The Development and Use of Strategic Business Performance Improvement Frameworks for Rapid Prototyping and Tooling

Executive Summary

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SUMMARY

Increasing global competition within industry has forced businesses to respond by reducing costs and product development lead times in order to survive. In the automotive industry, these strategic responses include the specific exploitation of new technologies and mergers with other companies to gain economies of scale.

BMW AG purchased Rover Group in 1994 but it wasn't until 1998 that competitive pressure led to the completion of the merger through the creation of a single "Group Function" structure within BMW Group. The BMW Board stated high-level objectives for the process but provided no mechanism to convert them into reality.

Similarly, the BMW Group Board initiated a business process "Re-engineering" programme in 1997/8 and stated cost, time and other objectives that would have to be met. The technical and process changes that would help to achieve the business improvements were being largely driven from the bottom of the organisation but there were no frameworks available to guide strategic technology introduction.

The principal innovations generated during the course of this research are frameworks for:

- Maximising the business benefits from the creation of 'Group Functions'

- Internal strategy creation for technology-based business sub-units

These two new frameworks have for the first time provided management and staff with the means to develop meaningful strategies and operational action plans from the corporate strategic objectives. The economic and business literature concentrates mainly on whole business strategy and merger activity, neglecting the need for guidance at the sub-corporate level. Although corporate strategy can provide the overall direction of a company, it is the managers that have to drive strategic change within the business.

The frameworks were developed by the author based on an in-depth review of the literature and the specific context relating to Rapid Prototyping & Tooling (RP&T) within BMW. The frameworks were validated within the business situation and further enhanced where appropriate.

The Group Function framework fills the process gap between the high-level objectives and the need for operational action plans. It provides a straightforward and easy to communicate structure to the process of optimising duplicated business sub-units. Use of the framework led to the retention of both RP&T teams and the initiation of beneficial synergistic activities. The framework should be applicable to other similar groups in similar circumstances.

The author developed a new strategy creation framework that for the first time combines a range of strategy development approaches from within the literature into a practical framework for sub-corporate strategy development. The framework was matched to the specific context of the RP&T case but could be used in other similar circumstances. The framework was used to successfully develop a new strategy for RP&T in BMW Group and includes new approaches developed by the author that reduce the impact of environmental change and uncertainty. The framework has been described in a stand alone form that can easily be more widely exploited.

To Jane, Clare and Sarah

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Declaration

I declare that the project work described in this report was produced by myself and none of it has been previously submitted for any academic degree. All sources of quoted information have been acknowledged by means of references.

Glossary

Bereich – A function within a division of BMW (*"Ressort"*) containing a number of higher level departments (*"Hauptabteilung"*).

CAX – Refers to any computer-aided process. For example two processes included within "CAX" are 'CAD' which is 'Computer Aided Design' and 'CAM' which is 'Computer Aided Manufacture'.

Context – The set of relevant business and other circumstances that relate directly to the group of particular interest. The word 'context' is generally used when discussing strategy development for a specific business unit. The relevant "context" for a case will lie within the broader business *"environment"*.

Core contextual themes – In order to describe a specific context it may be useful to break it down into a small number of broad themes. In order to differentiate the case-specific themes from others, they have been called "core contextual themes". The main purpose of the 'core contextual themes' is to guide the development of the *'strategy creation framework'*.

Element – Used within section 3 of this report. An element describes the smallest divisible activity or *"sub-team"* that performs an identifiably distinct *"function"*. The *TI-314 Group* was divided into "elements" for the purposes of analysis of the UK and German *"teams"*.

Environment – When referring to strategy development, the term "environment" is used to describe the broad, mainly business-related circumstances relating to a case. Not all of the environmental issues will be directly relevant for the purposes of strategy development. The business "environment" for a case includes the *"context"* that relates directly and specifically to that case.

Function – The word is used mainly in section 3 to describe the collective activities of a *"sub-team"* or *"element"* within *TI-314*. For example, performing all customer interface activities would be considered to be a "function" within "TI-314".

Generic strategy theme – A strategy can be considered to be a solution to a problem. . A 'generic strategy theme' is a solution to parts of the original 'problem' that vary over time or are difficult to define. A generic strategy theme is devised such that it reduces or eliminates the negative effects of some of the variables (or *'strategy influences'*) within the overall 'problem'. There may be several generic strategy themes within any one strategy, or possibly none.

Group – When not used in the names "BMW Group" or "Rover Group" or as a word in its own right within a sentence, the term "Group" refers to the "Rapid Prototyping and Tooling Group" *TI-314*. A "Group" within BMW Group is a team or set of teams working together below the *"Abteilung"* (department) level. The word is most heavily used in section 3.

Group Function – When the BMW Group board decided to bring Rover Group fully into the BMW AG organisation, they referred to the functions within the new

organisation as "Group Functions". A Group Function was consequently any organisational sub-unit that reported to a single manager that covered that set of activities for both the UK (Rover Group) and Germany (BMW AG).

Hauptabteilung – A higher-level department containing a number of departments (*Abteilung*) and reporting to the head of a *"Bereich"*.

Operational action plans – A set of plans at the operational level within an organisation e.g. *"Group"* level, that are followed in order to achieve a specific objective or set of objectives.

Rapid Casting (RC) – Casting methods that are based around Rapid Prototyping techniques.

Re-engineering – BMW Group initiated a business process re-engineering project (BPR). When the term "re-engineering" is used within this report it refers to the BMW Group project unless otherwise stated.

Research question – If a *strategy* is a solution to a problem, then the work that needs to be undertaken to solve the problem is defined by a set of 'research questions'. The answers to the research questions eventually lead to the creation of the *'strategy'*.

Ressort – A division within the company, headed by a member of the BMW Group board reporting to the CEO. Each Ressort has its own letter to identify it and has a number of *"Bereich"* within it.

Rapid Prototyping (RP) – Originally used for the Stereolithography technology, the term is used as a collective term for any (usually layer-based constructive) technology that is based on prototype part manufacture from CAD data. It usually excludes CNC techniques.

Rapid Prototyping and Tooling (RP&T) – The term is used for the name of the *"TI-314 group"* as well as an inclusive term for all Rapid Prototyping, Rapid Casting and Rapid Tooling technologies.

Rapid Tooling (RT) – An inclusive term for all tooling technologies and processes that are faster than conventional methods. Although most are considered to use layer-based RP technologies either directly or indirectly, the term can also include High Speed CNC machining.

Strategy – A strategy provides a vision of the desired future, a set of clear objectives and a set of guiding principles within which the objectives may be achieved.

Strategy development/ creation framework – Describes the complete set of guidelines that can be used to create a *strategy* for a particular case. The framework consists of a *"process"* and a number of tools and principles. The words "development" and "creation" are used interchangeably depending upon the syntax or grammatical requirements within a sentence.

Strategy development/ creation process – Describes the means or set of actions that result in a strategy being developed/ created. The words "development" and "creation" are used interchangeably depending upon the syntax or grammatical requirements within a sentence.

Strategy influence – A strategy is shaped by key factors of influences within the relevant business "*environment*" or "*context*". The shaping factors are referred to as "strategy influences".

Sub-context – The "*context*" of a particular case is likely to be made up from a number of identifiable situations referred to as "sub-contexts".

Sub-team – A "sub-team" is a sub-unit or group of people within a *team* that perform a *function* within that *team*. The word is most heavily used in section 3.

Target Setting – The process used by BMW Group to set annual targets for every manager and "*team*" within the business. The process is cascaded down from the board with input and acceptance at three concurrent reporting levels at a time.

Team – The word 'team' is used in its normally accepted sense to describe a number of people working together. In this report, the word is commonly used to identify members of either the German or UK "*TI-314 Group*". The word is most heavily used in section 3.

TI – Coded name of the "*Bereich*" responsible for engineering technology integration within each vehicle and manufacturing logistics.

TI-3 – Coded name of the 'Experimental Vehicles' higher-level department ('*Hauptabteilung*')

TI-314 – Otherwise known as "*Rapid Prototyping and Tooling*" abbreviated to "*RP&T*". TI-314 is part of the "Prototype vehicles" department *TI-31*, which is in turn part of the higher-level department "Experimental Vehicles", *TI-3*.

Contents

Tables

Figures

1 Introduction

1.1 Industrial Competition

Although businesses have probably always had to compete with each other for market position, the vigour of the competition is ever increasing as markets become more global and barriers to competition fall (Hamel, 1999; Porter, 1996). The speed of change is epitomised by the rapid emergence of digital technology (Downes and Mui, 1998). Technological change is one of the principal drivers of competition as it pervades the value chain and plays a major role in structural change and the creation of new industries (Porter, 1985).

Companies are competing primarily on the cost and response time of providing a service or product. Indeed, being late to market with a new product can cost a company very heavily by increasing the cost of development and manufacturing while reducing market price and profit margins (Hendricks and Singhal, 1997).

However, a strong competitive position on the cost and lead-time for the introduction of new products can strengthen a company's competitive position in additional ways. For example Honda and Toyota have been able to produce a greater variety of products than their competitors, providing the customer with a wider choice and hence a closer fit to their personal requirements (Stalk, 1988).

1.2 Strategic Responses in the Automotive Industry

During the late 1980s, Clark and Fujimoto (1991) identified two generic competitive strategies within the automotive industry:

- 'High-end specialists' who base their competitiveness on superior product ('Product Leadership')

- 'Volume producers' who compete on product price.

Over the last 40 years, the relative price of different automobiles representing these two strategies has converged (Leverton, 1998). Pressure has consequently been put on the high-end specialists, such as BMW AG, to increase technical innovation for differentiation, emphasise their brands and become more cost and lead time competitive (ibid).

The following sections identify some of the strategic responses to the competitive demands on the business.

1.2.1 A 'Platform' strategy

One solution to the product cost challenge is to reduce the variety of *completely* new vehicle designs generated within the company. By carrying-over a large proportion of the under-skin content of vehicles (the 'platform'), the development cost of each

1

new vehicle can be significantly reduced and consequently a greater variety of vehicles can be produced cost effectively and in a shorter time.

Ford, Volkswagen, Toyota, Honda and General Motors have successfully adopted a 'platform strategy', where they are looking to produce over one million vehicles per platform (Leverton, 1998). Other major manufacturers including Chrysler, Renault, Peugeot and Fiat are adopting a similar approach (ibid). A disadvantage of the platform strategy approach for the high-end specialist producers is that the commonality between vehicles may also reduce differentiation between them.

1.2.2   Product Leadership versus Process Leadership

Figure 1 below illustrates the competitive challenge between the core strategies of the automotive manufacturers. The companies that have pursued a 'Product Leadership' approach aim to consolidate their position through a stronger process focus. Those companies that are volume producers and have developed excellent processes are aiming to improve their products to remain competitive.
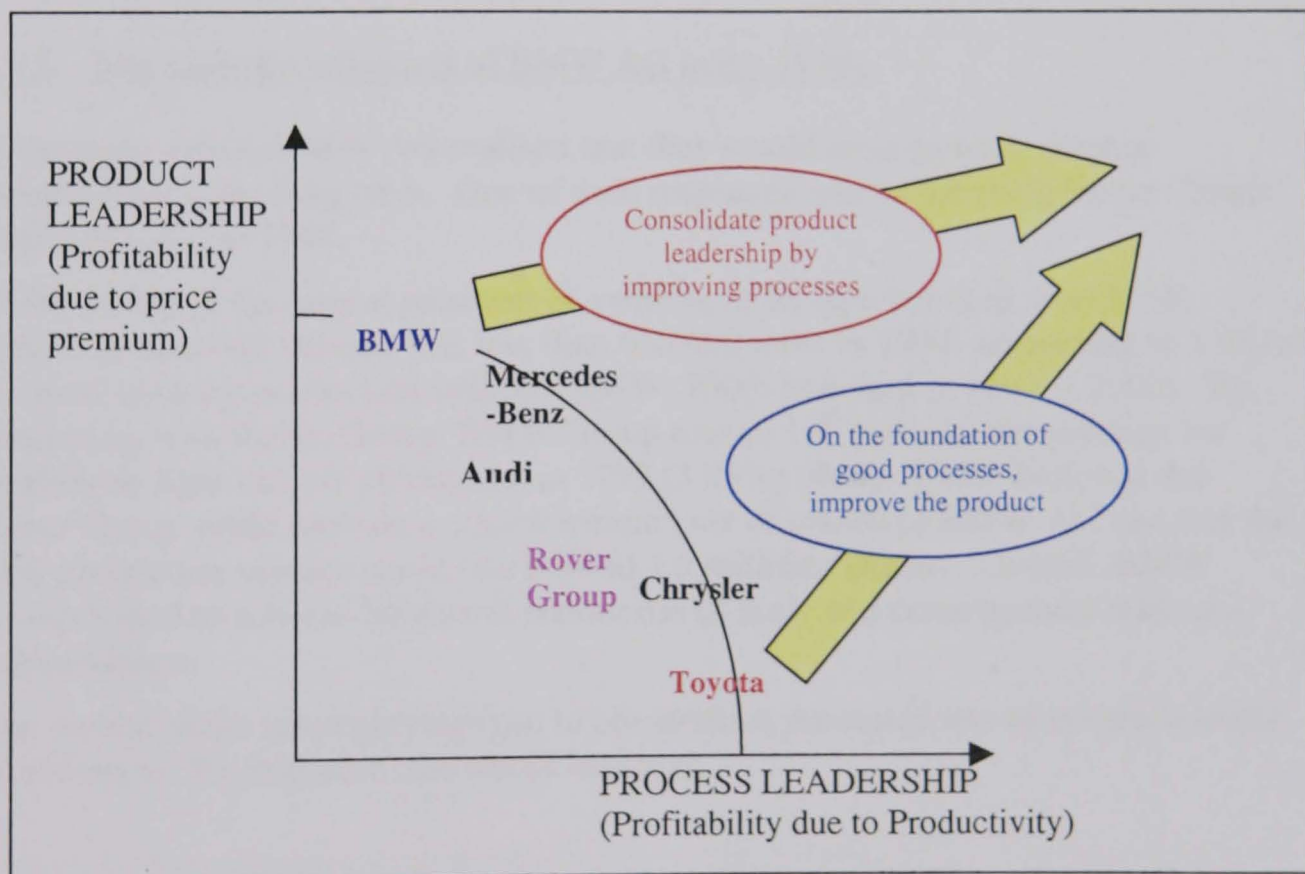
Figure 1. The Product Development Leadership Race of the Top Automobile Manufacturers. Adapted from McKinsey 1997.

1.2.3   Reduction of new product lead time and cost through Concurrent Engineering

None of the automotive companies can afford to be complacent about product development lead-time. In 1997, the average new product lead time in BMW was 60 months compared to US competitors taking 33 to 37 months and Toyota only 19 months (McKinsey, 1997).

One response to the need to improve processes is to introduce Concurrent
Engineering (CE) during the new product development process (Leverton, 1998). CE
helps to reduce product development lead times by performing as many design
processes in parallel as possible. Central to the success of CE is the appropriate use
of new technologies, most importantly Computer Aided Design (CAD) tools and
Rapid Prototyping (RP) (Jacobs, 1996; Clay and Smith, 2000).

1.2.4   Improving competitiveness through mergers and acquisitions

Another strategic response to the cost and lead-time competitive challenge is to
merge with or acquire other companies that can enhance the competitive position.
Synergies and other economies of scale can be gained in this way that can potentially
reduce costs or otherwise enhance operations (Hay and Morris 1979).

1.3   Strategic change within BMW Group

1.3.1   The strategic responses of BMW AG in the 1990s

In the early 1990s, BMW AG realised that they would have to act to remain
independent in the long term. One of their responses was to purchase Rover Group,
which they did in 1994.

BMW Group is the largest producer of vehicles of its type but their worldwide
vehicle production volume was less than 650,000 units in 1994, amounting to 1.9% of
the total industry production volume (BMW, 2000; Standard & Poor's, 2000). By
combining with Rover Group, BMW Group rose to 13th place in the rankings for
worldwide light vehicle production in 1999 (3.05%) (ibid). BMW believed that
Rover Group could provide a complementary set of brands to BMW AG and that the
total production volume could rise beyond 1.5 million vehicles. Overall, BMW
Group hoped to achieve long-term economies of scale and consequently maintain
independence.

The second major strategic response to competitive pressures was to initiate a series
of actions to 'Re-engineer' the whole business.

1.3.2   The BMW Group "Re-engineering" initiative

In 1996, BMW Group started an investigation into its competitiveness in conjunction
with the McKinsey firm of consultants. They identified that to remain competitive in
the long-term; they would have to reduce their cost of quality by increasing their
process focus (Figure 1 above). Rover Group on the other hand would need to
improve their product focus as highlighted by the diagram.

The review also highlighted that the BMW product development lead-time from
concept sign-off to Start of Production (SOP) would have to be virtually halved from
the existing 60 months. Reduction of the development lead-time would be achieved
through a greater focus on process and reduction of the manpower required to

3

develop a new vehicle. These would in turn reduce costs and increase the competitiveness of BMW products.

Following the competitive review, the BMW Board set the following strategic targets for "Re-engineering" in March 1997:

1) **Time to Market** – A 50% reduction in the development programme from concept freeze to SOP down to 30 months

2) **Development Costs** – A 30% reduction in the 'one-off' costs of product development compared to 1996

These targets were later used within the BMW Group 'Target Setting Process' that was initiated on 12th December 1998. 'Target Setting' provided the basis for cascading the BMW Group Re-engineering, Group Function and other strategic goals throughout the whole organisation and linking them into operational plans.

1.3.3   The formation of Group Functions within BMW Group

BMW invested more than £2bn in Rover Group over the 5 years following the purchase in an attempt to bring the infrastructure up to the high standard required of a BMW Group company. The original Rover Group Board was retained until the end of 1996 when the CEO of Rover Group was replaced by a BMW Board member. The new CEO maintained the low impact approach to the company but towards the end of 1998 it was clear that Rover's problems were becoming serious. On 23rd October 1998, the CEO was again replaced but this time a 'Turnaround Team' was announced, marking the beginning of a strongly interventionist approach to managing Rover Group. One of the outcomes from the announcement was the drive to set up 'Group Functions', bringing all Rover Group and BMW AG employees under a single organisational structure.

1.3.4   Rapid Prototyping technologies can help accelerate product development

Many case studies have demonstrated that among other things, the correct use of Rapid Prototyping and related prototyping technologies can significantly reduce the lead-time and costs of component development (Jacobs, 1996; Vasilash, 1997; Ramage, 1999; Clay and Smith, 2000).

Both Rover Group and BMW AG have mature Rapid Prototyping facilities that contribute to the new vehicle development programmes. The German and the UK facilities have some overlapping activities but also have complementary functions.

At the end of 1997, the BMW Group leadership decided to combine the Rapid Prototyping and Tooling groups in the UK and Germany, referred to internally as "TI-314", under a single manager (the author) from 1st June 1998.

1.3.5   The challenge for Rapid Prototyping & Tooling

There were two challenges facing the Rapid Prototyping & Tooling management:

(i) **Short term:** How to achieve a fully integrated single Rapid Prototyping & Tooling Group within BMW Group

(ii) **Medium and long term:** To develop a strategy for Rapid Prototyping & Tooling within BMW Group that would enable these technologies to make a significant and positive contribution to the BMW Group Re-engineering objectives

The BMW Group Board provided high-level objectives and guidelines for the Re-engineering and Group Function programmes. The Board did not however provide a mechanism that would enable the middle managers to convert the high-level directives into operational action plans. Some form of framework that could produce operational action plans from the high-level goals would therefore be beneficial to the middle management. If the framework could then be used more widely, it would help to provide a level of consistency in the thinking and approach within the company.

The Re-engineering programme resulted from a high-level strategic review and strategy development process. The top-down approach to strategic development could be referred to as 'deliberate' strategy development (Mintzberg and Waters, 1985) where plans or objectives are created. However, the strategic use of new technologies will be directly involved in achievement of the corporate strategic objectives. A clear understanding of the potential for technology use might normally be associated with staff-level employees and lower management, in which case the strategy might form in an 'emergent' way, from the bottom-up (Mintzberg and Waters, 1985).

There is a bewildering array of advice regarding strategy development at the corporate level but very little that can be used directly by middle management (Mintzberg et al, 1998). Since technological change is central to the Re-engineering strategy (Peppard & Rowland, 1995), it is reasonable to conclude that bottom-up strategic activity will be essential to success. Unfortunately, purely emergent strategy development is relatively unstructured and may not easily contribute to the Re-engineering objectives.

A framework was therefore required for technology strategy creation that enabled bottom-up strategy development to link with the objectives of top-down strategy, introducing strategic thinking lower down the business.

1.3.6   Objectives of the research.

Based on the demands of the business, the research had two primary objectives:

1) **Short term:** To provide a framework that will directly help to improve the *efficiency* of the Rapid Prototyping & Tooling (RP&T) Group in the UK and Germany (TI-314) by full operational integration of the two teams together (Group Function formation).

2) **Long term:** To develop a framework for strategy creation that will result in the creation of a single strategy for the UK and German teams, which in turn will improve the long-term *effectiveness* of the RP&T Group.

5

1.4 Research methodology

1.4.1 Objective 1 – Short term efficiency development of RP&T

The research followed the methodology outlined below:

1.4.1.1 Identification and definition of the problem.

The author identified the problem following a company-wide announcement that all Rover Group departments would become part of the BMW Group structure. The problem was that although the overall objectives had been communicated, they did not give any guidance on how to create a single integrated structure. The absence of guidelines was confirmed by the following data collection actions:

a) The complete set of internal documentation regarding all announcements was obtained through the BMW corporate communications group that control all such publications.

b) Informal discussions were held with appropriate executive and senior management within the business to ensure a full understanding of the issues and situation.

c) A short pilot study was undertaken by the author at the request of the departmental senior executive to clarify the key criteria for decision-making in the departmental structure integration. At the time of its completion, the author's pilot study provided the only guidelines for Group Function creation within BMW Group.

As a result of the above problem identification steps, it was clear that there were no guidelines within BMW Group to assist managers in deriving operational action plans from the high-level objectives in a way that would enable the achievement of the BMW Group objectives for Group Function development. The framework could also be used in other parts of the company to help provide consistency in the approach to the development of a fully combined organisation.

1.4.1.2 A literature review was undertaken for two primary purposes:

a) To identify whether any guidelines for post-merger business optimisation that existed within the literature. The author searched book and journal literature relating to mergers and acquisitions as well as for economic and management theory. The main search resources were:

- "Proquest" and "Ingenta Journals" for a broad-based review of business and socio-economic literature by author, keyword and subject

- "Econlit" was used to search for articles within economics periodicals by subject, keyword and author

- "OPAC" for subject and author searches for all books, periodicals and other contents of the Warwick University library. The main focus was on economic and business management literature.

- Additional authors were identified from within books and refereed papers.

b) Although no directly applicable methodologies were found, the literature search resulted in the identification of a range of relevant material that assisted in the development of the framework and in its use. For example, the literature on mergers and acquisitions provided a depth of background understanding about why mergers occur and what benefits might be expected. The financial accounting literature provided an understanding of cost analysis and comparisons that was used in the Group Function analysis process.

1.4.1.3 Derivation of the new framework for operational action planning.

The author performed two main activities:

a) Linked the BMW objectives to economic theory relating to mergers and acquisitions. The BMW Group objectives were then simplified to provide basic criteria for decision-making during the analysis process.

b) A framework for operational action planning was derived from the literature and the empirical situation relating to TI-314.

1.4.1.4 Measures for success of the framework.

The research was aimed at identifying firstly how effective the framework was in itself, i.e. answering the question 'how well did the framework work?' However, use of such a framework within the business context would do more than produce a direct output. The output itself should have wider implications and impacts. The second question was therefore 'what impact did the output from the framework have on the business?'

Three measures were used and split into two types:

a) **Measurement of the effectiveness of the framework in achieving an appropriate output.** In this case the measure was:

   (i) Whether operational action plans resulted from the use of the framework.

b) **Measurement of the impact on the business of the output from the framework.** The measures were:

   (ii) Whether the eventual structural outcome for TI-314 resulted from the analysis.

   (iii) Whether these actions were applied to the situation and what effect they had.

7

1.4.1.5 Use of the framework within BMW Group.

a) **Subject of the test.** The framework was tested in the live business context of BMW Group using the TI-314 Group as the subject. The author performed all the analysis work.

b) **Corporate data and communications.** The 'FO' department controls all communications produced by BMW Group and so this group was used as the source of all such documentation.

c) **Financial data sources.** Wherever possible, financial data was gathered for the complete year prior to the test itself. Data was taken principally from figures supplied by the BMW Group finance department and from budget data collected internally within TI-314. In a few cases full-year data did not exist. In these cases, data was taken over the longest period prior to the test and extrapolated for a full year if required. Other financial and comparative data was based on surveys performed by the TI-314 teams.

d) **Surveys.** A series of surveys was carried out during the course of the research programme. All the surveys were based on a version of the outline methodology proposed by Oppenheim (1992). The survey methodology was adapted by the author during the initial communications research (see Report 2). The author adopted Oppenheim's outline stages for survey development and use because it provided a useful summary of the approaches taken by other key authors in the field, for example, Moser & Kalton (1971), Evans (1995) and Fink & Kosecoff (1998). Oppenheim's prescriptive approach provides a clarity that is simple to communicate to people who are unused to generating and using surveys. The author personally carried out some but not all of the surveys. However, when other members of the TI-314 teams carried out surveys, they used the same methodology under the guidance of the author.

e) **Comparative data sources.** Benchmark cost and time data was provided through structured surveys performed by members of the TI-314 team in Germany and the UK with direction from the author to compare the performance of TI-314. An overall total of 26 RP bureaux were assessed in this way. Three main case studies with competitor companies provided an insight into the qualitative benefits that could be achieved through use of an internal RP&T capability (these were also used in the strategy research). The case studies were investigated by the author and Baden (Halliday and Baden, 1999). Additional material was obtained from case studies in relevant periodicals. The qualitative data provided background evidence to support the internal analysis work.

1.4.1.6 Results from development and use of the framework

a) Some of the results from using the framework were applied within the annual Target Setting process (see Appendix 2) for the German TI-314 team. Although the Target Setting process was not officially implemented in the UK until early 2000; the author applied some of the key operational actions

8

anyway. Consequently a number of common actions were undertaken between the two teams.

b) The framework was offered to another team within BMW Group and to the corporate training team to further test it out within the business. Unfortunately, BMW Group started to be broken down before any results could be achieved from these other potential users of the new framework.

c) The break up of BMW Group had a direct impact on the results from objective 1 because many of the synergistic effects did not have time to reach maturity.

1.4.1.7 The relevance of Business Process Re-engineering to objective 1

A central feature of the 'live' business environment of this research was the BMW Business Process Reengineering (BPR) (simply referred to as 're-engineering' within BMW Group) programme. The fundamental principles of BPR have a direct relevance to objective 1 in that the primary focus is on the processes that achieve results within a business (Peppard & Rowland, 1995). By focusing on the processes, it is inevitable that work will be done on the two other pillars of BPR i.e. people and technology. Once the BPR strategic direction has been determined, the required changes are carried out through 'operational-level action plans'. The generation of operational action plans is central to the achievement of objective 1 and consequently there are some strong common links between BPR and the work within objective 1.

