
<th>( P_1 )</th>
<th>( P_2 )</th>
<th>( P_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>M2</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>M3</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>M4</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Figure 1: Product/Market mix
Combined with market share, market size, market dynamics, product maturity, competitive behaviour (self and competitors) and risk evaluation, it provides the manager with an immediate picture of "where we are" and stimulates a systematic analysis of "where to go" as well as "where to get out".

By adding processes and technologies in the way shown in Figure 2, the Technology Balance Sheet (TBS) is obtained. [Fusfeld, 1989] Processes are defined broadly as value addition activities in the business, necessary to produce a product/service, as indicated by the crosses in the appropriate column. Similarly, technologies are defined broadly as the capabilities required to execute a process. [Burgelman & Rosenbloom, 1988; De Wet, 1990, De Wet, 1992].

![Technology Balance Sheet](image)

Figure 2: Technology Balance Sheet
This is called a TBS, because it shows the sources and application of technology in the company. This name also provides an immediate point of reference to the manager that understands the normal financial balance sheet and the information contained in that model of the business.

Application

The first function of the TBS is to provide a list of technologies relevant to the present business of the firm. Since technologies tend to be labelled in functional terms, this would give an indication of which of the multitude of technologies "out there" should be relevant to the firm.

Next, it provides an additional set of questions around markets and products, and may stimulate recognition of threats and opportunities. For example, if process PR1 was only used for product P1 and not for P2, the viability of maintaining a single process based on a single technology for a single client should be questioned (synergy in Ansoff terms). Similarly an expansion of the customer base may require additional processes and/or technologies. By expanding the TBS in figure 2 and adding dates as shown in Figure 3, some of the dynamics of future action could be illustrated.

![Figure 3: Expanded TBS Indicating future goals](image)
A note of caution
A distinction between "Processes" and "Technologies" in the TBS is not a straightforward process. It may take a number of iterations to find a "good" structure. This process in itself yields a valuable insight into the actual nature of the business and could thus lead to some more pertinent questions about strategy across the technology/corporate interface. The value chain model of the business [Porter, 1985], could provide a list of generic value addition activities as a point of departure for the identification of processes in the TBS.

Some alternative approaches

Core competencies
One alternative to having processes in the middle part of the TBS would be to emphasise Core Competencies there. [Prahalad & Hamel, 1990] This would be of particular interest to service type industries where processes may tend to be generic and thus less specific for the purpose of stimulating an alternative perspective on the business.

Complex symbols
Instead of using simple crosses to denote cross impact between two variables, more complex symbols may be used, such as digits to indicate strength of impacts or symbols to show present and future impact. Many variations have been found valuable in practice.

Financial Values
Investments in technologies and processes may be entered into a similar format with expected earnings per product to get an indication of ROI on technology per process. CSIR (South Africa) has developed a complementary system to support quantitative decisions on portfolio management, at both business unit and corporate levels. The TBS presented in this paper is therefore referred to as the morphological TBS.

THE TECHNOLOGY INCOME STATEMENT
Introduction
The technology income statement (TIS) also starts from the customer base (Product/Market mix), but in this case it is expanded into a morphology showing the maturity of products by means of expected future cash flows, as shown in Figure 4 below.
Figure 4: The Technology Income Statement

Products are classified into four categories, i.e.
- Products in the logistic phase, i.e. products sold to customers and generating an income due to spare parts and other logistical services being rendered
- Products that are being produced and will be in production for some time in the future
- Products that are under development and will only be produced in future
- Products that are still in the research phase and that would only go into production in the medium to long term.
Application

This morphology is called the TIS, because it identifies the contribution expected from the various product/market combinations and, by tracing this back through the TBS, the future contribution to be made by various technologies.

The first function of the TIS is to provide an indication of which technologies (or class of technologies) would be worth monitoring, due to their expected future relevance and contribution, as well as the level of resource allocation that may be appropriate for this monitoring activity. The second function of the TIS is to guide technology selection during the technology acquisition process. As a general guideline, the following typical strategies would apply to the various product life-cycle categories:

- **Products in Logistic Phase** - No investment in new technology. The main strategy should be to decrease cost of production and inventory in order to improve profit - focus on productivity.
  In some larger, long life-cycle products, intermediate performance-upgrades may be appropriate. In such cases investment in a mature technology should be considered.

- **Products in Production Phase** - investment in process technologies to improve productivity, quality and so on, may be found to be economically attractive.

- **Products in Development Phase** - design and test capabilities may be required; some attention should be given to using new products as an opportunity to establish production processes for future use, while phasing out present ones.
  New but proven technologies should be considered.

- **Products in the Research Phase** - technology selection is of prime importance. The effect of choices made at this point will only appear when it is usually too late to escape undesirable outcomes. Technology in this phase would refer to both product as well as process technology, and should provide maximum time to harvest income before the technology is replaced.

Two "life cycles" must be distinguished here, i.e. the product/process life cycle in terms of actual company business and the technology life cycle, or S-curve referring to the maturity of specific technologies. They are not necessarily coincident! MOT specialists and most small and medium-sized enterprises may find this remark rather trivial. Larger organisations need to manage this correlation formally. [Ansoff, 1986]
Figure 5 suggests one way of correlating product and technology life cycles. Two versions of the technology life cycle are indicated on the technology analysis map: View 1 is the more generic version, while view 2 is typically utilised by Arthur D Little, Inc. [Roussel, 1991]

![Diagram of technology analysis map]

**Figure 5: Correlation between Product/Process and Technology life cycles**

**Summary**
The two perspectives generated by the TBS and TIS respectively are:

- How to narrow down the search for technologies relevant to the enterprise, and
- How to distinguish between those that have relevance in the longer, rather than the short term.
However, this second process of strategic evaluation presupposes a skill in technology analysis, as discussed in the next section.

TECHNOLOGY ANALYSIS

While the TBS and TIS are intended to provide an answer to the question of "which technologies are relevant to the enterprise", - (even though this may only be a point of departure) - the main purpose of technology analysis could be stated to be the answer to the question of "how to observe technologies and interpret the information obtained in this way".

The wide range of perspectives and models developed in this respect, such as the functional classification of artifacts, the notions of trends and limits to attributes, S-curves and so on, provides the technology manager with a means to gain insight into and an understanding of the dynamics of the technological environment and thus be able to decide upon which technologies to choose for future utilisation.

A more detailed discussion of technology analysis is considered to be beyond the scope of this presentation, since it is a well-publicised topic [Van Wyk, 1988] and the main purpose of the present discussion is to highlight one of the lesser-known "tool-sets" developed around the MOT-process.

CONCLUSION

The purpose of technology in an enterprise is to contribute towards the achievement of corporate strategy and often to allow new strategic opportunities to be pursued. It is therefore a strategic imperative that trends and changes in technology should be observed and interpreted on behalf of the enterprise. The dilemma faced by companies to select those technologies that are relevant from amongst the multitude that are available, is addressed by the construct of the morphological technology balance sheet. In fact by constructing a map of the competitive strategy for each product-market combination, a direct trace could be made from technology to competitive strategy.

In addition, the technology income statement takes the process of technology identification forward into strategic planning, to ensure effective correlation between product/process and technology life cycles.

These concepts have been applied in a variety of companies of varying sizes over a considerable time span and have proven to be of practical utility, not only in its
generic form, but also as the point of departure for variations tailored to specific applications.

REFERENCES
Fusfeld, A: Lecture, Summer School: The Management of R&D and technology-based Innovation, MIT, Cambridge, Ma. June 1989. (Note: Fusfeld did not suggest the name Technology Balance Sheet, but proposed the structure to relate technologies to products via processes).