However, BPR differs from the work within objective 1 in that it looks to achieve step change improvements in both effectiveness and efficiency. Objective 1 was aimed primarily at achieving an improvement in the efficiency of RP&T, with the effectiveness being the function of objective 2. Additionally, although some step changes might be expected in achieving objective 1, the majority of changes are likely to take place over a longer period as the two teams increasingly align functions and processes.

1.4.2 Objective 2 – Long-term strategic development of RP&T

1.4.2.1 Identification and definition of the problem.

The author identified the need for a strategy development process for TI-314 to drive improvement in the long-term effectiveness of the group by:

a) Observing the link between the need for corporate improvement in cost and time in the new product development process and the potential for RP&T technologies to make a contribution. The observation was based on case studies within the business, collaborative projects and papers within periodicals.

b) Identifying the need for a long-term strategy or plan for TI-314 within the business to meet the corporate need for improvement.

c) Examination of the existing strategy development processes against the specific needs of the case and identifying a shortfall. The existing corporate processes were assessed on the basis of their intended purpose, actual use within the business, their inputs, outputs and process to reach a conclusion.

d) A search of the corporate processes and learning database did not reveal any formal procedure for internal strategy development.

The author concluded that either a strategy development process would have to be found that was held more informally within the business, or that a strategy development process would have to be found and/or developed based on external knowledge.

1.4.2.2 The author carried out an in-depth literature review:

An initial broad-based literature review covered the wide range of strategy and business management orientated literature to identify the core themes relating to strategy development. The aims of this review were to:

a) Identify the current thinking about strategy development

b) Identify whether any suitable process had already been created by other authors

c) Understand specific issues that might relate to the TI-314 case

d) Clarify whether the strategy development process can be the same for all cases or whether there might be differences according to the context and content of the case.

The literature review was carried out by using the databases described above plus:

- "Compendex" for engineering periodicals

- "BIDS IBSS" for additional social science papers

- "BIDS ISI" for scientific papers.

The core themes were then reviewed in depth. One core literature theme was that the context, content and process of strategy are linked to each other and are interdependent. The implication of this theme is that the context of the case affects the process and content of strategy development. The context of the case was therefore of primary significance.

1.4.2.3 The author carried out an internal survey on strategy development practice

a) An internal survey was carried out in order to further develop and substantiate the contextual information relating to the strategy development aspect of the case. The main objective was to identify any informal strategy development processes already being used within the company.

b) The survey followed the same procedure used throughout the research as described above. The sample included senior managers who had been involved in strategy development.

c) The results from the internal survey were compared with the core themes in the literature review.

d) The learning from the literature review and the survey was used in the next stage.

1.4.2.4 Development of the 'core contextual themes' for the case

a) Having established that the context drives the content and process of strategy, the next step was to correlate the context of the TI-314 case with the main literature themes. This stage also identified the outstanding features of the case that might be subsets of the main themes but hold a specific importance to the case.

b) The correlation analysis produced a set of "core contextual themes" specific to the TI-314 case. These 'core contextual themes' were in effect the outline requirements that would have to be fulfilled by the strategy creation framework. They would ensure that the strategy process and content would match the context and hence produce a valid strategy.

1.4.2.5 Development of the new framework for internal strategy development

The core contextual themes were then used to construct the strategy creation framework for TI-314. One dominant core contextual theme provided the main structure of the framework. The remaining themes provided an essential depth to the framework.

1.4.2.6 Validation of the framework in the business environment

As with the Group Function framework, the strategy creation framework had to be validated from two different perspectives that could be described as being a) internal and b) external to the framework:

(a) **How well did the framework work?** Was the framework well constructed? Was it easy to use? Was an acceptable output produced by using it?

(b) **What effects did using the framework have on the business?** What impact did the strategy created via the framework have on the business? Did using the framework have any secondary effects on the business other than simply producing a strategy?

Having broken down the validation process into these two main parts, the individual validation tests were as follows:

(a) How well did the framework work?

The following tests were performed to assess the 'internal' aspects of the framework itself:

(i) The primary validation test was to use the framework to generate a strategy for TI-314 within BMW Group. The author was responsible for all the work carried out in the validation process. Members of the TI-314

11

teams provided additional input during the use of the framework as directed by the author.

(ii) Whether the senior management within BMW Group accepted the strategy that resulted from using the framework.

(iii)The four strategy creation stages were validated in turn. The validation involved the identification of the successful and unsuccessful aspects of each stage of the framework and an assessment of the suitability of their individual outputs.

(iv)The framework was assessed as a whole. The effectiveness of the framework construction was assessed by looking at how well the six core contextual themes were covered.

(v) Tentative assessment of the practicality of the framework and whether the strategy was 'good' from the employee viewpoint.

(b) What effects did using the framework have on the business?

The remaining parts of the validation process took into account the 'external' impacts of using the framework as follows:

(vi)Identification of other value added through use of the framework e.g. the introduction of new ways of thinking or the use of new procedures within the business.

(vii)   Identification of any ways in which the strategy was used and the impacts that it may have had.

1.4.2.7   Use of the framework within BMW Group.

a) Surveys hold a central importance within the framework. Every survey used the same consistent methodology based on the approach proposed by Oppenheim as described above.

b) The following survey types were used:

- Investigative interviews with experts in the field
- Interview using a structured questionnaire
- Case study
- Supervised and unsupervised structured questionnaire by direct hand-out, posted and faxed distribution
- Telephone interview using a structured questionnaire

In total, 11 case studies were performed by the author with one member of TI-314 (Halliday and Baden, 1999); 14 academic and business experts were interviewed by the author and 7 other different surveys were undertaken; six of which were performed by members of the TI-314 teams under the direction of the author.

12

c) Data sources for financial and other data. Where financial and other data was required, every effort was made to use the data for the full preceding year. Where it was not possible to obtain data for the full year, the longest preceding period was used and extrapolated for a full year if required. All internal financial data was based on figures provided by the finance department or through the normal tracking processes within TI-314 e.g. for materials use, number of parts produced.

1.4.2.8   Improvements to the framework

Some improvements were made to the framework during the course of the validation. Other improvements were suggested following the review of the validation results. The improvements have been introduced into the "Improved framework", a deliverable from the research work contained in Appendix 1 of this report.

1.4.2.9   Use of the framework in future exercises

The "Improved framework" has been written as a stand alone document that can be used by other people who wish to develop a technology introduction strategy within a large business. It is hoped that other strategists will use the framework when it is made publicly available.

1.4.3   Measurement challenges in a 'live' business environment

The main challenges faced in attempting to measure the impacts of this research are as follows:

(a) **Long term effects.** Many of the impacts from this research will occur over the longer term and consequently fall outside the time scale of the research. In this case, proxy measures have been used to highlight where measurable outcomes are most likely to result in the longer term despite not being measurable in the shorter term.

(b) **Corporate change** affecting the outcomes from the research. The effectiveness of the outcomes from this research is heavily dependent upon the corporate context remaining within specific limits. For example, the split up of BMW Group inevitably had an impact on the ability to measure the effectiveness of the Group Function and strategic output from this research because it directly affected the subject of the research. As a result, continuity of the measurements was not always possible.

(c) **Appropriateness and timing of measure implementation.** Measurement systems have to be in place before research-related changes take place. Measures were implemented during the course of the research but the results from most of these measures did not become useful for some time after BMW Group split up. In other cases it was not always possible to compare like with like. For example the differences between Rover Group and BMW Group accounting systems made assessment of the Group Function benefits very complex.

(d) **Qualitative versus quantitative measurements.** A number of positive activities were initiated as a result of this research but few of them produced a numerically measurable outcome. Consequently, it was necessary to use proxy measures in the majority of cases. For example, the introduction of common database use is very likely to provide positive benefits by reducing duplicated activity and increasing data flows, however specific numerical measurement of the benefit is not practical. One type of proxy measure was therefore to count the number of databases that were being used jointly and to identify the qualitative benefits that were gained.

The 'live' business environment provided an interesting and challenging context for this research. However the introduction of quantitative measures and the use of proxy measures meant that it was possible to identify the majority of benefits that resulted from this research.

1.4.4   The relationship between this research and 'Action Research'

This research was carried out in a 'live' business situation where the results of the research were applied to the business on an ongoing basis. The act of performing the research had an impact upon the business in itself because information and ideas became available and were used before the research was completed. There are other parallels between this research and 'action research'.

According to Cohen & Mannion (1994) and Bell (1999), the principle features of action research are as follows:

1) It deals with concrete, on-the-spot problems

2) An immediate benefit is gained from it

3) It is flexible and adaptable

4) It relies on observation and behavioural data

5) It enables practical judgements to be made in concrete situations

6) Its validity depends upon the usefulness of the hypotheses created in helping people to act more intelligently and skilfully

7) The research is validated through practice rather than independently and then applied to practice

8) The benefits may be realised over a long period of time

This research had the following characteristics in common with action research:

- This research was performed in order to solve real problems within the business (cf. feature 1 above).

- Some immediate benefits were gained from the research activity (cf. feature 2 above).

- The outcomes from the research were flexible and adaptable within limits (cf. feature 3 above).

14

- The research enabled practical judgements to be made towards the end (cf. feature 5 above).

- Its validity relied upon the practical application of the frameworks and in their ability to help people act in a more rigorous and skilful way (cf. feature 7 above).

- The benefits from the research are likely to be realised over a much longer time frame than the research itself, in particular regarding the strategy creation framework (cf. feature 8 above).

However, the research did not conform to the Action Research methodology in all respects:

- A key foundation for the validity of the research was the in-depth literature review on the subjects concerned hence following a more conventional path than action research (cf. feature 6 above).

- This research was based on a combination of previous strategic and economic research and literature, factual numerical data and other data gathering. By not relying upon observation and behavioural data the information gathering was perhaps the weakest link between this research and action research. Although attitudinal surveys were carried out, these were neither observational nor behaviourally orientated (cf. feature 4 above).

One could therefore conclude that this research has a number of characteristics that link it strongly with action research. However it would perhaps be appropriate to suggest that the methodology is a combination of action research concepts and more classical research methods.

2 The Structure of the Research Portfolio

2.1 Recommended order of reading the submissions

It is recommended that the reports are read in their numerical order with the exception of Report 2, "communications development", which is peripheral to the main body of research. This executive summary provides an overview of the research carried out and the results from it.

Report 3 provides an introduction to Rapid Prototyping and Tooling (TI-314) and the development and use of a methodology to create a more efficient organisation between the UK and Germany.

Reports 4 and 5 cover the development and use of a framework for strategy development to increase the effectiveness of TI-314 within BMW Group.

The Personal Profile provides information about the author and his personal development over the duration of the Doctoral programme.

The recommended order of reading is therefore:

1) Executive Summary (Report 1)

2) Report 3: Development and use of a methodology for operational action planning within the BMW Group Function creation process

3) Report 4: Development of a strategy creation framework for Rapid Prototyping and Tooling

4) Report 5: Validation of the Strategy Creation Framework for Rapid Prototyping and Tooling

5) Report 2: Using a survey to assist communications development in Rover Group Design & Engineering

6) Personal Profile

2.2 Overview of the Submissions

The Executive Summary provides an overview of the main elements of the research portfolio.

Report 2:Using a survey to assist communications development in Rover Group Design & Engineering

The need for communications improvement was recognised by the senior management within Design Engineering following a successful exercise carried out by the author within the Powertrain organisation of Rover Group. Based on the Powertrain exercise, an extensive communications survey was carried out in one department of Design Engineering by a team of local managers led by the author.

The Powertrain and Design Engineering surveys were the first of their kind within Rover Group and significantly raised awareness of communications issues within the areas being surveyed and within Design Engineering.

The communications process proposal that resulted from the analysis of the survey results was implemented within the surveyed department. The research stimulated and provided the starting point for a company-wide review of communications and later the proposal became the basis for the corporate communications process.

The communications research provided a grounding for all later survey work within the portfolio and was a valuable learning platform for the research that followed. Although reference is made to this submission within the executive summary, it is peripheral to the main body of research and is therefore not covered in detail within the executive summary. It is recommended that Report 2 is read last.

Report 3: Development and use of a methodology for operational action planning within the BMW Group Function creation process

This report details the research carried out to fill the need for an operational action planning framework for TI-314 within the Group Function creation process. Operational action plans were needed to take full advantage of the synergistic opportunities available within TI-314 in Germany and the UK and consequently to improve the efficiency of the two teams, increasing productivity.

The financial crisis within Rover Group led BMW Group to join the two organisations into a single structure of 'Group Functions'. The BMW Group Board provided goals for the Group Function process but no guidance on how to achieve them. A literature review revealed that there was no specific guidance available for the development of Group Functions. The author consequently created a new framework based on the collated literature views, plus the BMW Group goals and requirements.

Beginning with the current situation and the required outcomes, the new framework acts like an active filtering process. It provides a structure for analysis that effectively closes the gap between the high-level goals and the need for a practical set of operational action plans with which to achieve them.

The new framework was used to create a set of operational action plans for Rapid Prototyping and Tooling and had the potential for application to other Groups within BMW Group.

Report 4: Development of a Strategy Creation Framework for Rapid Prototyping and Tooling

This report is concerned with the development of a new strategy creation framework for Rapid Prototyping and Tooling. Report 3 addressed the productivity improvement of the teams achievable through the Group Function creation process. For TI-314 to provide BMW Group with the maximum achievable business benefits, it was necessary to generate a long-term strategy but there was no guidance available within the company to suggest how this might be done.

17

The Re-engineering targets laid down by the BMW Group Board identified the gap between the current performance and the required future performance. The report proposed two hypotheses:

(i)   A strategy creation framework can be developed on the basis of the broad-based business strategy literature.

(ii)   The context of the situation would largely determine the most appropriate development process and content of the strategy.

The author identified a set of key themes on strategy development in the literature and was able to demonstrate that the second hypothesis was correct. Therefore, since the context of a case drives the best choice of process and the resultant content of the strategy, the next step was to make a link between the key themes in the literature and the RP&T case.

The literature review provided useful broad-based business-related advice on strategy development but lacked the required internal focus needed for the framework development. The author therefore carried out a survey within the company to investigate relevant strategy-related issues. Comparison of the literature review and the survey results provided additional insight beneficial to the development of the strategy creation framework.

The author then developed six core contextual themes for the case. These core contextual themes were effectively the requirements that would have to be met by the strategy creation process. The core contextual themes were:

- Environmental analysis and understanding
- Dealing with rapid change in the environment
- Cultural issues relating to strategy development
- Treating the strategy as a deliverable item
- Technology-related strategy development
- Strategy implementation

The framework was built up in three stages based on the six core contextual themes. The strategy was treated firstly as a deliverable item. Secondly, less prescriptive approaches were added to the framework to allow for environmental change and finally, considerations for strategy implementation were introduced.

A new strategy creation framework was developed by the author by adapting existing knowledge and applying it to a new situation.

Report 5: Validation of the Strategy Creation Framework for Rapid Prototyping and Tooling

This report covers the validation of the new strategy creation framework developed in Report 4 within a live business situation. The framework was used to create a strategy for RP&T within BMW Group.

The senior management within TI fully accepted the strategy that resulted from use of the new framework, satisfying one of the main criteria for success.

Use of the framework highlighted the issue that business-related strategy concepts may provide useful guidance but extra care should be exercised in their use for sub-corporate strategy development. For example, the Porter 'five forces' model may be completely invalidated when used internally due to the balance between internal demand and supply monopolies compared to generally more open competitive forces that apply in the broader external business context.

A new approach was developed by the author during the validation process to cater for two problems during the strategy development. Any strategy development may encounter difficulties with poor access to critical information and variation in key influences on the strategy as in this case. The development of 'generic strategy themes', which are strategic solutions that remain true under a range of different circumstances, may therefore be beneficial to more than the sub-corporate strategist. Use of such generic strategy themes may not remove the problems themselves but they have the potential to neutralise or reduce the impact of changes in the strategy influences. Additional proposals are made that should reduce problems with access to critical information.

Not only does the new approach make strategy development in a changing environment easier, it should also extend the valid life of the strategy by reducing the impact of environmental changes during strategy implementation.

The framework covered the six core contextual themes as required but some challenges remained with regard to cultural issues. Involvement of the implementation team and senior management in the strategy development was found to be important and beneficial throughout the process.

Use of the framework not only produced a robust strategy for TI-314 but also provided additional business benefits including:

- Senior management awareness of a new set of strategic possibilities for Rapid Manufacturing within the company
- The introduction of strategic thinking lower down the organisation
- A more rigorous approach to data gathering and analysis has been used and accepted by members of the TI-314 team

Overall, the validation demonstrated that the proposed strategy creation framework could successfully produce a deliverable output. The improved framework should therefore be able to provide a valuable contribution to the business by enhancing the internal approach to strategy development for technology-related service groups similar to TI-314.

3 Increasing the efficiency of TI-314 via Group Function creation

3.1 The background to industrial mergers

3.1.1 The benefits gained through Mergers

According to Hay and Morris (1979), there are three main theoretical motivations for merger:

1) **Increased market power** – by increasing market concentration

2) **Reduction in advertising and other promotional expenditure**

3) **Increased efficiency** – synergism

Synergism increases efficiency largely through economies of scale where more than one group can use focused resources more efficiently than they would be able to individually. Arguably therefore, the second item in Hay and Morris' list could be considered as a subset of item 3. Most notably, economies of scale include manufacturing, purchasing, R&D and finance.

Williamson (1985) identified one particular form of synergism, which he referred to as the 'M'-form organisation (see Figure 2 below). He found that multi-divisional firms such as GM and Dupont were 2-3% more efficient than other types of organisation. In the 'M'-form organization the single Head Office makes all the strategic decisions for the company, leaving the Divisional heads to concentrate on operational decisions, reducing the transaction costs within the business.

Head office – Strategic decisions and direction		
Division A Operational decisions	**Division B** Operational decisions	**Division C** Operational decisions
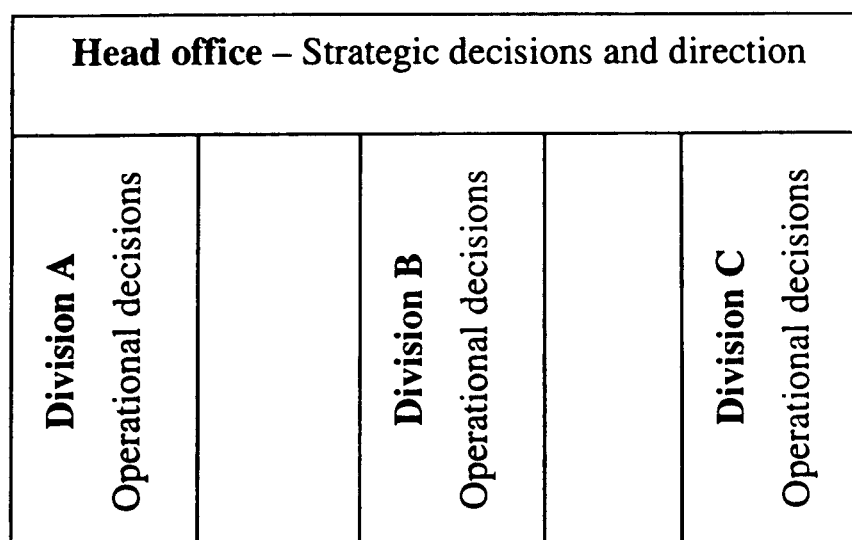
Figure 2. The 'M-form' organisation concept (Williamson, 1985)

On the basis of Williamson's work it appears that marginal efficiency benefits can be gained through merger. However, there is widespread scepticism about the benefits

arising from mergers (Devine, 1985; Martin, 1993; Clarke, 1985; Rhoades, 1998; Porter, 1987) so why do mergers occur?

3.1.2 The motivations behind merger activity

The strong scepticism of Porter (1987) about lack of shareholder benefit from mergers reinforces Hay and Morris' findings (1979). Their studies suggested that improved profitability did not arise from merger activity. Other studies by Devine et al (1985) and Rhoades (1998) draw the same conclusion. However, Rhoades (1998) who studied the banking sector suggested that other benefits apart from efficiency gains may have been gained, a position concurred by Brouthers et al (1998).

Brouthers et al (1998), suggest that the correct way to measure the success or failure of a merger is to compare the internally generated merger 'motives' or 'success factors' with the actual outcomes. On this basis, they argue, mergers appear successful within the organisation because the outcomes often fit the original motives for the merger. They break down the main categories of merger motives into:

1) Economic

2) Personal

3) Strategic

Although the above categories themselves do not appear to correlate with the three motives for merger from Hay and Morris (1979), the sub-headings within the 'Personal' and 'Strategic' categories do correlate well (see Report 3, section 3.1.3). The main difference between the two approaches is the assessment of success on purely economic grounds (Hay and Morris) compared to the use of internally generated, often non-economic measures (Brouthers et al, 1998).

We can conclude that mergers appear to occur for a wide range of reasons, not simply to increase shareholder value but also for less easily definable or visible motivations. Success or failure in merger activity is therefore something that should be measured against the original objectives of those involved.

3.1.3 Pitfalls and people in mergers

Merger experience in the banking sector has shown that the most frequent and serious problems are those relating to the integration of data processing systems and operations (Rhoades, 1998; Stylianou et al, 1996). The highly complex nature of automotive IT systems means that similar difficulties could also occur in that industry (Eichner, 1999).

There are of course ethical considerations within any merger due to the impact upon employees (Chase et al, 1997). The planned and considerate use of communications can assist in reducing or preventing uncertainty and other problems (DiFonzo and Bordia, 1998).

The literature provides a broad picture of the motivation for mergers, the ways of measuring success and some other considerations. The next section relates these

issues to the BMW Group requirements from the completion of the merger with
Rover Group through the creation of Group Functions.

3.2 The Formation of Group Functions within BMW Group

3.2.1 The BMW Group acquisition of Rover Group

BMW's purchase of Rover Group in 1994 was a 'horizontal merger', the
amalgamation of two companies with competing products (Clarke, 1985). Prior to
the announcement of Group Function creation in 1998, the Rover Group Board had
remained intact. From September 1996, both the Chairman and the Chief Executive
of Rover Group were also BMW AG Board members. Rover Group was effectively
a separate business unit within the BMW AG 'M'-form organisation.

The announcement of Group Function creation included a target of 1st March for
setting up the new BMW AG organisational structure, taking it back to a functional
or 'U-form' organisation, the Rover Group structural elements being absorbed into
the original BMW AG structure (see section 2 in report 3 for more detail).

3.2.2 Definition of a Group Function

The definition of Group functions was given as follows in December 1997 (reported
later in BMW 1999a):

"Group functions mean management and line functions involving Group-wide
responsibility and decision-making authority for the overall scope or Group-relevant
area covered by each function."

In effect the formation of Group Functions meant that all Rover Group structures
would be subsumed by the corresponding BMW AG structure.

3.2.3 BMW Group structures

Figure 3 below gives an outline structure of BMW AG showing TI-314. The BMW
AG structure is split into 'Ressort' (divisions). Each Ressort has a Board member at
its head and has a single letter denoting it, for example 'T' (Manufacturing). The
Ressort have areas within them called 'Bereich'. In this research, the Bereich of
interest is TI, which covers manufacturing process integration and logistics. Each
Bereich is further divided into 'Hauptabteilung' (higher-level departments) and
'Abteilung' (departments). In this case the Hauptabteilung is called 'Experimental
Vehicles' with the coding 'TI-3', covering the manufacture of prototype vehicles and
proving of manufacturing methods. The department of interest is 'TI-31' which
covers concept vehicle manufacture and logistics. Rapid Prototyping and Tooling is
one of the 'Groups' within TI-31.
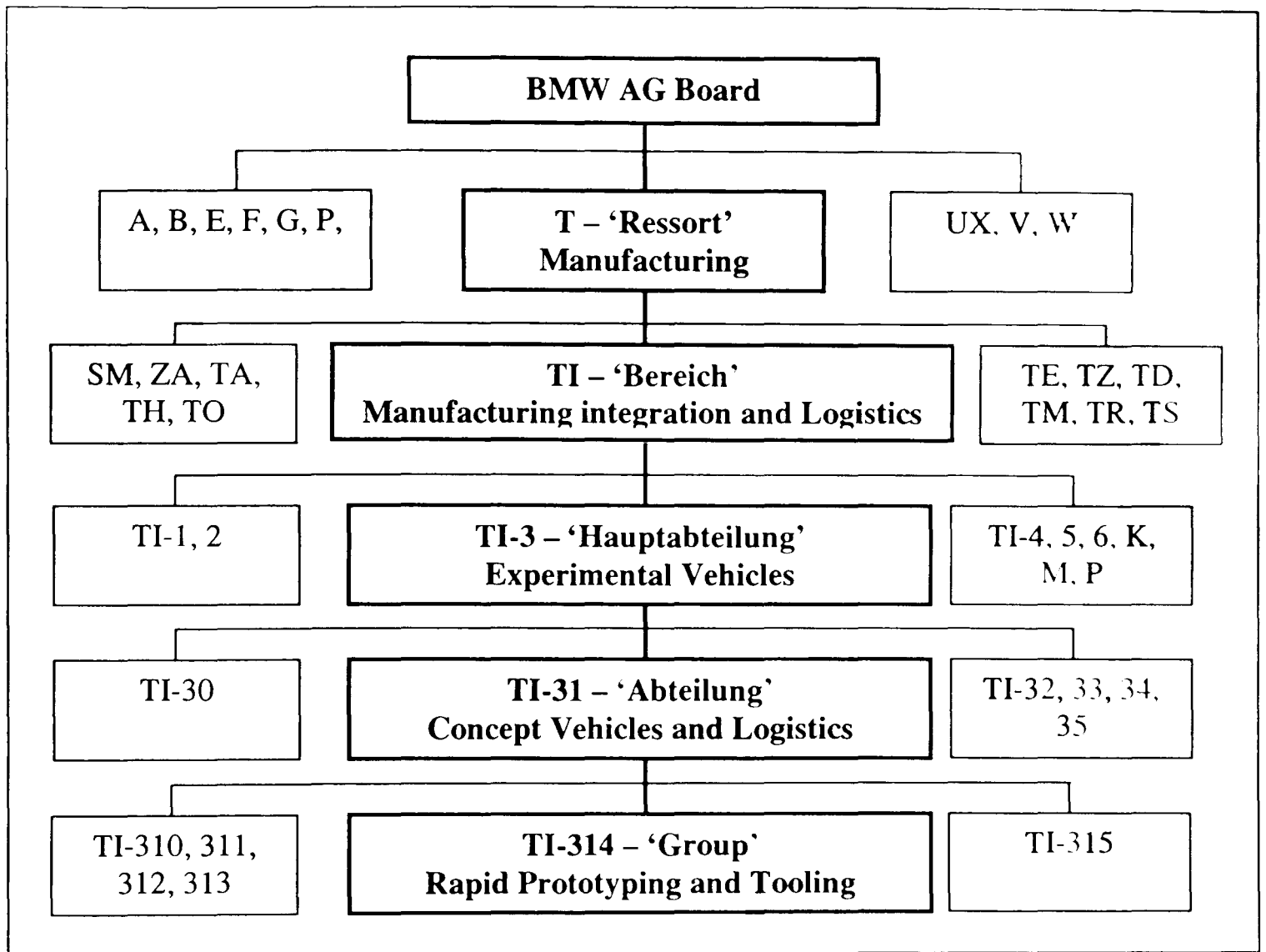
Figure 3. An outline structure of BMW AG in April 1999, showing TI-314

3.2.4 The role of TI-3 and TI-31

The role of the TI Bereich is shown diagrammatically in Figure 4 below. TI has an impact on the 'Time to Customer' for an ordered vehicle through its logistics, assembly and customer processes. It also has an impact on the 'Time to Market' of a new product through the activities of TI-3.

Experimental Vehicles (TI-3) supports the design development and manufacturing process maturation for BMW and Rover Group, integrating different concept, manufacturing and prototype activities. TI-31 builds all the concept vehicles for TI-3 along with provision of logistical support for all TI activities. TI-314, "Rapid Prototyping and Tooling", provides all the prototype parts for the prototyping activities within TI and across BMW Group.
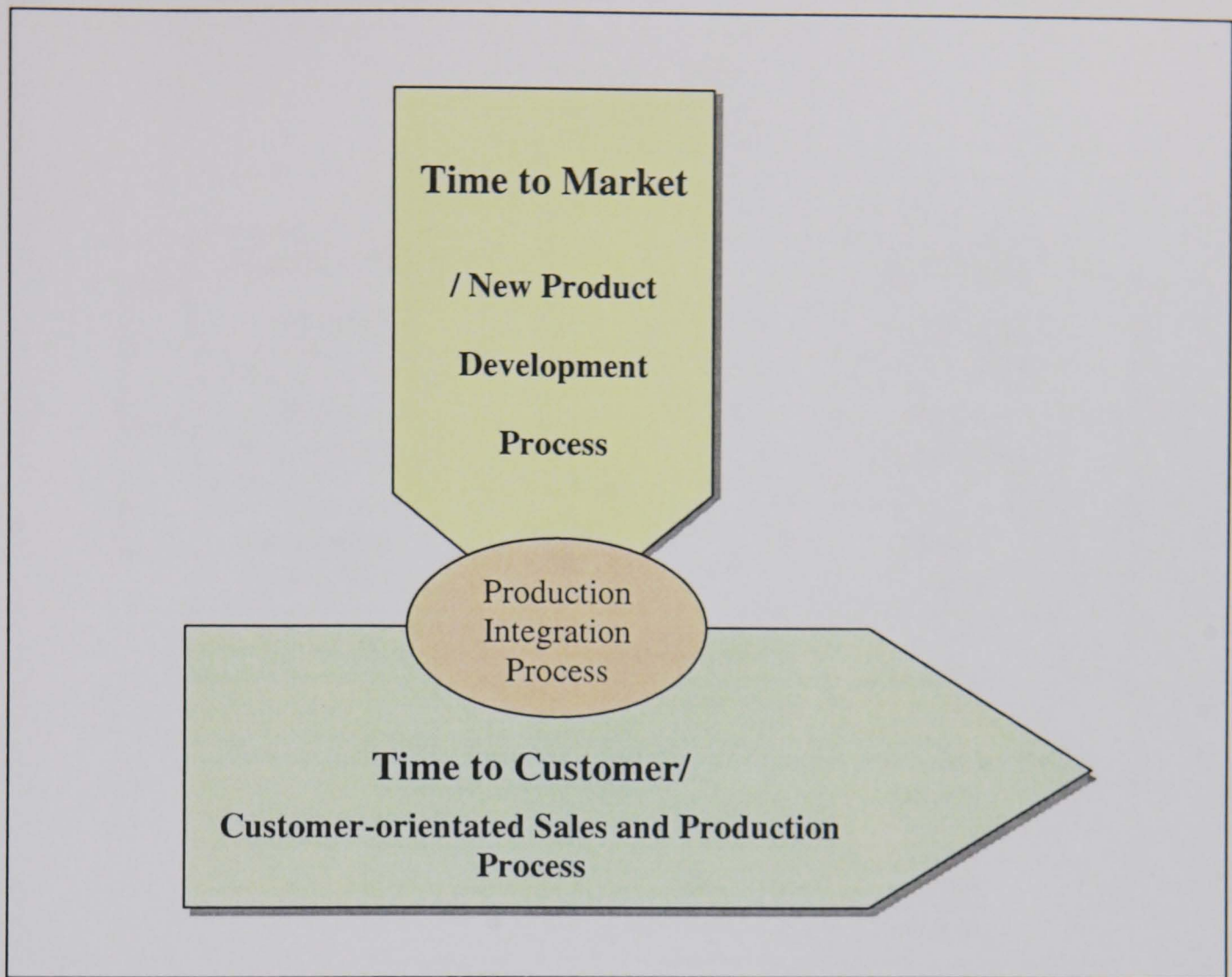
Figure 4. The role of TI, (Gotz, 1998).

3.2.5 The structure and purpose of TI-314

The organisational structure of TI-314 is shown in Figure 5 below. The 'Group' is split into two 'teams'. The German team has two 'sub-teams' and the UK team has five 'sub-teams'.

The purpose of TI-314 is summarised by the following:

- To supply high quality prototype parts very quickly
- To seek out, develop and integrate new prototyping technologies
- To be the company champion of best prototyping practice

TI-314 was formed from the German and UK teams prior to the company-wide creation of Group Functions initiated by the BMW Group Board at the beginning of 1999.
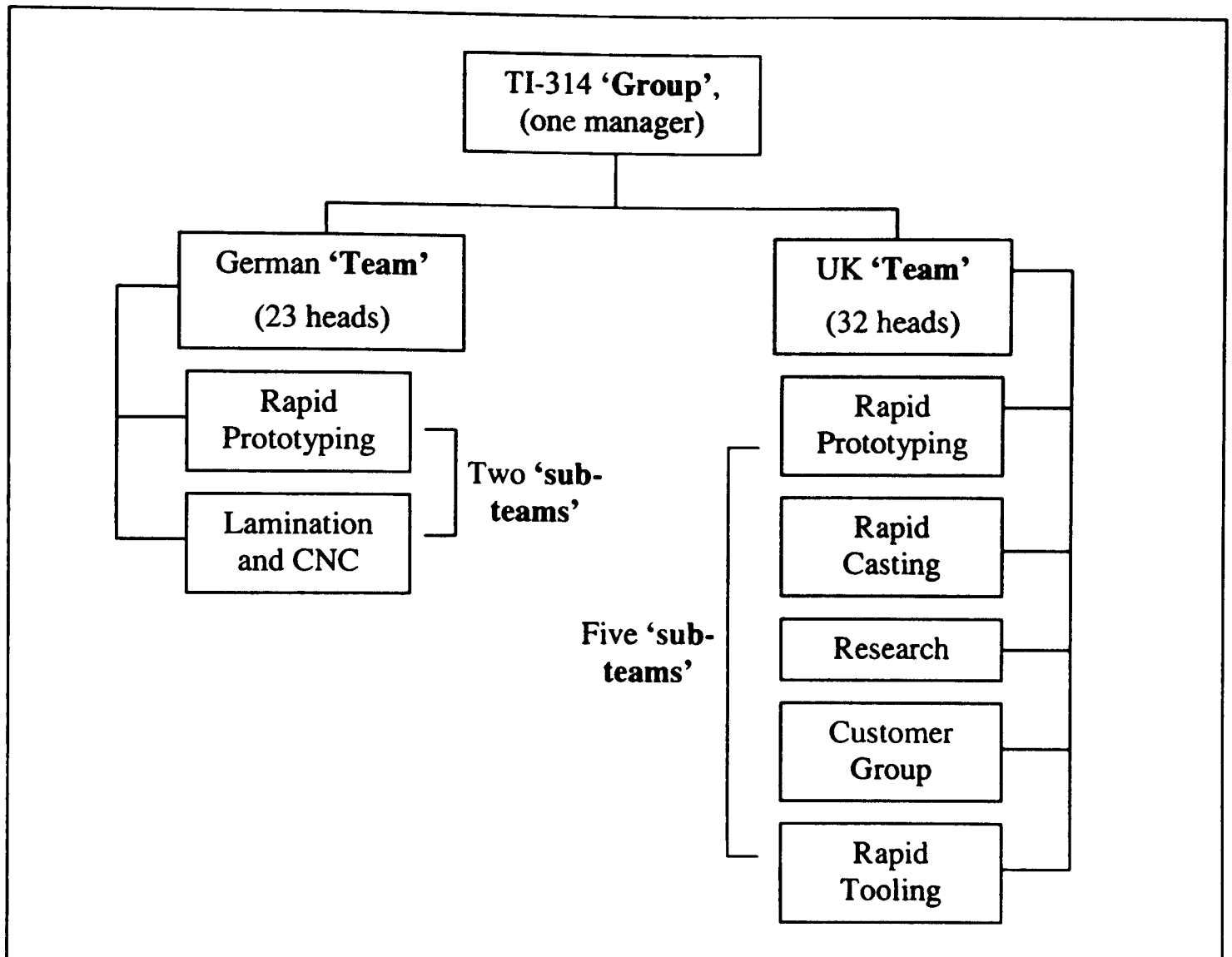
Figure 5. The structure of TI-314, Rapid Prototyping & Tooling

3.2.6   The creation of Group Functions

The two main targets set for the Group Function creation process were: (i) the announcement of the new structures by 1ˢᵗ April 1999 and (ii) the full organisational integration of the structures by 1ˢᵗ July 1999. Integration of the *structures* was seen as the first step in the full integration of the *activities* within the Group Functions.

Three possible categories of structural integration were proposed by the BMW senior management (Leube, 1999):

1) **Level 1: Best possible mirroring**, where similar departments in the two companies would align with each other but remain separate

2) **Level 2: Partial integration of functions**, where 'twinned' departments would use common processes and have the same structures. This structure would act as a step towards level 3.

3) **Level 3: Overall, consistent integration of functions in a newly defined common structure.** Level 3 is therefore the overall goal.

In the case of Rapid Prototyping and Tooling (RP&T), the organisational transition had already progressed beyond level 2 towards level 3 before the corporate

25

announcement of Group Functions i.e. the UK & German teams were already joined under a single manager. However, TI-314 still needed to complete the integration process within itself in order to gain the greatest benefits.

The framework generated in this report has been used to accelerate the internal integration of TI-314 to become a full 'level 3' structure. The integration process in part includes decisions regarding the Group Function 'level' for each of the sub-teams within RP&T.

The overall aim of the framework is to achieve the targets set out by the BMW Board. Consequently, the most appropriate starting point in developing the framework is the original statements made by BMW as outlined below.

3.2.7 BMW Group Function objectives, synergies and principles

The following objectives, synergies and key principles were stated by the BMW Board and senior management between February and May 1999.

a) Re-engineering objectives relating to TI-314

The Re-engineering programme provided the following objectives that related to TI-314 (Cremer & Wurst, 1999):

- **50% time reduction for Product development process**
- **30% reduction of one-off expenditure in Product development process**
- **Process reliability**
- **Flexibility of processes** to allow controlled deviation from the ideal if required

b) Synergies relating to TI-314 (Leube, 1999)

- Standardisation of processes and methods e.g. IT and vehicle projects
- Strengthening of purchasing power
- Implementation of 'Technologieverständnis' (common understanding of the way in which engineering projects should be operated) in the UK

c) Key Group Function objectives and principles relating to TI-314

The following objectives and principles were stated by BMW Group management (BMW 1999b; Leube, 1999):

- Realisation of learning curve effects and scale economies
- The standardisation of concepts and processes
- The joint use of skills and resources
- Joint and consistent targets
- BMW business process and organisation are 'Master', i.e. they take priority

- For defined tasks e.g. resource planning and steering, CAX methods, pre-development, etc. there will be only one function at one location

- Manageability: the final organisation must be manageable, there must be a deputy for the single manager at both locations

3.2.8   Comparison of the BMW Group objectives with the merger literature

The merger between BMW AG and Rover Group was based on the desire for BMW to remain independent. The drive towards the formation of Group Functions was a continuation of the original purpose behind the merger.

Comparison of the statements by the BMW leadership at the beginning of 1999 with the motives for merger stated in the literature shows a strong alignment between them (see Report 3, section 3.2). The BMW statements can be represented by the following motives for merger stated by Hay and Morris (1979):

- **Increased efficiency – synergism**, looking especially for reduction in costs and technical economies of scale

- **Creation of shareholder value**, in particular through the reduction of time-to-market

A small Group like TI-314 cannot affect each of the BMW criteria individually but it can contribute to the overall principles behind the criteria. The close relationship between the BMW criteria and the Hay and Morris motives, suggests that it will be appropriate to use the two motives for merger stated above within the new framework.

The guidelines provided by the BMW leadership state *what* needs to be achieved in the creation and integration of Group Functions, they do not identify *how* to achieve it. Group Functions will only achieve full efficiency through actions at the operational level that are determined by the corporate criteria listed above. There was no framework that linked the corporate criteria to relevant operational action plans and so one had to be created. The next section outlines the author's development of a new framework for Group Function operational action planning.

3.3   Development of the operational action planning framework

3.3.1   Objectives for the framework

The framework will be used in a practical environment and so the following objectives can be set. The framework must:

1. Produce a practical and valid output

2. Directly use the decision criteria

3. Be simple to use

4. Help to eliminate any unnecessary analysis work

3.3.2 Derivation of the main steps within the framework

The process steps have been derived logically. More detail is provided in report 3. The main process steps are shown in Figure 6 below.

The BMW Board identified the need for change within the current situation. The first step is therefore:

Step 1 "**Identify the current situation**".

Next, the requirement for change needs to be understood.

Step 2 is therefore "**Identify the factors driving change**".

The analysis process will involve the comparison of two (or more) teams. There will be differences between them. Therefore it may be necessary to prepare the teams in some way to enable them to be compared.

Step 3 is therefore "**Prepare the groups for analysis**". This step is explained in section 3.3.3 below.

The analysis will have to take into account the current situation ('inputs'), the drivers for change ('modifiers') and the limiting factors ('filters'). At all times during the analysis, the main question will be "How can BMW improve its performance through changes in these groups by the creation of Group Functions?"

Step 4 is "**Perform the analysis**". This step is explained further in section 3.3.4 below.

The analysis process will produce sets of operational action plans that will need to be checked for validity and conflicts. The final step is therefore:

Step 5 "**Check and finalise the outputs**". This step is explained further in section 3.3.5 below.

The five steps in the framework are shown in Figure 6 below.
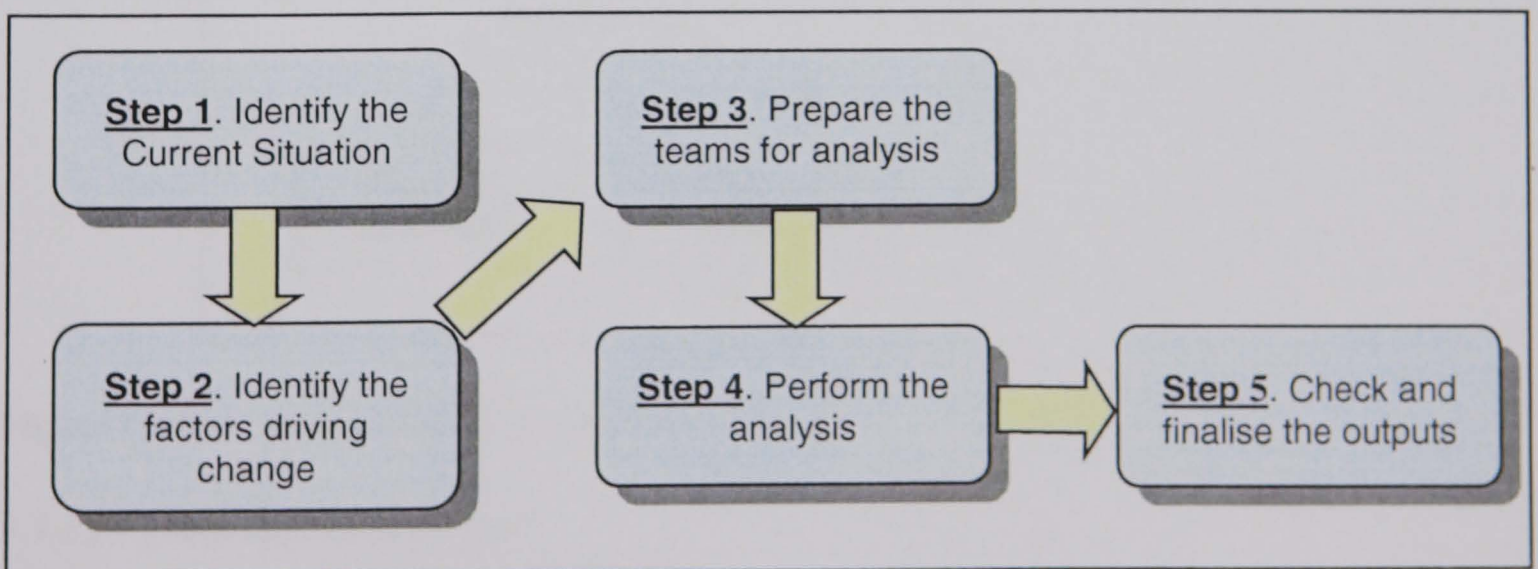
Figure 6. The five steps in the operational action plan development framework

3.3.3 Preparation of the team structures for analysis (step 3)

3.3.3.1 Overview of the preparation process

It is clear from Figure 5 above (page 25) that the German and UK teams are different. They do however both include similar functional elements within them but not necessarily within the comparable sub-teams. It will therefore be necessary to prepare the teams for analysis by breaking them down into these 'elements' that are small enough to have a unique function but large enough to avoid repetition in the analysis. Similar elements can then be compared and any elements not involved in the analysis stage can then be removed until required.

Figure 7 below illustrates the concept behind breaking down the sub-teams into 'functions' and then further into 'physical' and 'non-physical' elements. Some of the sub-teams have different functions within them. For example the Rapid Tooling team manufactures both 'hard' tooling and 'soft' tooling. The physical elements include people, equipment and facilities. The non-physical elements include the essential enablers such as databases and processes.
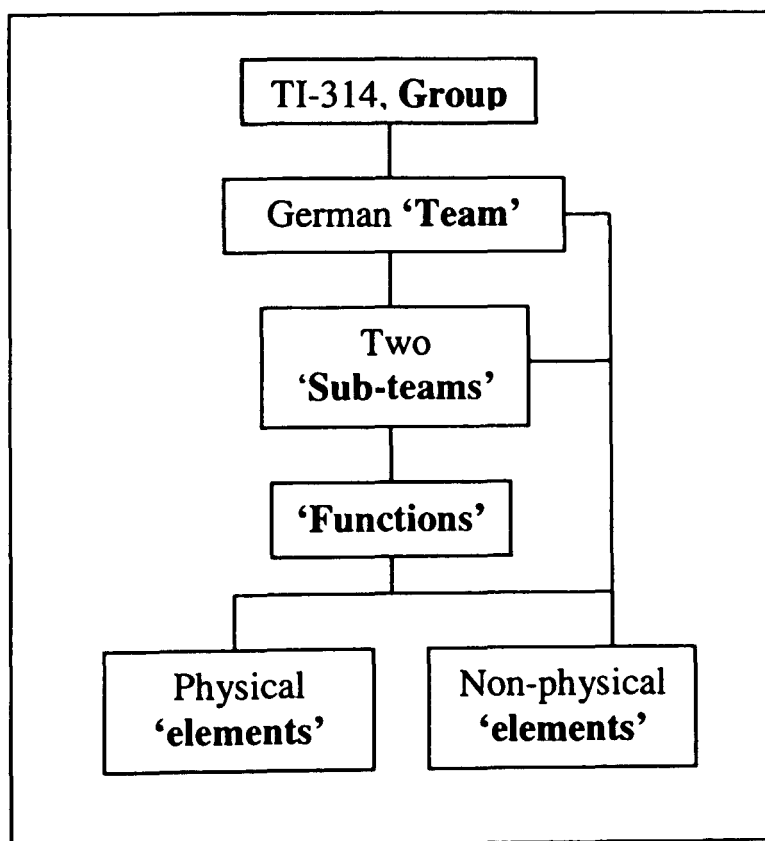
Figure 7. Nomenclature for the composition of TI-314

3.3.3.2 The preparation process

The preparation is broken down into three stages.

1) **Identify the organisational structure.** Organisational structures tend to develop along broadly functional lines, although other non-functional criteria

may apply. However, the existing structure is the most appropriate starting point for further break down of the group.

2) **Break down the teams and sub-teams into functions.** The aim is to identify the nature of the activities and dependencies of the sub-teams. For example, information flows, customer relationships, functional demands and inter-dependencies.

3) **Identify the physical and non-physical elements of the group.** Due to the portable nature of processes and databases (non-physical elements), these aspects of the group hold the greatest potential for synergistic benefits through alignment. The identification of duplicated elements is of particular importance since they can be compared against each other.

3.3.4   The Analysis process (step 4)

The analysis process will provide answers to the question:

> "How can BMW gain improved performance through these teams by the formation of fully integrated Group Functions?"

3.3.4.1   Content of the analysis process

The analysis process combines the information gathered during the first 3 steps of the framework and uses it to produce an output; the set of operational actions. The analogy of making a cup of filter coffee can be used to help explain the process (see step 4 in Figure 8 below).

The inputs to the filter include the 'water', which is the current situation of the group (step 1). The inputs include all relevant corporate current situation factors, such as organisation and core processes.

The 'ground coffee' represents the factors that will modify the current situation in a particular way – the drivers of change (step 2). These are the BMW objectives and guidelines, literature views and knowledge and current strategies, which have been reduced to the two main decision criteria.

Step 3 helps to make the analysis process possible and valid by breaking down the teams appropriately. This could be viewed as boiling the water before pouring it over the ground coffee.

The analysis process (step 4) uses the output from the first three steps and processes it to produce operational action plans, which provide the mechanism to achieve the Group Function objectives. This step is in effect 'making the coffee by pouring the boiling water over the ground coffee'. An additional useful output from the analysis process would be measures to indicate whether progress is being made towards the target.

30
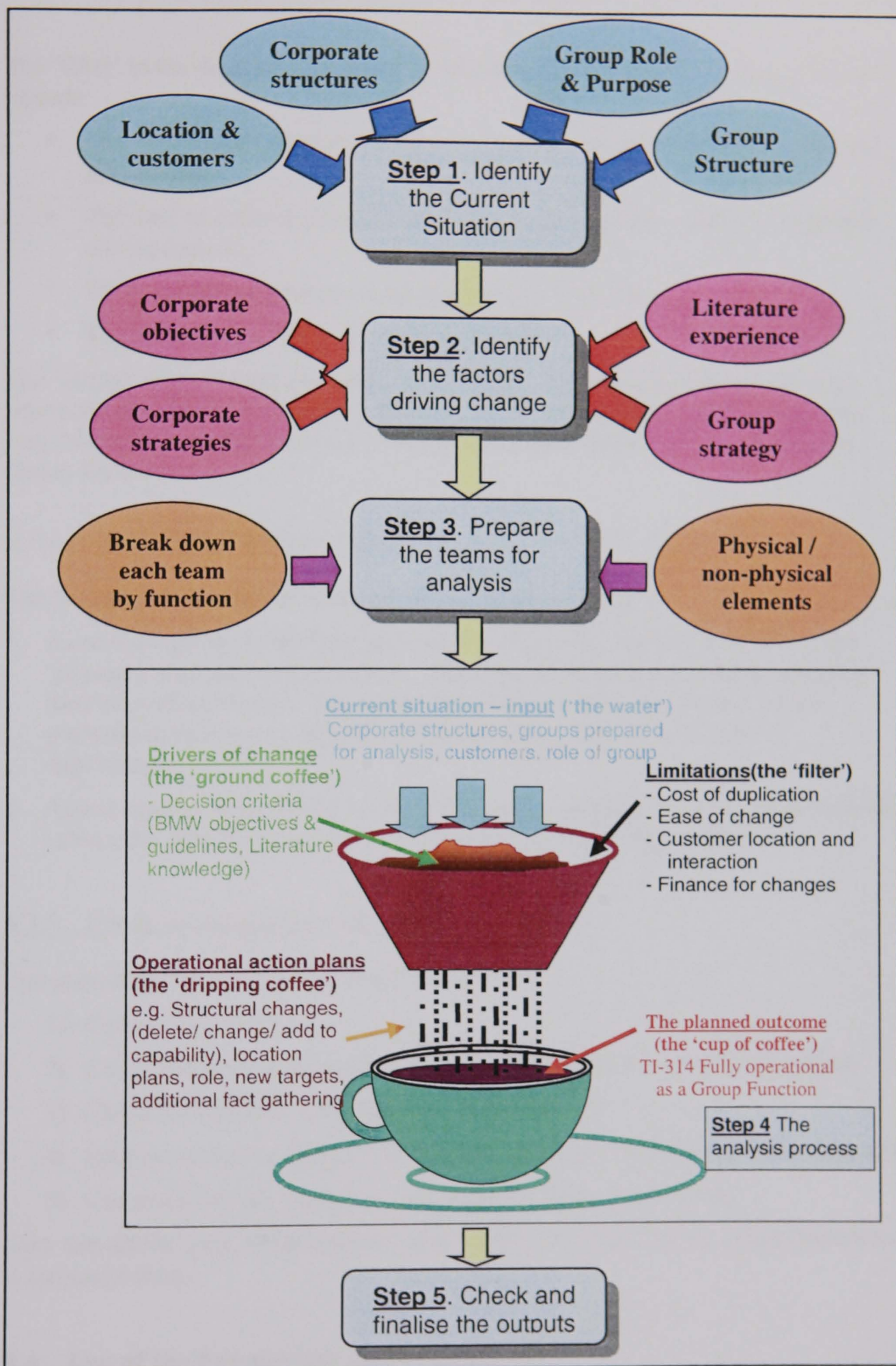
Figure 8. The operational action plan development framework

The 'filter' in the diagram, represents limitations to the possible outcomes. These include:

- The cost of duplicated facilities and processes compared to the benefits and alternatives

- The ease of making changes to the current situation e.g. mobility of people and equipment,

- Where customer groups are located relative to TI-314

- The ability to pay for any necessary changes

The 'output' from the coffee-making process (the 'coffee' dripping into the cup) represents the operational action plans that will finally result in the objective (the 'cup of coffee'), which is that TI-314 becomes a fully operational and integrated Group Function.

3.3.4.2 Running the analysis process

The prepared elements will be analysed in two main stages:

1. Assessment of duplicated elements between Germany and the UK, firstly the 'physical' then the 'non-physical'. The physical elements will be assessed for their cost effectiveness. The non-physical aspects will be assessed for the potential to increase synergism and share holder value by reduction of duplication.

2. Assessment of other opportunities to increase synergism and increase shareholder value other than by reducing duplication e.g. by better organisation.

3.3.5   Check and finalise the output (step 5)

The procedure for the checking stage will be:

1) Collate the actions

2) Check and resolve internal conflicts and duplications between the actions

3) Check for conflicts with the main limiting factors

4) Set time scales for the actions with the teams involved and agree the measures

5) Communicate the operational action plans to the whole group.

Now that all the steps in the framework have been covered, the use of the framework is covered below.

3.4   Use of the Framework to assess TI-314

Once the framework had been developed, the author used it for decision-making and operational action plan creation in the live business case of TI-314. The research methodology outlined in section 1.4 above was followed throughout taking each step of the framework in order.

3.4.1 Step 1 – The Current Situation for TI-314

3.4.1.1 The structure of TI-314

The team structure of TI-314 in the UK and Germany has been shown in figure 5 on page 25 above.

3.4.1.2 The 'physical' functions of TI-314

TI-314 is an entirely internal service in both the UK and Germany that produces a physical output from the following functions:

- Rapid Prototyping (UK and Germany)
- Rapid Tooling (UK only)
- Rapid Casting (UK only)
- Lamination and CNC model machining (Germany only)

The TI-314 Group also has the following support functions:

- Customer interface (UK only)
- Research (UK only)

3.4.1.3 The 'non-physical' (enabling) functions of TI-314

In addition to the above, the team has a number of enabling functions. In all cases, these are different between the two countries.

- Customer interface system and *processes*.
- Databases e.g. work throughput information, a photo library.
- Processes that are covered by ISO 9001
- Marketing of the Group within the company
- Quality standards. Few existed and none were common.
- Workload sharing. Less than 1% of total activity was shared.
- Materials purchasing.

3.4.1.4 The current strategy for TI-314

The strategic goals for TI-314 at January 1999 were:

1) To maximise the benefits from the two separate groups through aligning their activities to create a fully integrated Group Function

2) To generate a single coherent strategy for the development of Rapid Prototyping and Tooling in BMW Group

3.4.1.5 Factors that will affect the achievement of the Group Function objectives

The two major limiting factors for any development plans for TI-314 were:

1) The completion and agreement of a coherent strategy for TI-314

2) Obtaining financial approval to carry out the strategy

Tentatively taking the Porter (1985) 'five forces' model as a framework for the business environment; the following factors external to TI-314 would influence the TI-314 Group Function:

- System **Suppliers** who increasingly provide prototype parts to BMW

- BMW Group engineers who act as **Buyers** of prototype parts from the Suppliers

- External prototype part service bureaux and other BMW Group internal prototyping groups who act as **competitors** to TI-314

- **Potential entrants** includes new service bureaux

- **Substitutes** for Rapid Prototyping technologies can include new Rapid Prototyping and Tooling technologies as well as virtual design simulation acting as a replacement to the physical parts made by TI-314.

There were also BMW corporate factors that affected TI-314, the main ones being:

- **Location of the customer base** e.g. the engineering designers

- **Investment in new technologies and processes.**

- **Purchasing policy**

3.4.2 Step 2 – Identification of the drivers for change

The main corporate drivers have been identified in section 1.1 (page 1) and more specifically in section 3.2.7 on page 26 that resulted in the two decision criteria:

- **Increased efficiency – synergism,** looking especially for reduction in costs and technical economies of scale

- **Creation of shareholder value,** in particular through the reduction of time-to-market

3.4.3 Step 3 – The preparation of TI-314 for analysis

3.4.3.1 Internal organisational structure of TI-314

The structure shown in Figure 5 above is a useful starting point for the preparation of TI-314 for analysis but it hides a functional difference between the UK and German operations. In Germany the Rapid Prototyping team make parts from Silicone moulds and finish the RP parts themselves. In the UK, the Silicone moulding and RP part finishing is carried out by the Rapid Tooling team. It is therefore appropriate to

break down the UK and German team operations beyond the organisational sub-teams into functional elements.

3.4.3.2 Breakdown of the sub-teams by the functions that they perform

Function	Germany		UK	
	Heads	Output (No. of parts in 1998)	Heads	Output (No. of parts in 1998)
Rapid Prototype part manufacture	3	913 SLA 1231 SLS	6	2200 SLA 3200 SLS
Part finishing and assembly	1	As above	2	As above
Casting of PU parts (No. of moulds)	2	132	8	520
Rapid Casting	0	15	1	200
Rapid Tooling (tools/ parts)	0	0	8	30/ 3800
Lamination & CNC modelling	17	745	0	0

Table 1. The output and headcount for TI-314 'physical output' functions in Germany and the UK

Table 1 above breaks down the sub-teams that generate a physical output according to their functions in the UK and Germany. The table shows the relative numbers of people employed full time for the functions shown.

Other important activities without a direct physical output are listed in Table 2 below:

Function	Germany	UK
Research	Performed only to a limited extent by various members of the team plus occasional students	3 heads. Extensive activity including partnerships (3 heads) and European projects
Administration	Specific activities, 2 heads	Distributed throughout team
Customer interface and consulting	Distributed throughout the teams	3 heads in Customer Group plus distributed activity once projects initiated

Table 2. The remaining functions in TI-314, UK and Germany

The 'non-output' functions are more difficult to compare because the research and customer functions are distributed in Germany but specific in the UK and vice versa for administration. There may however be scope for assessing the effectiveness and requirements relating to the different ways of working in the UK and Germany.

Breaking the teams down into functions has allowed the two groups to be compared with each other, which was not possible with the original organisational structure. From here on, the above functions of TI-314 will be referred to as the 'physical elements' of TI-314.

3.4.3.3 Identification of the non-physical functions of TI-314

The current status of the non-physical functions has already been identified in section 3.4.1.3. From here on, these aspects of TI-314 will be referred to as the 'non-physical elements' of TI-314.

3.4.4 Step 4 – The Analysis Process

3.4.4.1 Analysis procedure

The analysis process has two main parts. The first part analyses the teams from the cash flow viewpoint and is covered in section 3.4.4.2. The second part of the analysis addresses less easily quantifiable synergies and is covered in section 3.4.4.3.

3.4.4.2 Cost assessment of the TI-314 elements

The steps in the cost assessment process were as follows:
- a) Statement of the assumptions for the analysis
- b) Selection of duplicated physical output elements for analysis
- c) Identification of relevant costs for the analysis
- d) Alternative options for analysis
- e) Analysis of the options
- f) Propose a suitable course of action.

a) The main assumptions are summarised as follows (see Appendix 3 for full coverage):

1. All cost data was supplied by the BMW Group and Rover Group Finance departments for the full year 1998 or current figures in 1999 as appropriate.

2. Manpower costs exclude local overheads because they exist regardless of the small changes in headcount encountered in this proposal

3. Productivity (output per man) is approximately the same in both countries but an improvement in productivity could possibly be achieved by increasing sub-team size (see Appendix 3).

4. The exchange rate varied approximately between 2.7 and 3.2 DM to the pound in 1999. This range has consequently been used as the extremes in the calculations.

5. A ±10% error margin has been used for the employment cost calculations to cover the full range of likely error.

b) The following elements were selected for analysis:
- Rapid Prototyping part manufacture

36

- Rapid Prototyping part finishing and assembly
- Casting of Polyurethane parts

Two UK heads from the Customer Group were added to the total for the RP element to calculate the productivity (see Appendix 3), so that the UK and German RP elements could be correctly compared. The German RP element performs all the customer interface activity relating to the RP and PU elements. These same heads were included in the calculations for the materials costs per man for the whole of the UK elements being analysed as listed above so that a representative figure could be calculated (see Appendix 3).

There was no cost flow analysis conducted for the remaining elements because there was no corresponding element in the other team (see Figure 5 page 25).

c) Relevant costs for analysis:

The employment costs per head are covered in detail in Appendix 3.

Deleting the relevant German elements would change the following:

- Employment costs (to become UK employment costs)

- Materials costs (transferred to the UK in options (i) and (ii)). These costs are different for the two teams and so the most direct way to calculate the difference is by including them in the figures per head.

If a head is deleted from one country and added to the other, the general overhead attributed to that head would remain in the original country but be spread among the remaining employees. General overheads e.g. building rent and power use, are therefore excluded from the calculations.

The UK employment costs per employee per year including materials and consumable costs (e.g. lasers for Stereolithography equipment) range from £46,036 to £56,267.

The same costs in Germany lie in the range £60,750 to £88,000.

d) Alternative options proposed for analysis

On the basis that the cost per employee is higher in Germany than in the UK, the three options concentrate on deletion of the German elements where there is duplication with the UK. The three main ways to delete the relevant German elements are:

(i)   Increase the efficiency of the UK elements to take up the capacity

(ii)   Increase the size of the UK elements to cover the German demand

(iii)   Outsource all activity in one or both countries

e) Alternative options for analysis

(i)   Increase the efficiency of the UK elements

Based on internal utilisation figures averaged over the full year 1998, it may be possible to increase the productivity of the relevant UK elements by up to

37

10% without increasing their size. However there would be some increase in employment costs due to overtime and of course additional materials and consumables used.

The demand in Germany amounts to approximately 50% of UK output for Rapid Prototyping and 25% of UK output for PU parts. Therefore a 10% increase in productivity in the UK would not cover the German demand on its own.

(ii) Increase the size of the UK sub-teams to cover the German demand.

The calculations have been taken in two stages. Firstly the overall employment costs are compared in conjunction with the investment costs for the project. Secondly, the calculations are rerun taking the relevant opportunities that would be lost into consideration.

1. **Taking into account total employment and project implementation costs.**

If the German equipment was transported to the UK and the UK facilities updated, there would be a total cost incurred of approximately £820,000 including the cost of outsourcing the lost output from the group during alteration work (see Appendix 3).

If an increase in productivity is included in the calculations i.e. option (i), then calculations based on the most favourable case could assume that six German employees are replaced by five in the UK. Also, the extremes of the employment costs bands have been taken i.e. £46,036 for the UK (the lowest overall) and £88,000 in Germany (the highest overall), giving the maximum employment cost saving of £41,964 per head per year.

Action	Calculation type	
	NPV at 26%	IRR
6 German heads replaced by **6 UK**	£52,000	37%
6 German heads replaced by **5 UK**	£111,000	43%

Table 3. NPV and IRR results for employment costs only

Based purely on the employment costs and investment required to transfer new heads to the UK, the proposal provides a positive investment decision outcome by both Net Present Value (NPV) and Internal Rate of Return (IRR) decision criteria. In both cases the discount rate is taken at the BMW Group level of 26%[1] and calculated over a 10 year period (see Appendix 3). The results are shown in Table 3 above.

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[1] The BMW choice of 26% as the IRR threshold would probably be considered high by many companies but the figure reflects the strong brand of BMW and helps to drive the high profitability of BMW by selecting only very strong project proposals.

2. Taking into account lost opportunities and other considerations.

In addition there would be other negative impacts on shareholder value in the short and long term:

- Rapid Casting would not be fully introduced in Germany, missing an opportunity to save at least an additional £400k per year[2] compared to existing processes. In which case the project would make a negative contribution to shareholder value.

- The service would be slower than at present by 1 to 2 days[3], contrary to current customer requirements (Baden, 1999)

- Know-how would be lost in Germany, affecting integration of best practice technologies into the business processes

The same NPV and IRR calculations were run again but taking into account the loss of potential savings through introduction of Rapid Casting in Germany. In this case, the project would never reach a positive value with a lost opportunity of £400,000 per year because it is greater than the employment cost saving. The project only shows an NPV at 26% if the lost Rapid Casting opportunity were to save only £50,000 per year, at which point the IRR is 32%.

The other two negative impact factors will be discussed in (f) below.

(iii)   Outsource all activity in one or both countries

The third option would be to delete the German and/or UK teams and satisfy the corporate RP&T demands entirely by outsourcing the activity. The following information was gathered by a benchmarking activity involving responses from 11 bureaux, undertaken by Price (1999). The RP results were later confirmed by a separate study of 15 Bureaux in Germany by Baden (2000).

- The cost of RP outsource ranges between 65-288% greater than the in-house cost depending upon the application

- The cost of RT outsource ranges between 55-110% greater than the in-house cost depending upon the application

- The cost of Lamination outsource is approximately 85% greater than the in-house cost.

- The lead times for parts produced by service bureau outside BMW Group were longer than by using the in-house capability.

The surveys suggested that deletion of either team and replacing them by outsourcing the work to Bureaux would increase costs overall. Appendix 3 shows

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[2] Based on internal cost saving estimates made against the full year 1998 and the estimated demand for Rapid Casting in Germany.

[3] Based on a 24-hour delivery service from the UK to Germany, and the effects of a more indirect service to internal German customers.

a calculation to identify the viability of outsourcing by taking into account the sale of equipment from the German team, reduction in employment costs and the total cost of outsourced RP&T work to satisfy the BMW demand in Germany. The calculation shows that the 10 year NPV at 26% is negative and so the project is not viable.

f) Proposal for a suitable course of action

The three most likely alternatives for improving the total cash flow for TI-314 have been analysed. All three options involve deletion of the RP and PU capabilities in Germany due to the higher employment costs for the employees in Germany.

Increasing the output of the relevant UK elements through efficiency improvements does not provide a viable solution because there would be a shortfall of capacity to supply both the UK and Germany.

Replacing the German team by a purely outsourced supply of Rapid Prototype parts results in an overall increase in costs despite income from sale of equipment and savings from employee salaries.

The replacement of the German RP and PU elements by equivalent UK employees provides a viable alternative when addressed on the basis of Employment costs alone. However there are mitigating issues that make this option non-viable from the cash flow perspective.

If the potential savings from the introduction of Rapid Casting are taken into consideration (only likely to occur if an in-house capability exists to drive it forward), then the proposal does not provide an overall positive cash flow over the longer term.

Additional factors must also be taken into consideration in making a proposal. If the German elements were deleted, the customer service would decline by comparison with the current situation. A slower response time would directly conflict with the BMW Group corporate target of reducing the new product development time by 50%. In addition, there would be a long-term impact on the integration of RP&T technologies into the business, potentially affecting the cost and time saving corporate targets adversely.

Overall, the analysis suggests that deletion of any of the existing elements within TI-314 is not currently viable. Since it appears that no direct cash flow benefits can be gained through deletion of elements, other ways of reducing costs must be sought. The next part of the analysis identifies potential synergies between the two teams.

3.4.4.3 Assessment of other potential Group Function benefits

The remaining analysis has been broken down into five categories covering the operation and composition of the elements being analysed. The assessment has been made against the Group Function decision criteria, identifying where benefits can be gained. The output from the process is a set of high-level actions that are listed in Appendix 4. The categories are shown below with the summarised actions.

(i) People, Skills and Knowledge

Actions:

- Identify where the sharing of labour between the UK and German teams would reduce costs

- Compare core capabilities and balance the workforce where needed

- Share learning when new capabilities are developed

(ii) Equipment and Facilities

The overall aim is to increase commonality where appropriate and encourage diversity where it strengthens the overall group.

Actions:

- Benchmark each other and appropriate external groups to find best practice

- Test new equipment and processes in one location only

- Look for common purchasing and maintenance agreements, decision-making principles and processes

(iii) Databases

Location is not a problem for databases because they are electronic. Agreements will be necessary regarding common language in some cases.

Action:

- Identify all databases where common usage would be beneficial and make plans to align them

(iv) Relationships

Action:

- Identify all current relationships and where commonality would be beneficial

(v) Activities

The activities of the teams generate their function. A full list of the activities is shown in Appendix 5.

Actions:

- Using the table as the starting point, identify the potential for commonising activities

- Identify work-sharing opportunities between elements with common activities to gain economies of scale plus balance workload schedules

- Assess each activity for opportunities to reduce supply timings

The high-level actions were then taken through the final stage of the process – step 5 "check and finalise the outputs".

3.4.5 Step 5 – Check and finalise the outputs

The collated actions are shown in Appendix 4. In studying these high-level actions, no conflicts or duplications were identified between them. There were no conflicts with the main limiting factors visible at this stage in the process.

3.4.6 Next steps

The following actions will be carried out in creating the detailed operational action plans:

1) The whole process will be communicated to the team leaders first and then to the whole team once time scales have been agreed.

2) Time scales will be agreed with the team for running through the analysis at the element level to create the operational action plans for each element

3) Steps four and five will then be run through again by the members of each element, based on the high-level action set; keeping in mind the two decision criteria.

An important aspect of the next step is the involvement of the team members in the process of devising the operational action plans. Change will occur over an extended time period and should be seen as a process of continuous improvement. A Kaizen-type approach would therefore be suitable (Imai, 1986).

3.5   Conclusions about the Group Function framework

The framework successfully brought together all the relevant factors and materials relating to mergers for the first time and provided a viable basis for operational action planning based on the criteria laid down by the BMW Group Board.

The framework provided a focus for organisational analysis and development based on corporate strategic criteria. TI-314 was broken down into its fundamental elements in order to ensure that a valid comparison could be made between the UK and German parts of the group.

All elements of TI-314 were retained as a result of the analysis and the key operational actions were fed into the corporate Target Setting process in 1999. Consequently, many of the actions were initiated in 1999. Although many of the actions remained incomplete and there is no information to identify measurable synergistic benefits, the following actions were initiated:

- Common concepts were agreed for the customer liaison process

- Expertise was shared through visits between the teams

- Development of a common web page was initiated

- Rapid Casting was used more vigorously in Germany during 2000 than in 1999

- A common costing system was generated

- Databases were shared, although language remained a problem in 1999

- Common marketing material was used on more than one occasion

- Workload sharing was initiated and developed to balance peaks and capabilities between the two teams through 1999 and early 2000.

The information provided by the Group Function framework and analysis was also used in the development of the Rapid Prototyping and Tooling strategy, which is covered in the remainder of this report.

At the time of writing this executive summary, Rover Group had been sold and split into MG Rover Group and Land Rover. Although the specific conditions that resulted in the creation of the Group Function framework no longer exist, the principles involved in its creation should remain valid for other cases where two relatively stable technology-based groups are being assessed for merger synergies.

The framework was created by the logical adaptation of the literature knowledge in conjunction with the specific context of the case and is generic in its nature. A range of different business sub-units could therefore benefit from the framework by adapting it to their own needs. The structured approach to Group Function assessment proposed by the framework would potentially produce more consistent results than through individual interpretation of the process. Use of the framework should reduce important Group Function factors being missed and inconsistencies in approach to Group Function analysis, both of which would probably reduce the potential value-added through Group Function creation.

The concept behind the framework is straightforward to communicate by using the 'coffee making' analogy and graphic, making it readily available as a discussion and functional item. Use of the framework encourages the user to follow a structured approach to the analysis process that takes into account all the relevant factors of the case and not just assume that headcount reduction is the obvious outcome.

4   Development of a Strategy Creation Framework

4.1   The need for a strategy creation framework

Two options were proposed for increasing the business benefits from TI-314. The first was the Group Function framework, which provides operational action plans for short and medium term efficiency improvement. Longer-term benefits will more likely be gained through improving the way that TI-314 interacts with the business. The second option for business benefit improvement would therefore be the development of a suitable long-term strategy for TI-314.

BMW Group has two potential mechanisms for strategy development. The first is a high-level process for market strategy development but it is highly confidential and is purely external market-focused. The process is unsuitable for internal strategy development because it is primarily targeted at identifying vehicle production volumes within carefully selected sectors.

The second potential strategy development process is the corporate "Target Setting Process" (see Appendix 2) introduced after the start of this research at the beginning of 1999. The Target Setting process starts from the Board-level strategic targets for the whole company and cascades down through the business involving three layers of management at a time. The process generates a set of targets for each layer of the organisation for the coming year. It does not provide guidance or demands regarding longer-term thinking, data gathering, scope beyond the function concerned or other attributes necessary for strategy development. It is an effective action planning method but not a strategy development tool.

Because the above mechanisms are unsuitable, there does not appear to be any guidance for internal strategy development available within the business. The aim of this research is therefore to develop a practical strategy creation framework from the information available. The following hypotheses have been set on the basis of existing knowledge:

1) It will be possible to generate a new strategy creation framework for Rapid Prototyping and Tooling based largely on the advice available within the literature on the subject and from other sources if required.

2) The nature of the new strategy creation framework will be largely determined by the context of the situation.

The starting point for the research is therefore the literature on strategy development.

4.2 The Practice of Strategy Development

4.2.1 Themes for developing the new strategy creation framework for TI-314

In reviewing the literature on strategy development it may be possible to identify some common themes that can be applied to the case. The methodology for the literature review is therefore:

a) To review the literature on strategy development identifying key themes.

b) Relate the key themes to the context of the TI-314 case, selecting 'Core Contextual Themes' that can be used to develop a new strategy creation framework.

4.2.2 Defining strategy

There is no single accepted definition for what a strategy is.

Sun Tzu (400 BC) is attributed with the statement (Hamel & Prahalad, 1989): "All men can see my tactics whereby I conquer, but what none can see is the strategy out of which great victory is evolved". Strategy is perhaps something that *guides* tangible outcomes and decisions.

The majority of strategy literature started to appear from the late 1950s. One notable business historian, Alfred D Chandler (1962) gave the following definition: "Strategy is the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out those goals".

A more recent definition is given by Johnson & Scholes (1999):

"Strategy is the direction and scope of an organisation over the long term: which achieves advantage for the organisation through its configuration of resources within a changing environment, to meet the needs of markets and to fulfil stakeholder expectations".

Strategy can be defined in so many ways that perhaps any single interpretation would be misleading (de Wit & Meyer, 1999; Mintzberg et al, 1998). Whatever the definition, the majority of opinion suggests that strategy provides positive guidance for the development of an organisation over an extended period into the future.

From the perspective of the operational manager, the diverse nature of the strategy literature and definitions of strategy must surely add to the confusion and mystique surrounding it. Through this research the author is aiming to reduce some of the problems surrounding strategy for the average manager who needs to create an internal strategy for a technology-centred part of the business.

45

4.2.3 The classification of strategy

Because the literature on strategic management is very broad, breaking it down into manageable categories makes it easier to understand and identify the parts of interest.

Among the variety of different views on strategy, Mintzberg et al (1998), suggest that there are ten schools of strategic thought. Three of the schools are prescriptive: 'Design', 'Planning' and 'Positioning'. These schools treat strategy as being something that is deliberately created by the leadership and then delivered. The remaining seven schools describe how strategy comes about. These schools are: given the titles: 'Entrepreneurial', 'Cognitive', 'Learning', 'Power', 'Cultural', 'Environmental' and 'Configuration'.

Strategy can operate at different levels. Johnson & Scholes (1999) suggest three levels:

- Operational (or Functional) level strategy

- Business Unit strategy

- Corporate strategy

Other suggested levels of strategy include 'Network level' (de Wit & Meyer, 1999) and 'Global' (Hill & Jones, 1998).

Managers within a business might naturally assume that only the literature relating to 'operational level' strategy would be relevant to them in developing an internal strategy. A review of this aspect of the literature suggests that 'operational strategy' would be too limiting as it primarily covers efficiency improvement within the business, leaving effectiveness and business strategy out. An internal technology-related strategy may well affect many aspects of the business or even its competitiveness in the marketplace and so higher-level 'business unit' and 'corporate' strategy literature becomes relevant. This research takes into account all the pertinent aspects of the broader strategy literature in order to avoid a narrow internal view that is only associated with efficiency development.

4.2.4 Strategy as an 'emergent' or 'deliberate' process

The process of strategy development can be viewed as either being 'deliberate' or emergent. The three primary prescriptive schools view strategy as being deliberately created, driven by top management and generating a 'deliverable' strategy complete at the end of the process. Other schools such as the 'learning' school see it as emerging in a series of small steps. These views have been represented by Mintzberg & Waters (1985) in the following diagram (Figure 9). The x-axis relates to the development of the strategy whereas the y-axis is an arbitrary representation of strategic position. Hence the 'intended strategy' is starting from a different strategic position than the 'emergent strategy'.

In the diagram, an 'intended strategy' is the course that an organisation intends to pursue. The 'realised strategy' may however be the result of 'deliberate' strategy formulation or of 'emergent' strategy activity, or a combination of the two. In some cases however, the strategy is 'unrealised'.

A realised strategy could be referred to as being deliberately emergent, resulting from the broad guidelines provided by senior management being worked on and implemented by people within the organisation.
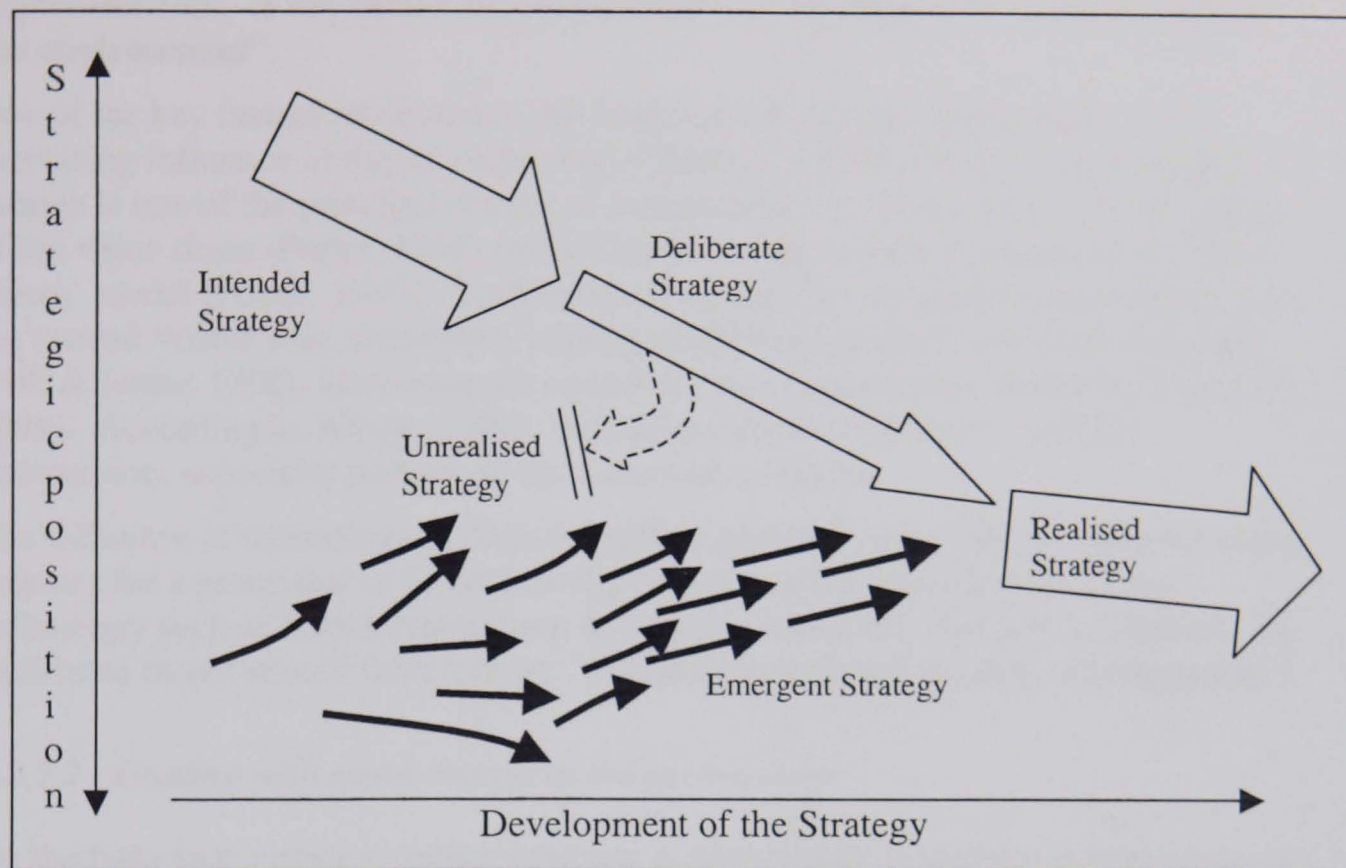
Figure 9. Deliberate and Emergent strategies (Mintzberg et al, 1998)

As these two approaches represent fundamentally different views on strategy development it will be essential to understand the implications. It is likely that both viewpoints need to be catered for when developing a strategy, as has been achieved with the new framework proposed in this research.

The first theme could therefore be **"Deliberate or Emergent strategy development as the dominant process?"**

Whichever process is dominant, the context within which the strategy is being created, either drives the strategy, shapes the outcome or is changed by the strategy (Mintzberg et al, 1998; Johnson & Scholes, 1999; de Wit & Meyer, 1999; Hill & Jones, 1998).

4.2.5   Strategy Context

4.2.5.1   The general business environment

Increasingly through the 1990s, there has been an observation that the marketplace is becoming more turbulent (Porter, 1996, Courtney et al 1997, Hamel, 1998). Change in macroeconomic factors, technology, social, demographic and the political aspects of the macroenvironment will inevitably have an impact and cause change down through the business affecting each aspect of the competitive forces outlined by

Porter (1980) (Hill & Jones, 1998). Change in the environment is inevitable and will affect the development of any strategy. It will therefore be important to understand how to handle environmental change during the strategy development and implementation. A key theme should therefore be "**Dealing with rapid change in the environment**".

One of the key factors attributed to the fundamental changes taking place is the increasing influence of digital technology (Downes & Mui, 1998). "Technological change is one of the principal drivers of competition", it affects almost every aspect of the value chain (Porter, 1985) and all aspects of the industry balance in the 'five forces' model (Porter, 1980). Technological change has continued to accelerate since the second World War, sometimes making established products obsolete overnight (Hill & Jones, 1998), increasing the overall levels of uncertainty (Johnson & Scholes, 1999). According to Whipp (1987), technology could be the new basis for competition, especially perhaps in the automotive industry.

The influence of technology is clearly highly significant, especially in the automotive industry for a group that is fundamentally focused on the introduction of new technology such as Rapid Prototyping & Tooling, where this research is centred. An additional theme should therefore be: "**Technology-related strategy development**".

4.2.5.2   Dealing with rapid change in the environment

On the basis that a strategy either emerges, is deliberately developed or some mixture of the two it is appropriate to look at how each method performs in a rapidly changing environment.

An emerging strategy can change incrementally as the environment changes around it. Emergent strategy is therefore flexible to change (Mintzberg et al, 1998). If the change becomes very rapid, an incremental approach may not be able to adapt quickly enough to cope with the change (Gaddis, 1997).

The 'incremental' approach has been successful at Honda, where it is described as "adaptive persistence" (Pascale, 1984). It has also been a successful approach when dealing with major technological change projects such as nuclear power plant (Collingridge, 1992).

By contrast, a deliberate strategy development process runs the risk that as soon as the strategy has been developed, it is effectively out of date (Mintzberg et al, 1998), it has fulfilled its purpose and should perhaps even be thrown away (Peters, 1987).

One possible solution is to create scenarios (Schnaars, 1987) where a range of different possible futures are created and assessed against each other. A development of the scenario approach specifically allows for environmental change (Courtney et al, 1997). The environment is carefully analysed and as much uncertainty as possible is removed through the analysis process. Four levels of environmental uncertainty are then established:

1. Clear enough future

2. Alternate futures

3. Range of futures

4. True ambiguity

Within these four categories they suggest different approaches for devising strategies. Once a strategic route has been determined, 'key trigger variables' are identified and tracked throughout the implementation of the strategy to check strategy alignment with the environment.

Any prediction about the future is likely to be wrong and so scenario-based approaches have limited effectiveness. An alternative is for strong teams to meet frequently and use real-time environmental measures, reacting quickly to change as it occurs (Eisenhardt, 1999). The approach could perhaps be associated with the concept of 'strategic intent' (Hamel & Prahalad, 1989), combining flexibility with a concerted common understanding of a common direction and purpose.

A central feature of rapid environmental change is technology.

4.2.5.3   Technology-related strategy development

It is essential that a business understands how it intends to compete in the long term when considering the application of new technologies (Loveridge & Pitt 1990). Perhaps reflecting this point, there has been a "growing interest in the integration of technological strategy into business planning" (Yuan, 1999).

Porter (1985) proposes three broad issues that technology strategy must address according to the way in which they can affect the competitive advantage of the business:

- "What technologies to develop
- Whether to seek technological leadership in those technologies
- The role of technology licensing"

The influence of technology on strategy development can be viewed from two perspectives. Firstly, there is the potential for new technologies to improve or radically change the whole business. The strategy development process would therefore need to help to identify these opportunities and exploit them. Secondly, if the context is largely technology-centred, then there may be some effect on strategy development.

Twiss (1992) links the development of an R&D strategy to the development of overall corporate strategy and proposes a decision-making process for R&D project selection. Included in his model is the 'PEST' analysis, linking R&D strategy to the corporate strategy.

The benefits achievable from technology can easily be underestimated by taking them at a superficial level only through formalised approaches (Clarke & Thomas, 1990). All the potential benefits must be taken into account (Swann & O'Keefe, 1990; Primrose, 1991).

Possible aids to technology selection and assessment include the technology development 'S-Curve' (Twiss, 1974; Foster, 1986); the 'industry life-cycle' (Twiss, 1992) and portfolio methods for making comparisons, perhaps plotting the nature of the application against its relative importance to the business (Twiss, 1992).

Top-level support and financial flexibility are required to ensure successful technology strategy development and implementation (Twiss, 1992) as well as dedicated individuals to see the projects through (Moenart et al, 1990; Twiss, 1992).

4.2.5.4   The interaction of strategy Process, Content and Context

The Context of strategy interacts with the Process and Content of strategy (Pettigrew, 1985). These three dimensions of strategy can be described as follows (de Wit & Meyer, 1999):

Strategy Process: Is the manner in which strategies come about. How should the strategy be formed, by whom, and when should they do it?

Strategy Content: Is the outcome from a strategy process. It is the 'what' of strategy, i.e. what should be the strategy for the company?

Strategy Context: Is the set of circumstances within which the strategy process is operating and the content is created. It is the 'where' of strategy, defining the environment both of the firm and external to the firm in which the content of strategy is being created through the strategy process.

The three dimensions of strategy are not separate parts of strategy; they interact and hence affect one another. One way of visualising the interaction between the three dimensions of strategy is shown in Figure 10 below. The content of the strategy is developed by the process through iteration (the spiral line). Both the process and content are affected by the context within which they exist.
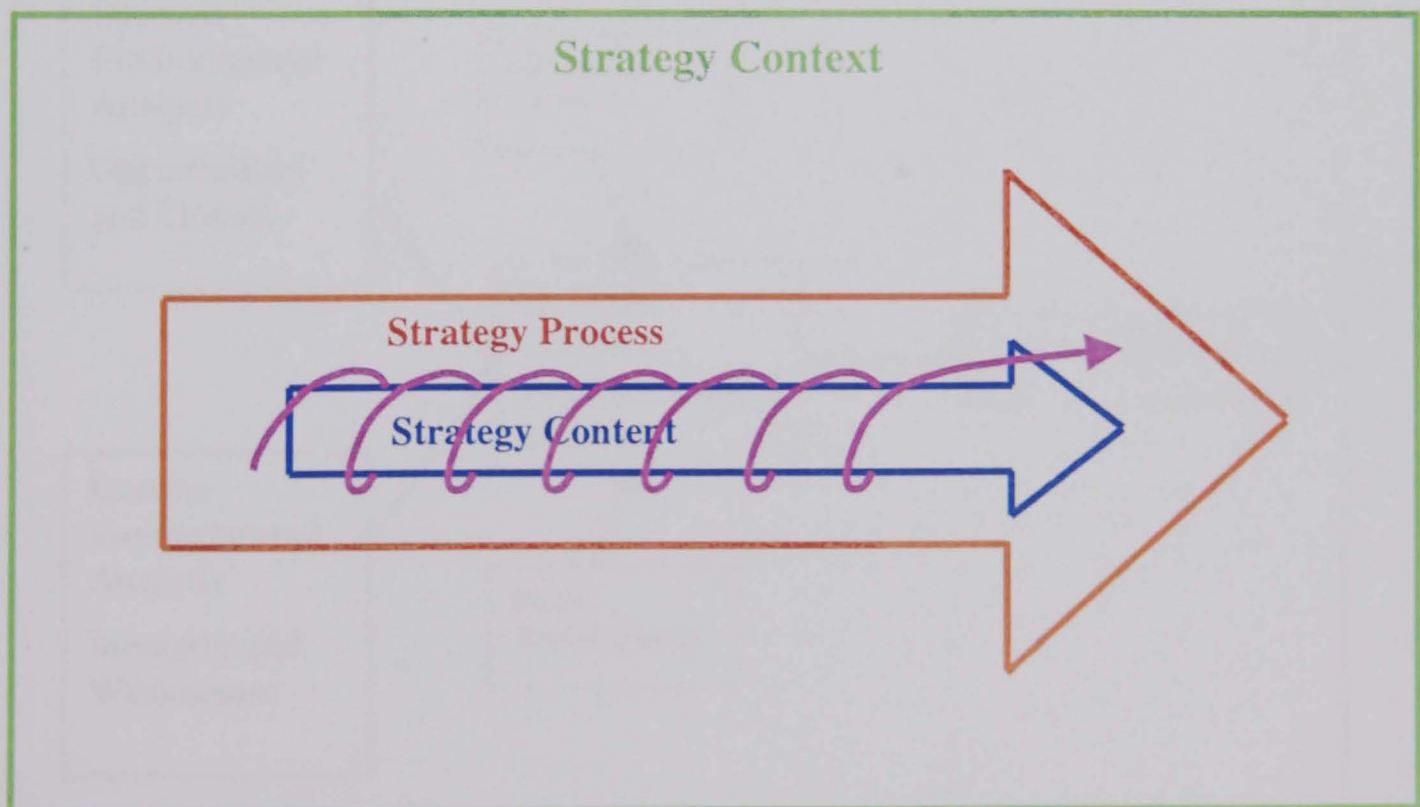
Figure 10. The interaction of strategy Context, Process and Content (de Wit & Meyer, 1999)

4.2.5.5 Strategy Context determines the Process and hence the Content

If the Context, Content and Process of strategy interact and affect one another, when the Context changes, so should the Process and hence the Content. According to Porter (1980), a business is affected by its environment. It can also affect its environment (Prahalad & Hamel, 1990).

One of the premises of the Configuration school is "to everything there is a season" (Mintzberg et al, 1998). Hart (1992) suggests different modes of strategy development according to circumstance as do Mintzberg & Lampell (1999) and Johnson & Scholes (1999). The process can be a synthesis of several different approaches according to the circumstances (de Wit & Meyer, 1999). The challenge will be to find the Process and hence Content best suited to the Context (Goold & Campbell, 1987). A full understanding of the relevant environment is therefore required. Consequently, due to the fundamental importance of the strategic context it is appropriate to include "**Environmental analysis and understanding**" as one of the key themes for the new strategy creation framework.

4.2.5.6 Environmental analysis

The Design and Planning schools of strategy development specifically include environmental analysis within their prescriptive processes. For example, a generalised version of the Design school model is shown in Figure 11 below.
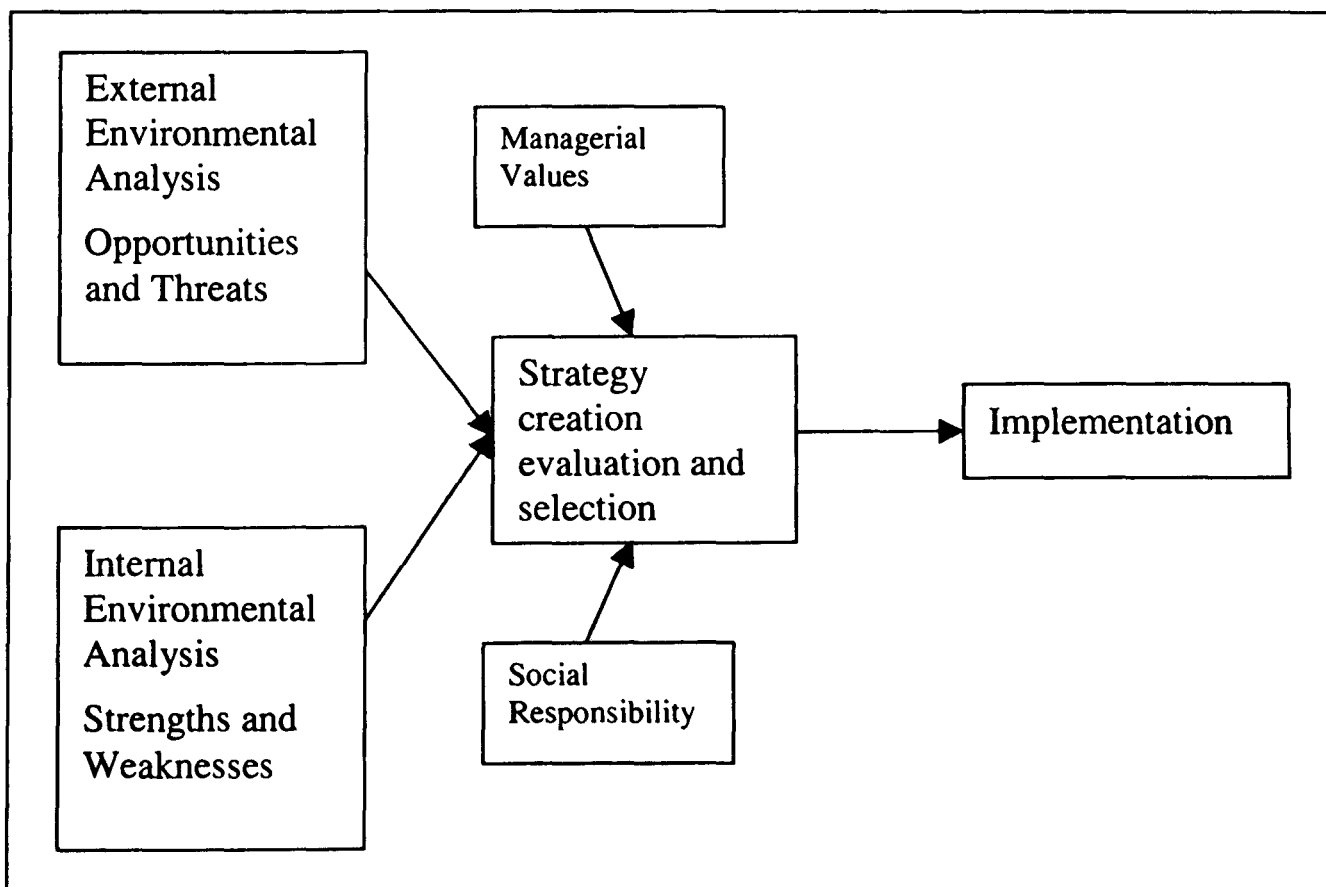
Figure 11. The basic Design school model (Mintzberg et al, 1998)

Splitting the environment between external and internal is also common to the change management literature (Pettigrew, 1985; Pettigrew & Whipp, 1993).

51

4.2.5.7 Analysis of the external environment

The comparison of Opportunities and Threats in the external environment against the Strengths and Weaknesses of the internal environment is proposed by the Design school (Andrews, 1980). The 'SWOT' analysis has its critics due to its subjectivity (Hill & Westbrook, 1997; de Wit & Meyer, 1999). However it can generate ideas, discussion and involvement in the strategy development process.

Checklist approaches for environmental analysis can help to identify those aspects of the external environment that have more affect on the company than others. The 'BPEST' analysis provided by Cole (1997) appears to provide good coverage and is consistent with checklists provided by other authors (Johnson & Scholes, 1999, Bowman, 1990; Andrews, 1980). BPEST includes:

- **Business**: State of the Industry; The market; Competitors; Suppliers

- **Political**: Legislation; Support for enterprise; Taxation; Political changes in other markets

- **Economic**: Interest rates; Employment levels; Inflation; Exchange rate; Shareholder confidence; Terms of trade

- **Social**: Skill levels; Population changes; Consumer confidence; Spending patterns

- **Technological**: Developments in: IT, Industrial applications and Materials

Additional guidance may be provided by the 'five competitive forces' model proposed by Porter (1980) shown in Figure 12 below.
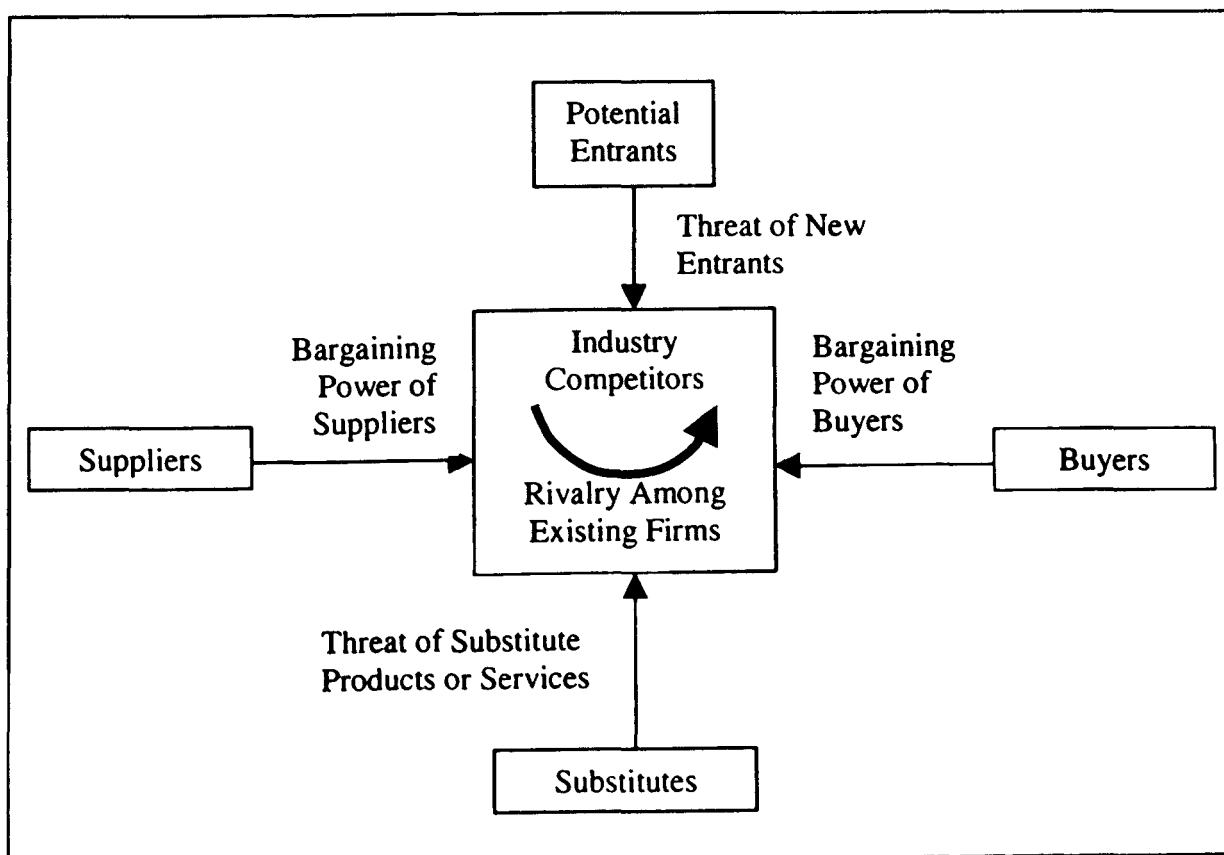
Figure 12. The 'Five Competitive Forces' model (Porter, 1980)

Porter's model illustrates the interplay between Suppliers, Buyers, Substitute products or services, potential new industry entrants and the existing industry competitors. Other business strategy models that may be beneficial in the environmental analysis include:

- The three generic strategies of Cost leadership, Differentiation and Focus (Porter, 1980)

- The concept of strategic 'Fit' (Porter, 1996)

- Market segmentation (Porter, 1980; Doyle, 1987)

It is not possible to identify whether all of the business strategy models and lists will apply to a group within a large organization. It is likely however that there will be some overlap between the external environment analysis and the internal environment analysis due to the interplay between the two for an internal group.

4.2.5.8 Analysis of the internal environment

Cole (1994) provides a generic checklist including organisational, cultural, financial, R&D, production, marketing and resource issues, showing some overlap with the external analysis.

How a group is organised can influence the effectiveness and efficiency of its 'Value Chain' (Porter, 1985) which consequently affects the value that a group can add to the organisation (Johnson & Scholes, 1999).

The effective development and use of 'core competencies' (Prahalad & Hamel, 1990), can affect the long-term competitiveness of the organisation. The flexibility and mobility of these competencies and the people relating to them directly affect their effective use.

Portfolio matrices can assist in the analysis of activities and products. The best known example of this technique is the Boston Consulting Group matrix or 'Boston Box' (Dyson, 1990). The technique can be used with a range of different axes, producing a simple visual output to more complex analysis.

Other analysis techniques such as the 'TOWS' matrix and scenario planning can be used for internal option planning and decision-making (Dyson & O'Brien, 1998), also the 'Concept Evaluation Matrix' (Pugh, 1996) and 'Association Diagrams' (Leverton, 1998).

During the process of internal analysis, an understanding of its relationship to 'best-in-class' competition would be beneficial. Benchmarking (Johnson & Scholes, 1999, Hill & Jones, 1998) is a well-acknowledged tool that starts with an understanding of the internal environment and links it to the outside competitive environment (Millard, 1995).

However the strategy develops and regardless of the methods and tools used to develop it, the strategy will have to be implemented to add value to the business.

4.2.6 Strategy Implementation

Kenneth Andrews (1980) stated "Since implementation can make a sound strategic decision ineffective or a debatable choice successful, it is as important to examine the processes of implementation as to weigh the advantages of available strategic alternatives."

The prescriptive schools of strategic thinking see the role of leadership in strategy implementation as pivotal to its success, (Andrews, 1980; Twiss, 1992; Kanter, 1983) requiring vision, commitment, information capture, delegation, empowerment and astute use of power (Hill & Jones 1998).

The Japanese take a bottom-up approach to strategy development, treating it as an emergent and continuous process involving everyone called "Kaizen" (Imai, 1986). However, the 'involve everyone' (Peters, 1987) approach may result in chaos and a more balanced approach would appear to be more practical (Thakur, 1998).

The Agile Manufacturing approach of integrating organisation, people and technology (Kidd, 1994) takes the practical viewpoint one step further into the working environment. Here the management of change must balance with leading change, the link between strategic and operational change, human resources and assessment of the environment (Pettigrew & Whipp, 1993).

A fixed plan can cause inflexibility (Mintzberg et al, 1998) and so the strategy can be made more adaptable through the use of vision and mission statements (Johnson & Scholes, 1999; Raynor, 1998; de Wit & Meyer, 1999). These statements can be made more interactive through the approach proposed by Hamel & Prahalad (1989) called "Strategic Intent". It involves the strategy implementers, bringing the future into the present and making it a natural part of everyday business.

The great body of evidence suggests that involvement of the strategy implementers in the strategy development and other factors relating to its implementation are essential to its success. The overall topic of **"Strategy Implementation"** is consequently a logical addition to the key strategy themes for the new strategy creation framework.

4.2.7 Summary of the key strategy themes

It has been possible to derive a set of key themes relating to strategy development from the relevant literature. These themes are:

- **Deliberate or Emergent strategy development as the dominant process?** This question highlights the need to choose between the two main concepts of strategy development process. If a specific outcome is expected from the strategy development process, then a deliberate process must form the basis for the new framework. If no specific outcome is required from the strategy development process, then emergent processes may be more dominant.

- **Dealing with rapid change in the environment.** If rapid change is a feature of the strategy context, then a purely deliberate strategy development process may be too rigid in its approach, other concepts may be required.

- **Technology-related strategy development.** Technology is central to competitiveness. Technological change is probably the dominant factor driving environmental change. If technology is a part of the context then related approaches will be required in the framework.

- **Strategy Implementation.** For the strategy to be beneficial to the company, it will have to be implemented.

- **Environmental analysis and understanding.** Whichever process is used, it will be necessary to fully understand the strategic context.

These themes cover key business strategy issues and highlight the importance of the context in strategy process choice and strategy development. Having covered the broad business context, it is worth looking at the BMW Group context relating to strategy development before looking at the specific context of TI-314. The author carried out an internal survey on strategy development as part of identifying the BMW Group internal context.

4.3   Internal assessment of strategy creation practice

4.3.1   The need for a survey

The literature on strategy development is broad-based but identifies the importance of understanding the context. A survey within BMW would help to identify the internal practices and views regarding strategy development. In particular, the survey aimed to discover how experienced BMW managers develop a strategy for their own groups.

4.3.2   Survey Methodology

The survey methodology was based on the learning gained during the communications research (Report 2), which was developed from the methodology proposed by Oppenheim (1992) as shown in Appendix 6. A structured interview approach was chosen to allow for directed data gathering with a degree of flexibility to suit individual experiences and insights.

The hypotheses for the survey were:

1) People and groups within BMW Group have processes or ideas for creating strategies that would either be directly or indirectly useful in creating a strategy for RP&T.

2) There is no formally communicated advice available within BMW Group for strategy development at a sub-business unit level.

3) Different people use different approaches to strategy development according to circumstances.

4.3.3   Results from the internal survey

Interviews were completed with eleven senior managers with relevant strategy development experience within BMW Group. Additionally, two external respondents were also included in the survey; both of them run Rapid Prototyping and Tooling groups in competitor companies.

The main results were as follows:

1) All of the respondents had views and a personal approach towards strategy development. The views fell broadly into the following categories:

- **It is a planning process.** The respondents holding this view had a strong involvement with project planning and management.

- **It is a step-by-step learning process.** The respondents who gave this answer run RP&T departments in competitor companies. They felt that the strategy had to allow for technology and internal environment changes.

- **It is an analytical process.** The respondents who gave this answer had been involved in corporate and technology strategy development at a high level.

- **It is a team involvement process.** This response was made by a non-technical middle manager. However most of the respondents included some degree of team involvement as part of the process.

2) Nine of the BMW Group respondents stated that there were no guidelines for strategy development within the company. One of the respondents referred to the BMW Group corporate marketing strategy development process. The remaining internal respondent referred to the Target Setting process as being the internal corporate strategy development process.

3) Other points arising from the survey were as follows:

- Involve the team members throughout the strategy development

- Gain buy-in from top management

- Culture differences would have an effect on the strategy development, most likely regarding communication between the parties

- The Pettigrew (1985) Context, Content, Process approach is an essential basis

- Retain flexibility in the final outcomes to allow for environmental change

4.3.4   Conclusions from the survey

The results from the survey confirmed the three survey hypotheses as described below.

The processes proposed (results point 1 in section 4.3.3) and ideas expressed (point 3 in section 4.3.3) appeared to be relevant either directly or indirectly to strategy development for RP&T (survey hypothesis 1).

There does not appear to be an internal strategy development process, confirming survey hypothesis 2, however the 'Target Setting' process does provide an annual planning mechanism and should possibly be considered in this context.

The respondents had a range of views according to their personal experiences (results point 1 in section 4.3.3) confirming survey hypothesis 3.

The processes and ideas gained during the survey were complementary to and consistent with the literature on strategy development. The four categories of strategy development process echoed the views of Minzberg et al (1998) and other authors e.g. de Wit and Meyer (1999).

The survey strengthened the platform of knowledge on which the new strategy creation framework was built.

4.4   Development of the Core Contextual Themes for TI-314

Key strategy development themes have been derived from the literature in sections 4.2.4, 4.2.5 and 4.2.6.

It has been established that the context of a case will be the primary determinant of the strategy process and content for that case (section 4.2.5.5). It is unlikely that the context of any one case can be perfectly defined but it should be possible to cover the most important aspects of it by identifying 'Core Contextual Themes' for the case. These core contextual themes are features of the context that must be covered by the strategy creation framework. They are in effect requirements that must be met by the strategy creation framework.

The next step is to understand how the general themes derived from the literature align with the case and whether there are any additional key features of the TI-314 context that should be taken into account. The process is illustrated in Figure 13 below. The literature on strategic management has generated a number of key themes that are then compared with the RP&T context. There may also be additional themes that did not appear in the literature that need to be taken into account within the strategy creation framework. The comparison process will produce a full set of 'core contextual themes' for RP&T that can then be used on the development of the strategy creation framework for this case.

4.4.1   Environmental analysis and understanding

It has already been established that a core theme throughout all strategic activity is the role of context. The framework must therefore include this as a core contextual theme for TI-314.
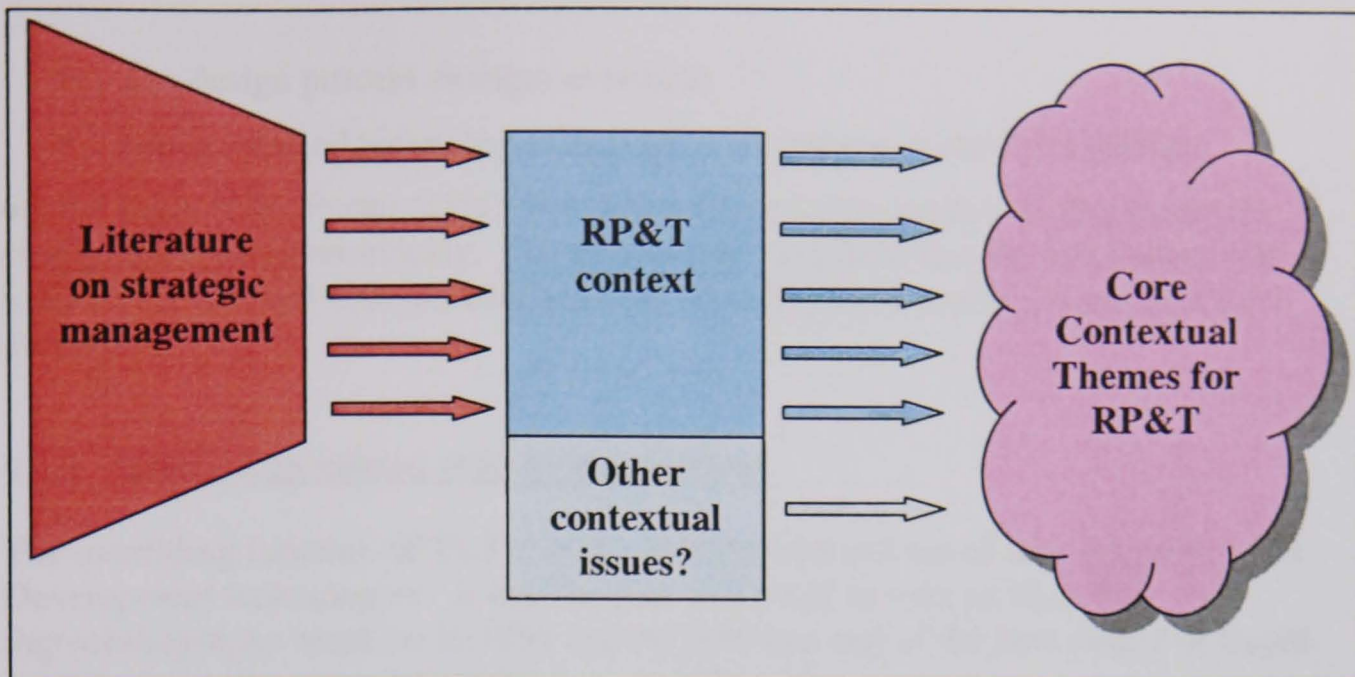
Figure 13. Comparison of the main literature themes with the context of RP&T

4.4.2 Dealing with rapid change in the environment

The automotive environment is changing all the time and becoming increasingly competitive. Time-based competition is affecting all industries, including automobile manufacture (section 1.2).

BMW Group was itself undergoing radical organisational change by forming Group Functions with Rover Group and with regard to its internal processes within the Re-engineering programme.

The technological environment relating to TI-314 was also changing rapidly, for example:

- By 1999 the speed of RP systems had increased by a factor of over 10 compared to the early 1990s.

- Between 1994 and 1999 there were seven software upgrades for 3D Systems Stereolithography equipment alone.

- The main technology trends are towards faster and cheaper machines (Grimm and Wohlers, 1999), and better material properties.

- The economic manufacture of production parts without tooling (Rapid Manufacturing) is starting to become a reality. Functional parts have already been made for Space Station applications (Dickens, 2000). The latest thinking strongly suggests that Rapid Manufacturing will revolutionise the way in which components are manufactured over the next decade or so.

- The number of Rapid Prototyping machines sold worldwide increased from 922 in 1994 to 4259 in 1998 (Wohlers, 1999).

Demand for the services of TI-314 is highly unpredictable:

- Vehicle programmes change their dates and quantities required

- The availability of new services from TI-314 affects demand

58

- The design process changes over time

- Design-related technologies change over time e.g. virtual simulation

On the basis of the Porter (1980) five competitive forces model, all five forces are changing almost continuously. The framework must therefore be able to deal with rapid environmental change, which should consequently become a core contextual theme.

4.4.3   Technology-related strategy development

The overriding function of TI-314 is the introduction and use of new Rapid Product Development technologies. It was the first in the UK to own an SLA-500 Stereolithography machine in 1991 and by 1999 had one of the best ranges of Rapid Prototyping and associated applications in industry[4]

The partnership with Warwick Manufacturing Group (University of Warwick) has been built up to help ensure that the technological development of the group was based around sound research. The relationship with WMG forms part of an overall technology research-centred approach to Rapid Prototyping & Tooling.

Technology is central to the present and future for RP&T and consequently this theme should be included in the framework as a core contextual theme for TI-314.

4.4.4   Deliberate or Emergent strategy development as the dominant process?

The founding principles of the strategy creation framework depend upon whether it should follow a deliberate or emergent approach.

The approach for TI-314 must be basically deliberate for the following reasons:

- A strategy was requested as a 'deliverable' with timing associated with it.

- The 'delivered' strategy would then be used as the basis for the financial approval of a new project.

An appropriate core contextual theme for the TI-314 strategy creation framework would therefore be:

"Treating the strategy as a deliverable item"

This core contextual theme is consequently briefly reviewed in the following section.

4.4.5   Treating the strategy as a deliverable item

A deliberate approach to strategy development has the potential to produce significant content (Mintzberg et al, 1998) to the strategy. The analytical approaches can also provide a strong understanding of the environment (internal and external

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[4] According to a verbal statement by Terry Wohlers, a world-recognised authority in the field of Rapid Product Development in December, 1999.

context) at the time of the analysis. There can be difficulties with a planning-type approach due to the commitment and control required, possibly leading to failure of the project (Gray, 1986). A planning-type approach may also be restrictive due to the high level of detail required (Hayes, 1985).

A structured approach to strategy development, produces useful presentation material that may be useful in persuading top-level management about the proposal. Top management plays a critical role in the introduction of innovative technologies into the business (Twiss, 1992).

4.4.6   Strategy Implementation

The strategy is intended as a deliverable that must be implemented if it is approved. Strategy implementation must therefore be included as a core contextual theme.

4.4.7   Other context-related themes

Since the first core contextual theme relates to environmental analysis, any new TI-314 environmental feature identified during the strategy development will be picked up. However in going through the external and internal environment checklists to make a quick check of factors that might affect the strategy development process, cultural factors are identified as a factor that should be considered in strategy development.

One feature of the TI-314 internal environment that is perhaps unusual is the cross-cultural nature of the context. Culture has been taken to mean both national and corporate culture. It is therefore appropriate to add one final core contextual theme:

"Cultural issues relating to strategy development"

This core contextual theme is briefly reviewed in the following section.

4.4.8   Cultural issues relating to strategy development

We can expect to find cultural differences between people from different countries and from different organisations because it is a learned, collective phenomenon (Hofstede, 1991). If strategy development is problem solving, then it is likely to pose some culture-related challenges. According to Trompenaars (1993), "Culture is the way that people solve problems".

Direct advice on how national or corporate culture differences might affect strategy development is diffuse in the literature and is open to wide interpretation due to the vagaries of interpersonal interaction. However, cultural issues should be taken into account when planning strategic change (Johnson, 1992).

<u>4.4.9   Summary of the core contextual themes for TI-314</u>

The six core contextual themes for TI-314 have now been derived from the literature on strategy development and correlated with the context of TI-314. These core contextual themes define the performance requirements that must be met by the strategy creation framework as it is used.

The senior management in BMW made the direct request that a strategy be created for TI-314. Consequently, a deliberate strategy development process was chosen as the basis for the new framework. However, the choice still holds open the possibility for emergent strategy processes to occur within the deliberate strategy framework.

Use of the environmental checklists identified that a suitable additional theme would be 'Cultural issues relating to strategy development'. The six core contextual themes for TI-314 are:

- Environmental analysis and understanding
- Dealing with rapid change in the environment
- Cultural issues relating to strategy development
- Treating the strategy as a deliverable item
- Technology-related strategy development
- Strategy implementation

Now that the core contextual themes have been derived, they will be used to develop the new strategy creation framework for TI-314.

4.5   Development of the strategy creation framework

<u>4.5.1   Methodology for the strategy creation framework development</u>

The core contextual themes will all be covered as the strategy process is built up over four main stages:

1) **Treating the strategy as a deliverable.** This stage provides the main structure for the framework. The environmental analysis, culture and technology core contextual themes are also included as required.

2) **Allowance for the changing environment** during and after the strategy development process. The culture and technology core contextual themes are included as required.

3) **Implementation considerations.**

4) **The process as a whole.**

61

4.5.2 Starting assumptions

1) TI-314 has many attributes that make it similar to a normal business, in line with the Porter (1980) five forces model and so TI-314 could be regarded as a business within the BMW Group. It may therefore be possible to apply the business strategy models. However TI-314 has no control over total revenue streams and it does not generate a profit or a loss. Consequently, the normal business strategy models may not fully apply for TI-314 and care will have to be taken in their application.

2) The strategy creation framework is being created for a group with limited resource working in a practical environment. The framework must therefore reflect these limitations.

4.5.3 Treating the strategy as a deliverable item

4.5.3.1 Choice of strategy development process

The overall shape of the strategy development process has been determined by the need to deliver a strategy for assessment. Taking an 'emergent' strategy development approach as the basis for the framework is therefore not viable. Within the 'deliberate' strategy development approaches, there are three choices: the Design, Planning and Positioning schools. A more detailed debate over the choice between these three approaches is given in section 5.2.2.1 of report 4.

A Planning-based approach would require a high level of control and resource and would not suit the practical environment of TI-314.

The Design school approach is general and simple (Andrews, 1980) and allows for the inclusion of other approaches, which is likely to suit this case.

The Positioning school approach is strongly focused on the competitive business environment, which does not fully align with the internal situation of TI-314.

The Design school process as shown earlier in Figure 11 has been chosen as the basic outline for the strategy development process but will be adapted to meet the needs of the remainder of the core contextual themes.

4.5.3.2 The TI-314 environment

The TI-314 internal and external environment does not entirely lie within the BMW Group environment. As shown by Figure 14 below, it is skewed by the technology focus of TI-314 and the fact that not all of the BMW Group internal and external environment relates to TI-314.

The suggestion is that the terms 'internal environment' and 'external environment' do not have a precise meaning in this context and therefore some overlap can be expected.
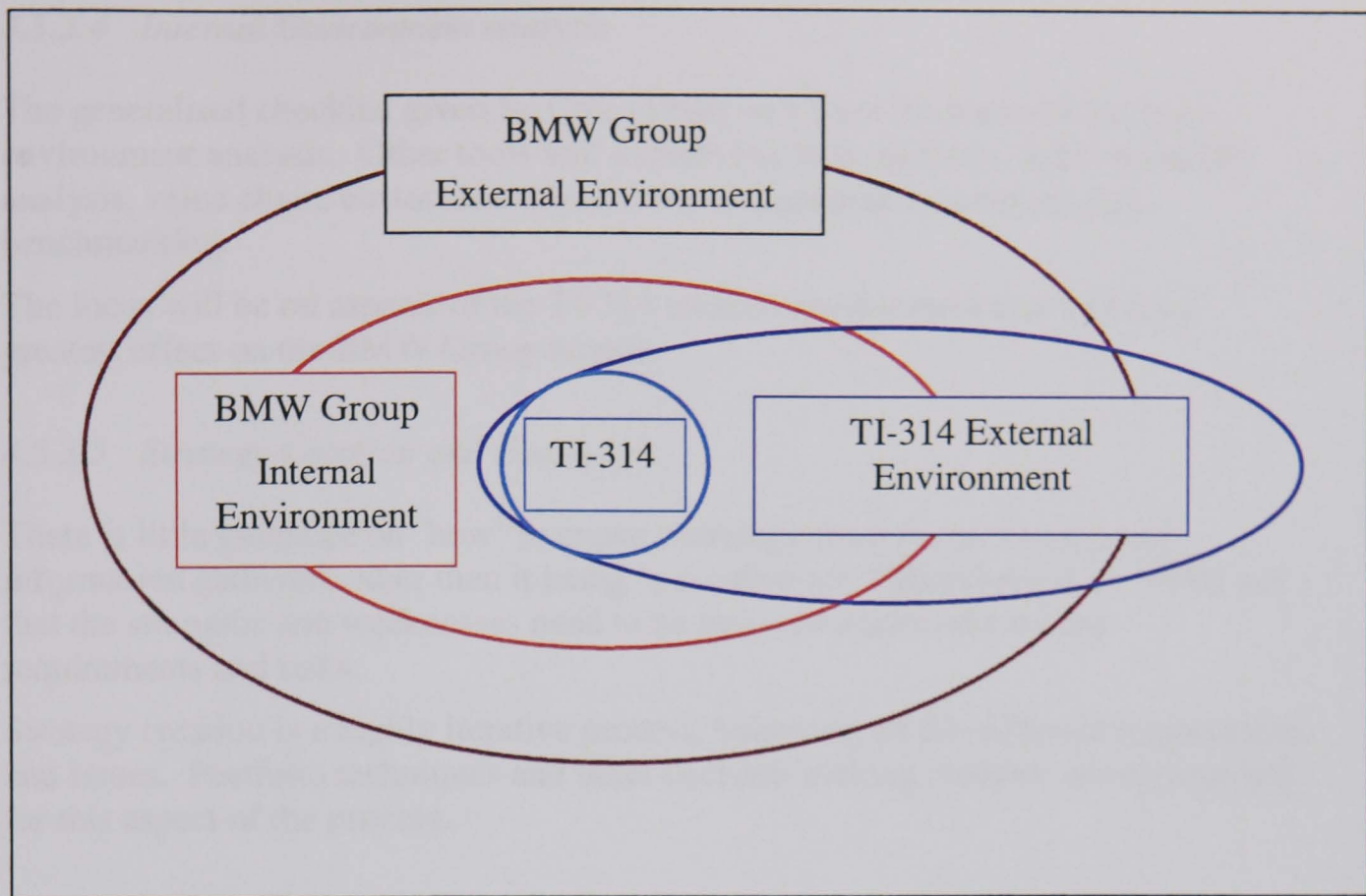
Figure 14. A model of the relative internal and external environments for TI-314 and BMW Group.

4.5.3.3 External Environment analysis

The general BPEST checklist will be used to cover the key issues in the external environment.

The Business analysis will be tentatively based on the Porter five forces and market segmentation models (1980 & 1985). Market segmentation will be part of analysing customer requirements using surveys and other analysis techniques.

The Political, Environmental and Social environment analyses are expected to have little specific impact on TI-314 because they will be largely covered by the BMW Group strategy and targets. Further judgement will have to be made during the strategy development process.

The external environment relative to TI-314 itself will include the internal aspects of BMW Group as well as the specific TI-314 external environmental factors. The most important factor for TI-314 will be the technological environment relating to Rapid Product Development Technologies.

The technological environment analysis will be carried out through discussions with external experts, company visits, benchmarking, portfolio analysis and other means.

4.5.3.4   Internal Environment analysis

The generalised checklist given by Cole (1994) will form the basis for internal environment analysis. Other tools will include Portfolio analysis, R&D portfolio analysis, value chain, customer analysis, core competence assessment and benchmarking.

The focus will be on aspects of the TI-314 internal environment that will have greatest effect on the BMW Group targets.

4.5.3.5   Strategy Creation and Evaluation

There is little guidance on 'how' to create a strategy from the environmental information gathered, other than it being 'a creative act' (Mintzberg et al, 1998) and that the strengths and weaknesses need to be assessed against the market requirements and risks.

Strategy creation is a highly iterative process, balancing all the different requirements and issues. Portfolio techniques and other decision-making methods are appropriate for this aspect of the process.

4.5.3.6   Practical considerations

The company CEO is considered to be the strategist within the Design school. In the case of TI-314, the Group Leader will be responsible for the strategy development, aided by members of the team as appropriate.

The Design school model includes inputs relating to social responsibility and managerial values (see figure 11 on page 51). Social responsibility should be a natural consideration. Managerial values will largely come from the BMW norms and communicated values but may have to be learned through experience.

The TI-314 strategy will therefore have to take into account 'emergent' strategic activity prior to the 'start' of the exercise and that activity will continue after 'completion'. During the strategy development, normal business demands will probably have an adverse effect on resource available for strategy development.

Strategy development is not a purely logical and linear process. The introduction of new ideas and the effects of changes in the environment all have to be taken into account throughout the exercise.

4.5.4   Allowing for changes in the environment

4.5.4.1   Environmental change during strategy development

The strategy development process is likely to take several months (Hamel & Prahalad, 1994) during which time the environment will change. The BMW Group internal environment has become increasingly turbulent since 1994, with accelerated change since the announcement of Group Functions in 1998.

The adaptation of a scenario planning approach proposed by Courtney et al (1997) appears to have potential and will be included in the 'toolkit' of the strategy creation framework. One concern with this method is the amount of resource that might be required to follow it correctly.

Unpredictable environmental change may also lead to an increase in the number of strategy iterations but again the additional resource required would limit the level of activity possible.

Overall, changes in the environment during the strategy development will necessitate changes to the basic Design school model. Aspects of the more 'emergent' schools of thought will need to be introduced into the strategy creation framework to allow for environmental change during strategy development. Environmental change will of course continue after the strategy has been completed, which will involve the addition of other concepts to the framework.

4.5.4.2   Environmental change during strategy implementation

The aim will be to reduce the impact of environmental change by generating a form of stability that is largely separate from the environmental influences. The following additions are proposed:

- **Core competencies** (Prahalad & Hamel, 1990) can be identified and developed on the basis that they will provide stability and flexibility to the organization if chosen and maintained correctly.

- The concept of **Strategic Intent** can be used to ensure that the strategy does not stand still and that everyone can relate to the overall direction of the group. Appropriate development of a **vision** and **purpose** for the group will be a part of this approach.

- **Organizational flexibility.** The strategy must engender flexibility so that TI-314 can react to environmental changes. Flexibility must however be balanced against compromise of efficiency and effectiveness.

Rapid change is a fact of modern business life. The strategy creation framework must consequently be able to cope with environmental change without compromising the overall outcome. Involvement of team members has been a theme during the strategy development and is a central theme for successful strategy implementation.

4.5.5   Strategy Implementation

Once the strategy has been approved as a project detailed action plans will have to be developed by the people who will implement them. Involving the implementers from the very beginning can help to increase the chances of success in introducing new technology (Turner, 1999). These plans will then be implemented using normal project management guidelines. Where specific change is required, the Context, Process, Content, (Pettigrew, 1985) concept will be used.

The strategy will be kept 'alive' through use of a feedback mechanism based on 'key trigger variables' that are set up to detect changes in the environment that might

adversely affect the strategy implementation. These variables will be assessed frequently. Scenarios developed during strategy creation may also be used for reference during the implementation if appropriate.

4.5.6   The Process as a whole

The strategy creation process (Figure 15 below) can be broken down into roughly four stages. In reality it may be difficult to distinguish between these stages:

     (i)   Initiation and rough strategy creation

     (ii)   Strategy development and selection

     (iii)   Approval of the refined strategy

     (iv)   Implementation

4.5.6.1   Stage 1 - Initiation and rough strategy creation

The senior management of TI asked for a strategy to be created for TI-314 based on the performance gap between the existing prototyping capabilities and the corporate targets.

The first stage gathers all the existing data together. The outcomes from the first stage will provide the initial ideas for the strategy and how it might be developed.

The strategy development is initiated by the senior management and created with their involvement as well as the relevant team members. Involvement of the senior management goes throughout the whole process and is shown by the large pink background arrow. Involvement of the TI-314 team members increases throughout the process and is shown by the large blue background arrow.

The initial strategy ideas are developed further in the second stage.

4.5.6.2   Stage 2 - Strategy development and selection

This stage is where the strategy is created. In the case of TI-314 this stage includes:

- The environmental data capture

- Analysis of the data

- Prioritisation of the data gathering and analysis tasks

- Prioritisation and alignment of the strategy ideas

- Input of 'emergent' ideas and chance occurrences

The main concepts and 'tools' used in this stage of the process can be grouped into:

- Data capture tools

- Technology related models

Figure 15. The strategy Development Process proposed in Report 4

Legend:
- Stage 1
- Stage 2
- Stage 3
- Stage 4

Previous RP&T Strategic thinking

TI-314 Internal & External Environment

Organisation, Resources, Cultural, Financial, R&D, Production, Marketing

Political, Resources, Financial, Organisational, Technical, Processes

TI-314 Internal Environment

BMW Internal Environment

Team involvement

Senior Management involvement

Corporate Strategy & Targets

ROUGH
• Purpose
• Key themes
• Vision

Refinement

Tools for:
Focused Data Capture & Strategy Development

Iteration and Analysis

Data capture

Iteration and Refinement

Prioritisation

Refinement

Refined Strategy Proposal

Actions & Plans

Implementation

Approval Process

GAP

The need for an RP&T Strategy

Current Prototyping Performance

Team Specific External Environment

External Experts

PROBLEM

Frequent Reviews of Key Measures

Technology Users and Vendors

Customers Demand and future needs

Market for Services

RP&T & IT Technology Trends

Check Against:
- Key Trigger variables
- Key Themes
- Purpose
- Vision

67

- Business strategy concepts and tools
- Analysis and decision-making tools
- Prioritisation tools

The output from the second stage is a refined strategy.

4.5.6.3 Stage 3 - Approval of the refined strategy

The approval process is likely to effectively start before the end of the second stage due to the involvement of the senior management. The overall process is likely to happen in two steps. If the senior management informally approve the strategy, it will go on to the formal financial approval process.

If the project goes forward for formal approval and is unsuccessful, there is little chance that it will get a second chance. Content, timing and the right overall approach are therefore very important.

If the project is successfully approved it will go on to be implemented.

4.5.6.4 Stage 4 - Implementation

Implementation effectively starts at the beginning of the process and runs right through to the end in the form of the team and senior management involvement.

A feedback loop is required to ensure that the implementation remains on track and that the strategy concepts remain valid. 'Key trigger variables' will be identified and used to monitor the environment. If the variables go outside predetermined limits, the strategy will then be reviewed and revised if necessary.

4.6 Conclusions about development of the strategy creation framework

1) The strategic context determines the strategy development process and content.

2) Key strategy development themes were deduced from the literature. These themes were aligned with the TI-314 case and formed the basis for 'core contextual themes' relating directly to the context of TI-314. These core contextual themes were then used as the foundation for the strategy creation framework development. The core contextual themes were in effect a set of requirements that had to be met by the strategy creation framework to align it with the context of TI-314. The core contextual themes are:

- Environmental analysis and understanding
- Dealing with rapid change in the environment
- Cultural issues relating to strategy development
- Treating the strategy as a deliverable item
- Technology-related strategy development
- Strategy implementation

68

3) It was possible to develop a new strategy creation framework that could be used to develop a strategy for TI-314 based on the six core contextual themes. No similar framework has been identified in the literature. Strategy development approaches found in the literature on strategic management appear to take either too narrow or too diffuse an approach to strategy development. The narrow approaches are often chosen to highlight a specific theory or concept. The diffuse approaches are perhaps attempting to satisfy the needs of the complete spectrum of contexts. **The new strategy creation framework presented in this work has for the first time attempted to synthesise a single framework from the broad literature on strategic management that is specifically orientated to a particular context.**

4) **Several different schools of thought on strategy development have been brought together in a logical way for the first time to match a specific context.** The framework has been developed with the intention of being practical and will be tested out in a real business case.

5) Business-related strategy concepts and tools may be appropriate for use in this case but must be used with caution because the context relates to an internal group within a company and not a stand alone business.

5 Validation of the Strategy Development Framework

5.1 Validation Methodology

5.1.1 Scope of the validation

The author has used the strategy creation framework in the business environment to create a strategy for TI-314 during 1999. The framework was fully used to the end of stage two as defined in section 4.5.6.2. Stage three included senior management approval of the strategy but not project approval. Stage four of the process was partially validated but was dependent upon financial approval, which ran outside the scope of this research.

5.1.2 Validation process

The validation has been split into two parts:

a) **Validation of each stage in turn.** The successful and unsuccessful aspects of the framework are identified and the suitability of the output from each stage.

b) **Overall assessment of the framework.** The effectiveness of the framework construction is assessed by looking at the coverage of the six core contextual themes and the practicality of the framework.

5.1.3 Improvements to the new framework

The author produced recommendations for improvement to the strategy creation framework during the validation process. The improvements are listed in section 5.5. The improved strategy development process is shown in Figure 20 on page 89. The complete framework is explained fully in Appendix 1, which is a stand-alone document suitable for distribution.

5.2 Assessment of the framework in each stage

5.2.1 Stage 1: Initiation and rough strategy creation

5.2.1.1 Previous strategic activity

There was some strategic activity in both the UK and Germany prior to the start of this research but mainly centred in the UK. Most of the effort was targeted at the generation of operational benefits such as cost and time savings and to drive forward the integration of RP&T into the business. One specific exercise initiated by the

70

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70

author addressed the problem of future demand prediction with some success (Ramage, 1999). Overall, there was no RP&T presence in the corporate strategic goals.

The conditions for emergent strategic activity matched those suggested by de Wit & Meyer (1999) and Mintzberg et al (1998) and consequently some more random strategic activity took place e.g. the introduction of Rapid Casting within the Powertrain business.

5.2.1.2   Data gathering methods used in stage 1

The main data gathering methods included management team 'away days', discussions with senior management and more general, unstructured data gathering such as visits to companies and reports from conferences. Overall, the data gathering generated involvement and interest in the strategy development within the TI-314 teams at an early stage.

The internal and external environment analysis helped to reveal gaps and opportunities, customer information, technology issues and the capabilities of the two RP&T teams.

5.2.1.3   Outcomes from stage 1

The main outcomes from stage 1 were as follows:

- Retention of the original vision and purpose for the group: "To be the best integrated and exploited RP&T capability in the World"

- Identification of some key strategy influences and research questions

- Generation of some initial strategy themes e.g. operations management focus

5.2.1.4   Overall assessment of stage 1

This stage provided a starting point for the rest of the strategy development process.

Early involvement of the management team enrolled them into the strategy development process.

The initiation of the strategy process was too informal, with no agreements between the senior management and the strategy development team.

Recommendations for improvement are shown in section 5.5.

5.2.2   Stage 2: Strategy development, refinement and selection

5.2.2.1   New approaches developed during stage 2

A strategy is developed with a view to improving shareholder value by some means. In this case, a strategy is intended to provide guidance for managers to develop

operational action plans that will result in increased shareholder value by providing a positive contribution to the corporate targets. The strategy acts as an interface between the corporate targets and the operational action plans as illustrated in Figure 16 below.

The approach taken by the author is that a strategy will apply within a general context (the 'principal strategy influences' in Figure 16) but it should be able to allow for a range of different sub-contexts that may arise due to changes within the business.

The strategy is created from a combination of the influences on it (the boxes on the left of Figure 16) and strategy development tools. The strategist and/or operational managers then use the strategy to generate operational action plans (e.g. OAP1, 2 & 3) based on the specific needs of the sub-contexts (e.g. SC1, 2 & 3).

Principal strategy influences		Different sub-contexts	Different plans for each sub-context
Internal & External Context		Sub-Context SC1	Operational action plans OAP1
Corporate targets	Strategy	Sub-Context SC2	Operational action plans OAP2
Strategy models & concepts		Sub-Context SC3	Operational action plans OAP3

If significant sub-context change occurs go back to strategy

Figure 16 The link between context, the strategy and operational action plans

The strategy is in effect a set of guidelines or rules from which the current context can be used to develop valid operational action plans (outputs) for a range of different inputs or sub-contexts at any one time. If the sub-contexts change later, then so will some or all of the operational action plans, in which case the strategy is used to develop new operational action plans to suit the new sub-contexts. If the whole general context changes e.g. the BMW Group stop making cars and make wardrobes, then the strategy itself would probably have to be reconstructed from scratch.

Although strategy itself has been described in ways approaching the explanation given by the author above (e.g. Johnson and Scholes, 1999;Mintzberg et al, 1998; Hill and Jones, 1998), none of the explanations are as specific. The aim is that a range of different people will use the strategy creation framework developed in this research and so a clear explanation of the role of a strategy should be beneficial.

Understanding the strategy influences is fundamental to the creation of the strategy and so gathering data on them is probably the biggest task in the strategy development. The strategist therefore needs to develop research questions to explore the strategy influences. Each research question will then have a data gathering or analysis method associated with it. This new approach to expressing the linkages between the research questions and data gathering/ analysis methods was developed by the author during the validation process based on the concept of association diagrams (Leverton, 1998). An important benefit of the diagram is that it can be used to aid communication of the research procedure being followed. The association diagram in Figure 17 provides some examples.
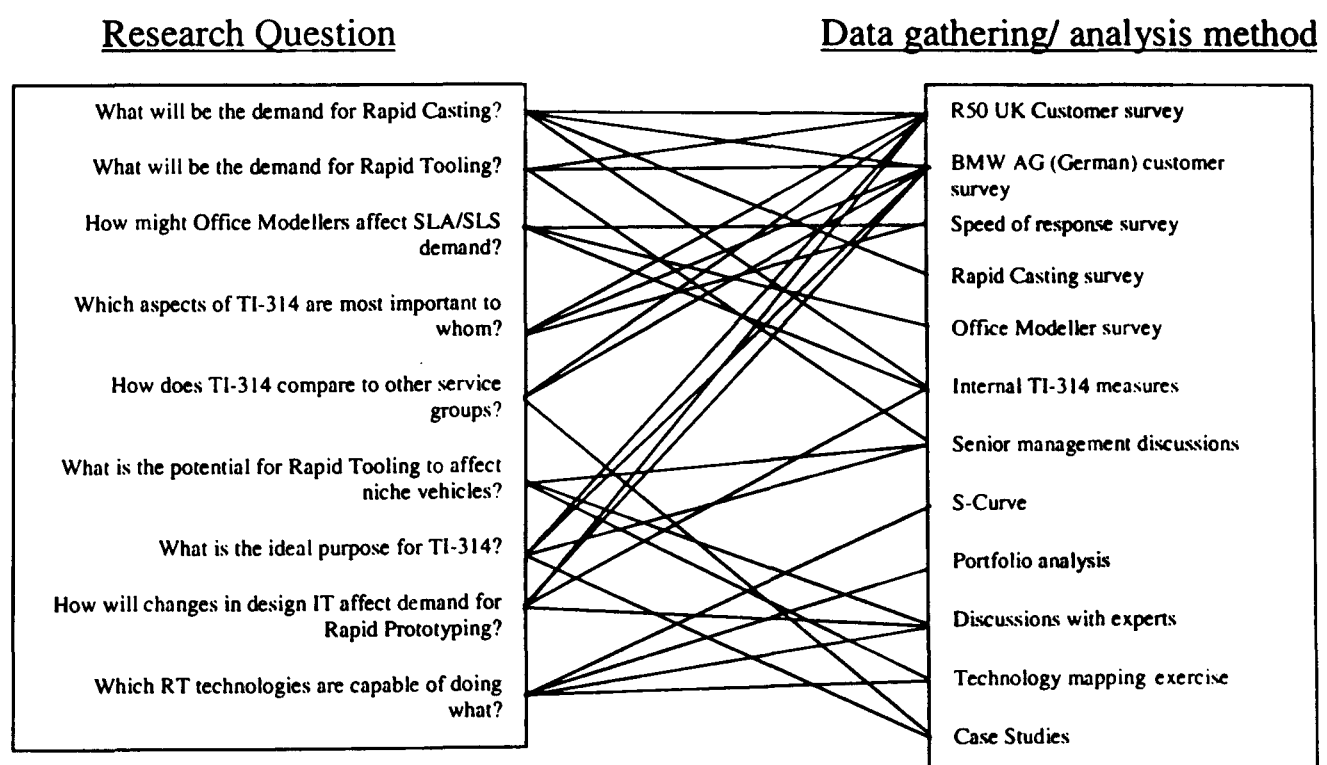
Figure 17 Example of the linkage between research questions and data gathering/ analysis methods

There was often more than one data gathering/ analysis method associated with each research question. For example looking at the above table, the first research question "What will be the demand for Rapid Casting?" The lines running across to the data gathering methods from this question, link it to the UK and German customer surveys as well as the specific Rapid Casting survey and past output from TI-314. The research question "What is the potential for Rapid Tooling to affect niche vehicles?" will be taken as the second example. In this case the connecting lines join it to "Senior management discussions", "Discussions with experts" and the "Technology mapping exercise". The diagram is therefore a compact way of illustrating the link between research questions and data gathering and analysis methods.

5.2.2.2 Visibility of strategy influence status

During the research it became clear that two aspects of the strategy influences made strategy development more difficult; the visibility of their status and the way in which that status changed.

The visibility of a strategy influence is largely a function of the ease of access to data that defines its status at any one time. Having an unknown quantity in an equation can cause serious problems. For example, the scale of any potential funding for the strategy was not disclosed at any time during the strategy development, resulting in a multiplication of the scenario workload. Another example is the unpredictable nature of the demand for RP&T services in both countries. Variations in demand have historically occurred rapidly and with little warning due to late changes in vehicle programmes.

Even if the status of a strategy influence has good visibility, if it is changing rapidly or in an unpredictable way, then it will be much more difficult to allow for it in the strategy.

Having encountered the above problems the author devised the concept of 'generic strategy themes'.

5.2.2.3 Generic strategy themes

In the literature review, one method was identified that claimed to be able to deal with different levels of change in the environment (Courtney et al, 1997). The method involved the generation of multiple scenarios. The approach demands intensive research into the variables, eliminating them by precisely identifying their status, something that was simply not possible for practical and confidentiality reasons in this case. The strategist then has to generate a potentially large number of different scenarios depending upon the number of variables that are left undefined. The amount of resource required in the TI-314 case to make the Courtney et al method work properly, meant that because no other approach could to be found the author had to develop one.

The author identified five main options to reduce the negative effects from poor visibility of strategy influence status or rapid change:

1) Neutralise the impact of variable influences

2) Reduce the impact of variable influences

3) Understand the effects that the influences can have and allow for them

4) Do more iteration of the strategy content

5) Combinations of the above.

The new proposal offered here is that the impact of poor visibility or changes in the influences during strategy development may be reduced by developing 'generic strategy themes'. A 'generic strategy theme' is a solution or combination of solutions to either a single or several research questions that either neutralises or reduces the impact of one or more strategy influences. The result is that the strategy influences

can have a range of values or effects that can be catered for within the strategy, which will still produce a valid set of operational action plans as the output.

An additional benefit is that the strategy is more future-proof because the effects of the variable influences on the strategy have been reduced or neutralised. The idea is therefore well suited to the environment relating to this case and other situations where small departments (and possibly companies in general) are required to develop a strategy within a changing environment and cannot access full information about the status of strategy influences.

The concept is not the same as producing a department that has high flexibility possibly at the expense of efficiency and/ or effectiveness. The overall objective of the strategy is still to maximise shareholder value and the operational action plans generated from the strategy will be clearly focused on the corporate goals. The flexibility comes within the decision-making processes/ guidelines (the strategy) that generate the operational action plans. Figure 18 below provides examples of some of the main generic strategy themes and their linkage to the strategy influences. The diagram works in the same way as Figure 17 above but in this case the strategy influences have been linked to generic strategy themes.
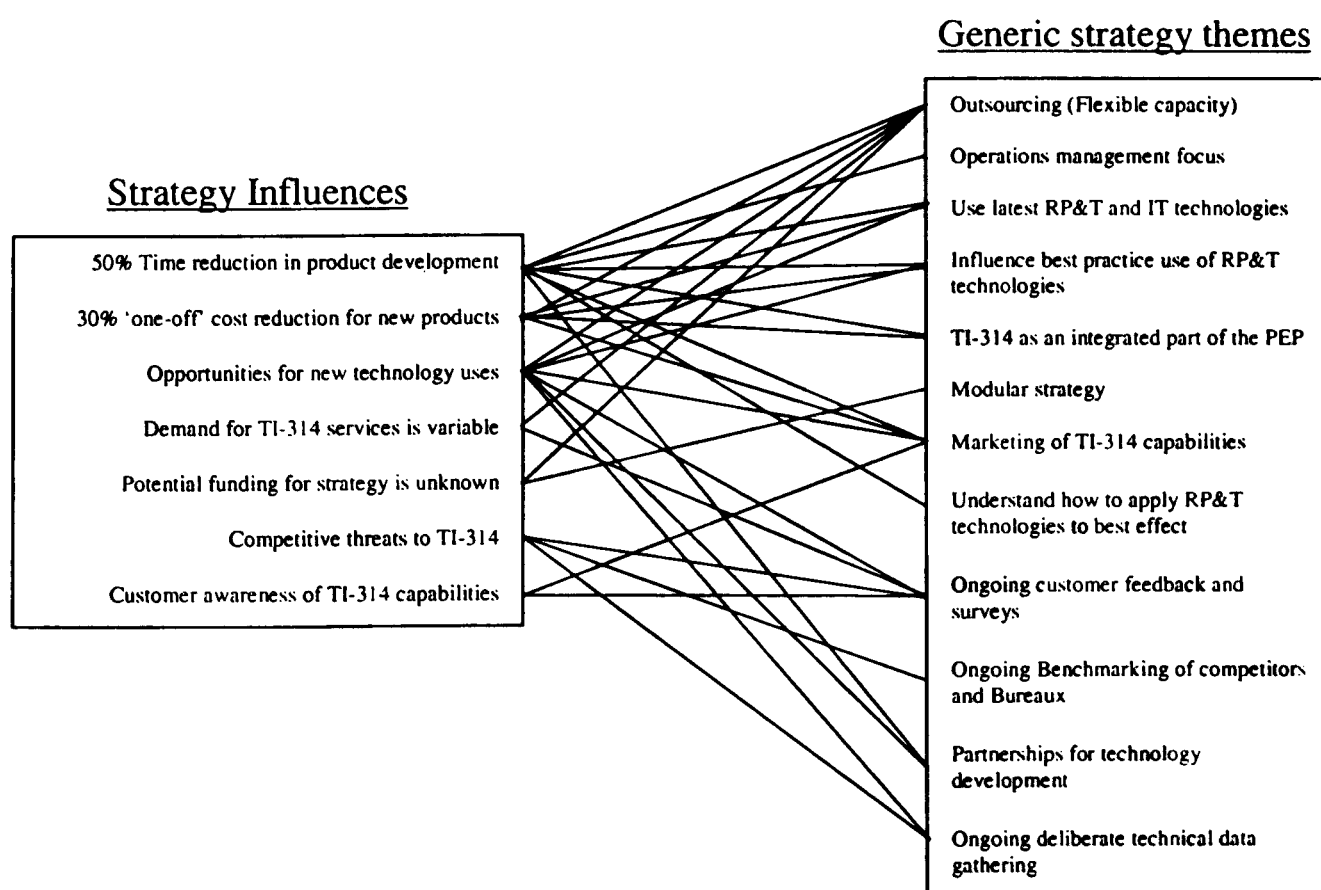
Figure 18. Example of the linkages between strategy influences and generic strategy themes.

The link between strategy influences and generic strategy themes can be illustrated by the following example. The strategy influence "Demand for TI-314 services is variable" has been linked to two generic strategy themes: "Outsourcing (flexible capacity)" and "Ongoing customer feedback and surveys". The linkages identify that

this strategy influence can be reduced or neutralised through these two generic strategy themes. By setting up an outsource capability in conjunction with the internal capacity, variations in demand could be handled by outsourcing the overflow that the internal facility cannot cope with. In addition, the use of customer feedback and surveys would help the team to be proactive in changing the internal capacities and processes and possibly external outsource partners. Unforeseen changes in the demand profile would consequently be less common. Application of these generic strategy themes would consequently reduce the impact and risks associated with changes in demand.

Development of the generic strategy themes is at the heart of the strategy. The generic strategy themes are based on the strategy influences that are investigated through research questions. The most important data gathering method was the use of surveys.

5.2.2.4   The use of Surveys for data capture in stage 2

The author developed surveys to answer the research questions as they evolved (Halliday, 1998, 1999a, 1999b). The type of information and its sources determined the survey format. The methodology provided consistency and a degree of rigour in the data gathering process.

The author devised the aims and hypotheses for each survey. Other people performed some of the surveys under the initial instruction of the author and sometimes in partnership with the author. The person carrying out the survey had responsibility for the final survey design and the results obtained.

The surveys included customers of TI-314, case studies of high-performing companies and competitors and discussions with experts. See section 1.4.2.7 on page 12 of this report (Research Methodology) and section 2.2.2.1 of report 5 for more detail.

An example of a survey questionnaire is shown in Appendix 7.

5.2.2.5   Other data capture methods

Two trained researchers/ experts provided specific reports (Wimpenny, 1999; Illston, 1999). The rigour and quality of these reports meant that the time invested by the author was low compared to the value of the output.

Other data capture methods included attendance at conferences by team members, extensive use of related literature, company visits and a variety of other minor inputs. This diverse data gathering activity provided directly relevant information as well as some background emergent strategic activity and involvement in the strategy development.

Brainstorming was used twice throughout the strategy development process. It provided a level of involvement and sharing as well as some beneficial ideas.

5.2.2.6   Technology-related models used for general guidance

The technology S-Curve (Foster, 1986; Twiss, 1974) and the industry lifecycle provided some general guidance regarding what might happen as each of the relevant technologies developed but these models were used with caution. They are both generalised curves that appear to apply when averaged over many cases. They cannot however be used for specific prediction about the future for any particular technology or product.

It can be difficult to obtain objective data relating to new technologies and the development of any one technology may be dependent upon the development of many other 'sub-technologies'. There may also be external factors such as macro-economic trends or irregularities in the market diffusion characteristics of a product that are contrary to otherwise commonly accepted models such as the industry lifecycle (Grimm & Wohlers, 1999).

Trend analysis provided some information but again objectivity and timeliness of data was a problem.

Overall, although these methods provided some guidance and a way of visualising data about technology developments, they were used with caution as they can only provide a retrospective view. Their power is limited by the unpredictability of business and technology development.

5.2.2.7   Business strategy concepts and tools

The **Porter five forces model** was a useful communication tool for describing the TI-314 business environment. It fitted the TI-314 situation with the exception of the competition within the industry because TI-314 has a special market position. If TI-314 had a complete monopoly, then potentially the model would not apply at all with the exception of substitution by other technologies. The model was beneficial but was used with caution.

The **BPEST** environmental analysis checklist did not directly apply to the TI-314 situation. Some interpretation was required. The **'Business'** and **'Technical'** features were dominant within the model due to the nature of TI-314.

The **'Political'**, **'Economic'** and **'Social'** aspects of the model were less relevant to TI-314 because most of these factors are filtered out through the BMW Group goals and processes.

Overall, the BPEST checklist helped to ensure that key aspects of the external environment were assessed but did not universally apply to the TI-314 case.

The **Market segmentation** concept highlighted that different customers had different requirements. In this case it was important to identify that the same customer may have widely contrasting requirements at different stages in the development of a product. The segmentation is therefore as much based on activities as it is different customers. Overall the concept was beneficial because it encouraged analysis of the customer base.

SWOT was used in stage 1. In stage 2, a **TOWS** matrix was constructed to provide an overview of potential actions and strategy content, as shown in section 9 of Appendix 1. The method helps idea generation and communication between team members. It was a useful tool for involving team members.

5.2.2.8 *Analysis and decision-making tools*

Fishbone analysis was useful where the problem could be clearly defined and structured but not otherwise.

Portfolio analysis was used on several occasions throughout the process. The method enables features of different technologies or concepts to be visually represented against each other. The tool is consequently useful for idea communication. The drawback with portfolio analysis is the same as with many of these approaches; the accuracy of the outcome is only as good as the data going in. Much of the initial data was subjective in the portfolio analysis that took place because the studies involved many totally new or unproven concepts. Where a portfolio plot looked like it would be directly beneficial to the strategy development, further data capture was more rigorous.
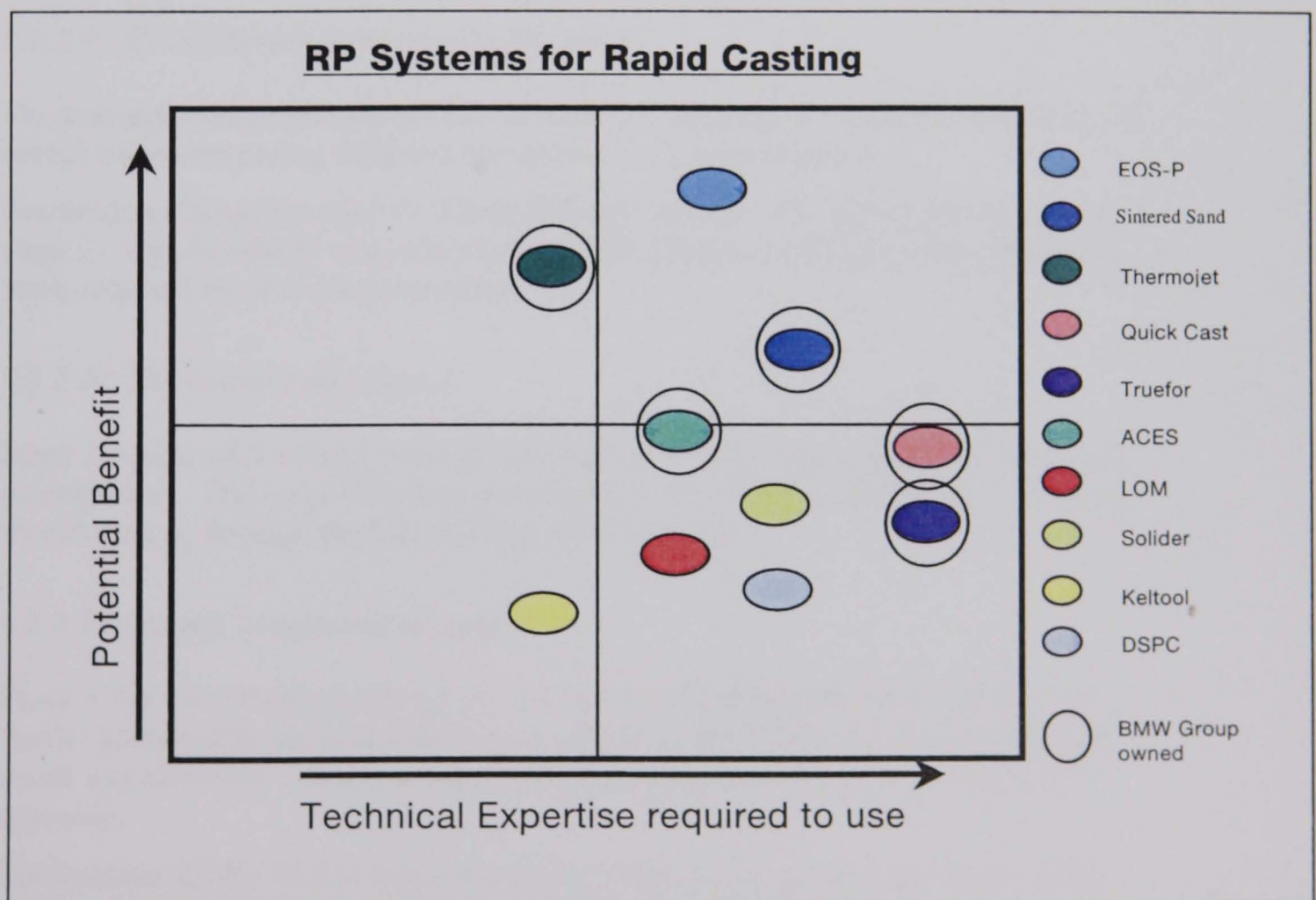
Figure 19. A portfolio diagram for Rapid Casting technologies (adapted from information supplied by G Tromans).

Figure 19 above is a portfolio diagram for Rapid Casting technologies with the potential benefit plotted against the technical expertise required to use the technology.

The technical expertise axis was based on the estimated number of months to train a new user to use the technology. The potential benefit axis was estimated on the basis of a calculation of:

- The potential range of components to which the technology might be applied

- The size of the components

- The relative benefit for each technology in terms of cost and time savings within the group

Portfolio matrices were not used on their own. Two or even several different matrices are often required because any one matrix only provides a single viewpoint.

The portfolio technique has the flexibility to allow a wide range of characteristics to be plotted against each other. It was a useful tool in the strategy creation framework because of its flexibility and potential influence on technology selection in particular. If the technique is used incorrectly with inadequate data it could lead to poor technology decisions and consequently reduce the effectiveness of the strategy.

Association diagrams enabled communication of idea correlation in a simple way. These diagrams were not used as much as perhaps they could be in future.

5.2.2.9 Prioritisation tools used in this stage

The concept evaluation matrix was not used within stage 2, perhaps it may be more useful when comparing different operational action plan options.

Scenario planning was used to assess different options to a limited extent later in stage 2. The drawback with this method is the amount of analysis and preparation work required for it to work properly.

5.2.2.10 The output from stage 2

Stage 2 produced a refined strategy that was informally approved by the TI senior management. The stage therefore overlapped with stage 3 in this respect. Stage 3 would then go through the financial approval process.

5.2.2.11 Overall assessment of stage 2

Stage 2 was the primary strategy development and refinement stage. Most of the 'tools' proposed in the framework were used to good effect and the required end result was achieved. The later part of stage 2 merged into stage 3, the strategy approval.

Involvement of the TI-314 team was largely centred around key members of the management team. The remainder of the team were kept informed of progress. Some key fact holders were drawn into the process as required.

Reducing the effect of the variable influences was central to being able to produce a viable strategy by the end of stage 2.

5.2.3   Stage 3: Informal and formal approval of the refined strategy

The strategy was fully supported by the heads of TI, TI-3 and TI-31, following two presentations of the strategy.

The generic strategy themes were complete but the status of many of the strategy influences was still unclear.

The heads of TI and TI-3 took responsibility for the formal approval process following their acceptance of the strategy (See report 5, Appendix 1 for the key slides in the strategy presentation; the actual presentation was made in German).   The formal approval process started with the heads of TI and TI-3 lobbying executives of other relevant departments.   Unfortunately the formal approval process was never completed due to the fundamental changes that took place within BMW Group during the early part of 2000.

5.2.3.1   Overall assessment of stage 3

The stage was successful because the strategy was approved at the 'Bereich' level.

Stage 3 started during stage 1 and increased in activity as the strategy progressed.

The exercise was largely 'bottom-up' in terms of information flows.   However it also had a top-down aspect to it regarding corporate drivers and overall timing of the development activities.

5.2.4   Stage 4: Implementation

Most of the comment on this stage is made later in section 5.3.6 where the involvement of team members and senior management in the strategy development is covered in particular.

5.2.4.1   Development and use of action plans

High-level action plans were developed from the generic strategy themes on three separate occasions as part of the strategy proposals.   These action plans were used for the 1999 Target Setting in Germany and demonstrated that the concept of generic strategy themes would enable action plans to be formed correctly from them.

5.2.4.2   Use of Change Management principles

The change management principles proposed by Pettigrew (1985) and in other change management literature was an ongoing consideration during the strategy development.   The focus on context was completely in keeping with the general principles of the strategy development process.

80

5.2.4.3   Overall assessment of stage 4

This stage started at the beginning of the strategy development process, running in parallel with the rest of the process stages. Probably the most important aspect of the stage is the involvement of the team and senior managers in the strategy development. Full assessment of this stage could not be carried out without running the final detailed strategy for perhaps a year or more.

5.3   Assessment of the framework as a whole

The previous section covered the content of the framework by looking at each stage of the process in turn. This section identifies whether the framework met the requirements of the six core contextual themes by reviewing the coverage of each in turn.

5.3.1   Understanding the RP&T environment

There was mixed success in this part of the framework. The framework worked very well where the availability of information was under the control of the strategy team e.g. technology issues. There were problems when information about influences was more difficult to obtain e.g. sensitive corporate issues.

The main solution to this problem was to devise generic strategy themes that enabled a viable strategy to be developed that could cope with these problems.

An alternative approach for sensitive corporate information would be for the senior management to provide a range of different assumptions for the strategists to work from. These 'hints' would not actually give away the sensitive information but would allow the strategy development to proceed.

5.3.2   Dealing with rapid change in the environment

5.3.2.1   Handling environmental change during strategy development

The use of scenarios was considered to be largely impractical in the way intended by Courtney et al (1997) due mainly to the resource that would have been required to research the data adequately. Some scenarios were developed but the range of variable factors made this route very costly compared to the benefit gained.

The use of generic strategy themes was the primary solution to the problem of change during strategy development. For example, estimating future demand for Rapid Prototyping & Tooling services is a long standing problem for the teams. Introduction of the generic strategy theme 'flexible capacity' by outsourcing excess work removes this problem and also solves some others at the same time.

81

5.3.2.2 Handling environmental change during strategy implementation

Although the strategy has not yet been implemented, it probably contains the basis for successful implementation under changing environmental conditions (the main strategy principles are shown in Appendix 1 of report 5). A possible way of identifying whether the strategy will be able to handle a changing environment is to look at whether it potentially covers the basic needs for strategic intent (Hamel & Prahalad, 1989).

A stable sense of purpose over time is provided by a combination of the TI-314 purpose statement (which is covered by the aims for RP&T in the presentation to Dr Leube, January 2000) and the generic strategy themes, which are also included in the presentation but not referred to as such.

Clear direction is provided by the commonly held vision of the group (Senge, 1990), which is "To be the best integrated and exploited RP&T capability in the world", the purpose (Campbell & Alexander, 1997) and the generic strategy themes.

A view of the future in the present is given by a combination of the vision, purpose, generic strategy themes and the proposed ongoing environmental analysis based around the use of 'key trigger variables' (Courtney et al, 1997).

A range of means will be used **to achieve the ends** by providing the implementation team with the empowerment to determine how they should achieve their targets (a feature of internal strategy development that came out in the strategy process survey). Financial flexibility is one of the generic strategy themes required in the strategy. The implementers should be in a position to decide for themselves which technology solutions are best suited to achieve the goals set.

A marathon in 400 metre sprints. The project management principles used in the implementation will determine how the plans are carried out. This point will depend upon the group and management concerned.

The above principles for strategic intent can be identified within the strategy for TI-314, with the exception of the last two points. These aspects will depend upon the way in which the implementation is managed. It is possible that the concepts outlined within the strategy creation framework and the content of the strategy are aligned with the principles of strategic intent. If this is so, then it is likely that the strategy will have a good degree of flexibility to cope with environmental change during implementation. This point will of course only be finally proven once the strategy is carried out.

5.3.3   Cultural issues relating to strategy development

It is not possible to clearly state the impact of national or corporate cultural traits on the strength of a single strategy development exercise. Although the culture-related research literature can provide some guidance, it must be interpreted in a very open way because it relates to averages and not individual cases.

The aim of the recommendations in this case is to reduce the risk of cultural and other communication factors having an impact on the strategy development. By

emphasising the importance of excellent communications and feedback during the strategy development process, differences in approach are more likely to be identified and mutual understanding gained. On the basis that "...culture is the way in which a group of people solve problems", (Trompenaars, 1993) the iterative process of strategy development is bound to be more challenging if the different people involved feel that the problem should be solved in a range of different ways. Cultural factors may or may not have a bearing on the development of a strategy. Whoever is involved, improving communication within the strategy development group is likely to assist mutual understanding regardless of their background.

The framework provided general but not specific guidance on national and corporate cultural issues. The main recommendation is the up-front identification and agreement on the needs of the process in terms of communications in particular.

5.3.4   Treating the strategy as a deliverable item

The strategy creation framework enabled the delivery of a viable strategy from the viewpoint of the senior management in TI and has therefore been successful. The views of some team members within TI-314 also suggest that the strategy is appropriate to their needs at a high level (Halliday, 2000).

5.3.5   Technology-related strategy development

The technology-related data capture and assessment was relatively straightforward during the strategy development process. The data capture methods outlined in stage 2 (section 5.2.2) were all used effectively. Technology-related iterations of the strategy themes were also straightforward due to the wide range of information available within the team and through external sources.

There are no changes proposed for the technology-related aspects of the framework.

5.3.6   Strategy Implementation

5.3.6.1   TI-314 team involvement in the strategy development

Throughout the strategy development stages, the RP&T team members have been involved in a range of ways. Involvement of the implementers is probably the strongest theme relating to strategy implementation in the literature and coming out of the in-house survey on strategy development.

It was not practical to involve everyone in every aspect of the strategy development process and so a small number of people were involved according to the needs at the time and their potential contribution to the strategy. A natural outcome was that members of the management team within TI-314 were the main contributors in the early stages through 'away day' sessions and data gathering exercises. The whole TI-314 team was kept informed about progress as appropriate. As the strategy progressed more members of the team became involved in the strategy development.

Team involvement was beneficial to the strategy development process and most of those involved found it interesting but also frustrating at times. Whether the level and nature of the involvement could have been significantly improved cannot be determined through this type of research but would possibly be a topic for further study.

5.3.6.2 Senior management involvement in the strategy development

There were 12 meetings with senior management in TI during the course of the strategy development. Although the involvement helped to maintain momentum in the strategy development, there are significant aspects that could be improved on in future strategy development exercises. The improvements can be reduced to:

- Clear definition of terms (such as 'strategy') and expectations from the exercise

- Clarification of roles and responsibilities

- Clear agreement on the needs of the strategy development process and identification of any factors that might make it easier or more difficult if no action is taken.

5.3.6.3 The Change management approach

During the strategy development, the 'Context, Process, Content' concept was maintained as a fundamental theme for implementation. The Beckhard & Harris (1987) concept of defining the current state, the desired future state and then plotting a course between the two (also an outcome from the internal strategy development survey, section 4.3) also remained central to the thinking about strategy implementation.

5.4   Practical Assessment of the Strategy Creation Framework

5.4.1   Assessment of the strategy from the employee viewpoint

A measure of a good strategy has been suggested by Hay & Williamson (1997) from the perspective of the general employee (within a business). Their criteria will be assessed individually:

1) "that the strategy provides inspiration in the form of a worthwhile, relevant goal;".

> The overall goal of TI-314 is to provide competitive advantage to BMW Group. The pursuit of Rapid Manufacturing (Dickens, 2000) as proposed in the strategy will assist directly in achieving the main corporate targets of cost and time reduction, most probably a relevant and worthwhile goal.

2) "that it helps individuals see the linkage between their own tasks and the initiatives being taken elsewhere in the company".

A survey (Halliday, 2000) of team members of TI-314 indicated that the strategy helped them to see where TI-314 should be going in the future and how they might contribute to it.

3) "that it can be used by individuals for guidance for the trade-offs and prioritisation decisions they make day to day"

> The generic strategy themes including the purpose of the group provide guidance in this respect at a high level. Development of the more detailed action plans will further assist in this respect.

4) "that the strategy creates discretion for the individual to manoeuvre by loosening some existing constraints and generating some new options".

> Empowerment of the TI-314 team is at the heart of the strategy. An example is the need for flexible financing of new equipment proposed in the strategy, so that the team can decide which is the best technology for the company.

5) "that it facilitates communication by establishing a common language which everyone in the company can use".

> The generic strategy themes provide a relatively simple and understandable basis for communication of the strategy. Common reference to the themes, purpose and vision of TI-314 will make them part of a common language for the team.

The above evidence is not conclusive regarding the fit between the strategy content and the Hay and Williamson criteria. However, the above points may suggest that the strategy has the possibility that it could be considered to be a good strategy from the point of view of the general employee.

5.4.2   Practicality of the framework in the working environment

The framework appears to be practical in a number of ways:

1) It provides guidance and background information for people that have only a limited experience of strategy development.

2) It offers a methodology for data collection and analysis which will consequently improve the chances of a sound strategy being developed on the basis of valid information.

3) It is based on a framework that is designed to deliver a strategy but also allows for the more natural and random aspects of strategy development.

4) It proposes approaches that will help strategists to deal with changes in the context during and after strategy development, as might be expected in any normal business situation.

5) Some allowance has been made to enable other people to use the framework by reducing the risks of personal factors having a negative impact upon the successful creation of a strategy.

One less practical aspect of the framework is that it proposes business-related strategy concepts and tools. Use of these tools will require a level of awareness from the strategists using the framework about the relevant business context and the implications of using the tools.

Overall, the framework has some strong practical attributes but these will have to be proven through repeated use and further development of the framework.

5.4.3 Discussion

5.4.3.1 The effects of corporate changes upon the research

The changes that took place throughout the duration of the research had a dominant effect on the research itself. Initially, the organisational change of bringing together the German and UK RP&T teams provided the catalyst for the research content. The corporate need to improve both the efficiency and effectiveness of the RP&T group led to the need for both of the frameworks.

The ongoing changes that took place within BMW Group led to the need to devise new approaches to strategy development such as the 'generic strategy themes' concept. If little or no change had been taking place, such solutions would not have been necessary.

There were also negative effects resulting from the ongoing change within BMW Group. The high level of change activity within the company reduced the effectiveness of some of the measures used because the two teams had so many other challenges to deal with at the same time that the research was being conducted.

The most significant negative effects on the research resulted from the split up of BMW Group, effectively interrupting the development of the changes initiated by the research output. Splitting the BMW and Rover Group teams meant that the synergies that were starting to show as a result of the Group Function operational action planning activity could not be fully realised. For example, whereas some common database and work sharing activity had started, the synergistic benefits were stopped while in the early stages of their development.

The split up of BMW Group also meant that the strategy creation framework output could not be tested right through to implementation. The strategy had been created and accepted by the senior management but implementation was not re-activated until some time after the split. However more positively, the creation of the new MG Rover Group company meant that new opportunities have arisen to use the strategy creation framework within new contexts.

Overall the change taking place within BMW Group produced a net positive effect on the frameworks created within this research. As is often the case, the main innovations in the research were driven by a need to solve immediate and unexpected problems. The problems that were generated during the course of the research thus became spurs to create new solutions. The problems that occurred after the main research had been completed can in themselves provide lessons in the vagaries of business development and no doubt the meat for future case studies.

5.4.3.2 Strengths and weaknesses of the research process

The research process displayed the following strengths:

1) The outline classic research methodology ensured that the overall research maintained a good level of rigour throughout.

2) The methodology had some parallels with 'action research', which were beneficial to the process and the company. For example, use of a live situation allowed direct real-time refinement of the process and the framework.

3) The direct involvement and influence of the researcher meant that a strong focus was kept on achieving the research objectives throughout and will have accelerated their achievement compared to an off-line research approach.

4) The live situation led to spin-off benefits such as the introduction of rigorous research techniques within the team and raised awareness about strategy development at a level in the organisation that would not otherwise have happened.

The research process also displayed the following weaknesses:

1) The overall duration of using the frameworks meant that it was only possible to carry out one test on each framework; more iterations would have been desirable.

2) The involvement of the researcher in a manner similar to the 'action research' approach, increased the risk of subjectivity in some aspects of the process. For example, an objective assessment of whether the cultural aspects of the strategy creation framework were fully successful was not possible due to the intimate involvement of the researcher in that part of the subject matter.

Overall, the research process benefited from a combination of the rigour associated with a more classic research approach and the real-time involvement and direct influence of the researcher in the subject matter associated with an 'action research' methodology. In the view of the author, the weaknesses of the process used were outweighed by the strengths.

5.4.4   Other outcomes from using the framework

The research work resulted in the development of a new strategy creation framework that was not previously available either in the literature or within the business. Use of the framework within the business context provided some useful outcomes in itself as described below.

5.4.4.1   Top management awareness of radical future possibilities

The strategy proposed for Rapid Prototyping & Tooling development within BMW Group included the concept of Rapid Manufacturing. In explaining the strategy to the BMW Group senior management, it was necessary to explain the longer-term potential of Rapid Manufacturing. The concept of Rapid Manufacturing was fully accepted by the senior management and so awareness of the radical new options open

to BMW Group in the future through Rapid Manufacturing resulted indirectly from use of the framework.

5.4.4.2 *Embedding strategic thinking lower down the organisation*

The TI-314 management team and other members of TI-314 were involved in the strategy development process. Their involvement introduced strategic thinking at a lower level in the organisation than would otherwise have been the case because strategic thinking tends to be seen as the reserve of senior management.

Use of the framework raised a general awareness within TI-314 of the strategy development process and the linkage between the TI-314 targets and the corporate goals.

5.4.4.3 *A robust strategy was generated for Rapid Prototyping & Tooling in BMW*

There is now a robust strategy for Rapid Prototyping & Tooling within BMW Group that is adaptable to a wide range of different possible futures that was accepted by the senior management within BMW Group. No accepted strategy previously existed.

Since the break up of BMW Group in 2000, the RP&T strategy has been taken up again by BMW and pursued. Additionally, the great majority of the strategy is being used within MG Rover Group.

5.4.4.4 *Data capture processes introduced into the organisation*

Five members of TI-314 were involved in running surveys as part of the strategy development process. Having used the survey process presented in this research, these people now have a new competence in rigorous data capture methods that they did not previously have.

5.5 Summary of the improvements to the strategy creation framework

During the course of using the strategy creation framework, a number of improvements were made to it. The improved strategy development process is shown in figure 20 below (and also figure 8 in Appendix 1). The improvement recommendations have been collated and summarised in this section.

1) At the start of the strategy development process the following should be agreed between the parties involved in the strategy development:

- The Purpose, Objectives and Outcomes from the process

- The scope of the strategy

- The roles and responsibilities of the all those involved in the strategy development including the senior management and the strategist(s)

- The definition of 'a strategy' according to the people involved

Figure 20. The Improved Strategy Development Process
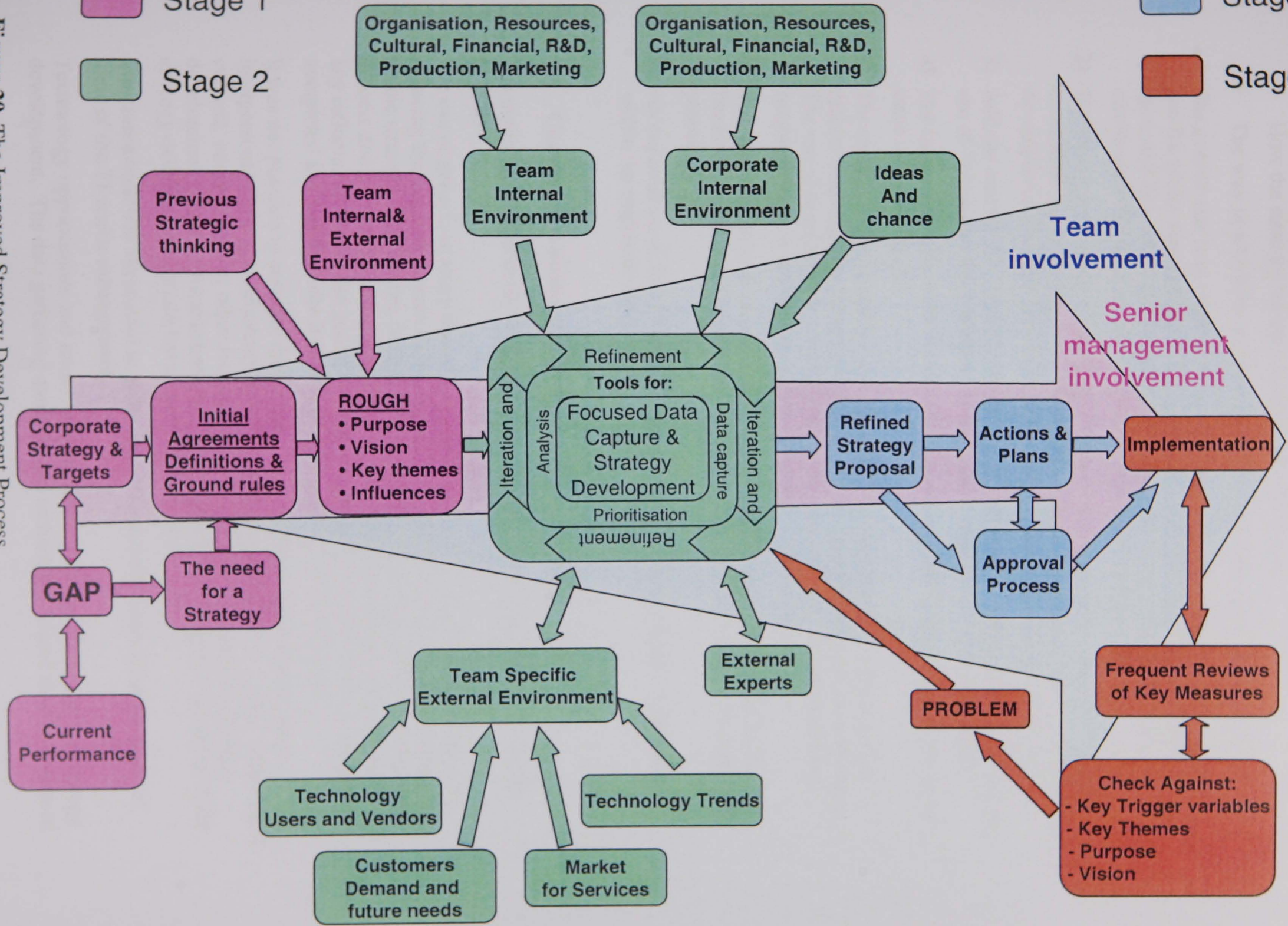
89

- How the strategy creation framework will be used

- The way in which the process should be reviewed and progress monitored

The overall aim is to create a strong dialogue and trust between the strategist(s) and the senior management. If the process is correctly established at the start then there will be a much greater chance that any necessary changes to the interaction can be made during the course of the strategy development process.

2) The timing and nature of the involvement of team members should be carefully considered against a range of criteria including their aptitudes, interest in strategy development, the likely duration of the strategy development and other factors.

3) Add the concept of 'strategy influences' and reduction of their impact through the use of 'generic strategy themes' as covered in section 5.2.2.3 of this report.

4) The improved framework should illustrate the way that stages 3 and 4 start at the same time as stage 1.

5) The strategist should understand the needs and expectations of the decision-makers and align the nature and content of the strategy presentations with them. The use of familiar and simple graphics can help with the communication of issues relevant to the strategy and its potential to the business.

6) The strategist should understand the informal aspects that lie behind the formal financial approval process so that he or she can assist more fully in the approval process.

7) An explanation of the Context, Content, Process concept should be included within the improved framework.

5.6 Conclusions about the framework as a whole

The models provided in the framework guided the environmental analysis for the strategy.

The use of generic strategy themes enhanced the strategy development process by reducing the negative impact of the changes to or lack of visibility of the influences on the strategy. Difficulties were encountered early on in the strategy development process due to changes in the environment and lack of information about some of the key influences. Use of the generic strategy theme concept allowed the strategy to be completed and should make it more robust in a changing environment.

It was not possible to separate the effects of any culture-related factors from interpersonal ones. Consequently, the improved framework aims to reduce the risk of cultural, interpersonal or other factors having an adverse affect on the strategy development process. Establishment of clear understandings at the beginning of the strategy development should have a beneficial effect.

The framework was successful in generating a valid deliverable from the point of view of the TI senior management.

Technology opportunities and issues were adequately dealt with during the strategy development. The data gathering methods and technology-related models proposed

in the framework proved to be sufficient for the task. The models must be used with caution due to their generic nature but may be useful for general guidance.

The involvement of team members was a challenging issue because a balance had to be struck between involving the whole team and the practical problems that would cause. The improved framework shown in Appendix 1 includes some suggestions that are likely to help the strategist understand how to gain the right balance of team involvement in strategy development. The importance and complexity of the team involvement issue makes it a suitable area for further investigation.

Senior management involvement in the strategy development was essential to its progress. The senior managers were responsible for approving the final strategy and so their involvement in its development was appropriate. Feedback and communication could be improved by discussing the requirements of the strategy development process between all those involved in its development at the beginning.

The change management approach used in the framework is principally based on the Pettigrew (1985) 'Context, Process, Content' model. The framework also caters for the main aspects of the Beckhard and Harris (1987) approach to change management. In addition to these approaches, project management principles will be used during the implementation of the strategy.

The strategy appeared to match the criteria laid down by Hay and Williamson (1997) for a good strategy, something that can only be tested out over time.

The framework has been designed to be practical and appears to have the flexibility to handle environmental change during the strategy development.

In addition to the creation of a robust strategy for Rapid Prototyping & Tooling within BMW Group, use of the framework has led to some secondary benefits through involvement of the TI-314 team and senior management within BMW Group. These additional benefits include:

- Senior management awareness of a new set of strategic possibilities for Rapid Manufacturing within the company

- The introduction of strategic thinking lower down the organisation

- A more rigorous approach to data gathering and analysis has been used and accepted by members of the TI-314 team

The new strategy creation framework has been developed in this research to fulfil a need within the business. The author has developed the new framework from the diverse and often contradictory literature on the subject, producing a viable and largely practical guide for strategy development that can be used by operational managers within the business. No such strategy creation framework existed before this research. However there are probably very many managers who are asked to create a strategy for their business unit or department that could benefit from this guide. The improved framework in Appendix 1 has been written with those managers in mind.

6   Future Work

6.1   Further work on the strategy creation framework

6.1.1   Broadening the applicability of the framework

Not all potential users of the strategy creation framework will necessarily want to have the same amount of detail within the framework. The framework could therefore be developed on three levels:

1) **Basic**: for broad guidance only. Quick and simple to pick up and use

2) **Intermediate**: on a similar level to the existing framework. For use by managers who already have a good level of strategic knowledge

3) **In-depth**: for managers who would benefit from a much deeper understanding of the principles and thinking behind the framework and would be prepared to undertake some study to achieve it.

These different levels of the framework could potentially be accompanied by additional materials and even training courses of perhaps half a day, one day and one week respectively for the three levels.

6.1.2   Improvement of the framework

Further work can be done to improve the framework itself and make it suitable for a wider range of contexts as follows:

1) Clarification and improvement of descriptions and explanations including improved and additional graphics

2) Include an explanation about how to create a framework for different contexts

3) Test out the framework in a range of different contexts to extend the understanding of its potential and limitations

6.2   Future use of the strategy creation framework

In the short term the framework will be used to develop strategies for various functions within MG Rover Group. Because the company is new the internal context and related business context are both new. There is a need to develop strategies for various functions. The initial work will focus on the Vehicle Engineering function and the Product Engineering department.

6.3 Associated research opportunities

Apart from taking the frameworks as a whole, there are some associated areas of research that would strengthen the understanding and effectiveness of strategy development within the business:

- There is considerable scope for further study into the development and effective use of the generic strategy themes. The application of generic strategy themes in different contexts is likely to be particularly instructive to test how well the generic nature of the concept stands up. This simple new concept provides a different perspective on strategy development and will be researched further by the author through future strategy development work within MG Rover group.

- Involvement is a central theme relating to the effective implementation of strategies, however there was little scope in this research to perform a specific study on this aspect. Further research could study the best ways to involve team members, balancing between the positive aspects of involvement and them having to deal with the frustrations of direction changes and setbacks.

- The Group Function framework could provide valuable guidance for companies involved in merger activity. Further work on this framework could focus on making it more adaptable to different situations, devising rule sets that will enable the situation to be defined and the appropriate sub-elements created.

- Probably the most difficult area of study to make objective within this research related to the ways in which national or business culture impacts the development of strategies. It is unlikely that international co-operation will decrease in the future. Consequently research into ways of making inter-company strategy development more successful would be beneficial to the wider business community.

7 Overall Conclusions

A. The Group Function framework

1) BMW Group completed their take-over of Rover Group at the beginning of 1999 by announcing the full integration of the Rover Group structure into a BMW Group 'Group Function' structure. Although high-level objectives and guidelines were announced, there was no framework provided to convert the objectives into an operational reality.

2) In a review of the relevant literature, the author found that there was no guidance for combining sub-groups within a business to gain the synergies required by the business.

3) The author developed a new framework based on the literature and was aligned to the BMW Group objectives.

4) The new framework was used in the business context of RP&T within BMW Group and produced a number of beneficial operational outcomes:

- The avoidance of duplicated work by sharing databases, using common material in a web page, use of common marketing material e.g. graphics and case studies

- The avoidance of unnecessary outsource costs through workload sharing

- The use of best practice such as the development of a common customer-related interface and common principles for job costing

- The transfer of best practice and expertise between the two teams such as the more vigorous use of Rapid Casting in BMW Group and the transfer of sintering expertise.

5) One of the outcomes from the analysis was that TI-314 retained duplicated elements in both countries, against the general trend at the time. Deletion of the duplicated German elements would have increased the total costs in the longer term and adversely affected prototype job lead times and customer service.

6) Information generated in using the framework was also used in the creation of the Rapid Prototyping & Tooling strategy.

7) The total benefits from using the Group Function framework were probably not realised due to the eventual sale and break-up of Rover Group.

8) The Group Function framework could probably be used as the basis for analysis and decision-making in a range of similar situations. The concepts behind the framework are relatively straightforward and easy to communicate by using the 'coffee-making' analogy and graphic produced by the author.

B. The Strategy Creation framework

9) BMW Group's Re-engineering programme demanded reductions of 50% in new product lead-time and 30% in development and tooling costs. Rapid Prototyping

& Tooling technology case studies have demonstrated significant cost and time savings compared to conventional methods. A strategy for Rapid Prototyping & Tooling within BMW Group was consequently requested by the senior management.

10) No integrated strategy existed for Rapid Prototyping & Tooling within BMW Group but there was no framework that existed within the company that could assist in developing one.

11) The author performed an in-depth literature review but the advice is very disparate and the great majority of research has been performed on the whole business case. Little advice is available for internal strategy development other than for operational efficiency improvement.

12) The author conducted an internal survey in order to search for informal advice and found that strategic management practitioners within the business held some of the main views represented in the body of literature. No informal framework existed for internal strategy development and the advice was based on the personal experience of those interviewed.

13) The author demonstrated from the literature that the process and content of strategy are integrated with the context. Hence the process and content of strategy development are dependent upon the context.

14) The author used core themes within the literature relating to strategic management to derive six 'core contextual themes' aligned to the Rapid Prototyping & Tooling case. These core contextual themes were then used to create and shape the new strategy creation framework.

15) The new framework was validated by using it to develop a strategy for Rapid Prototyping & Tooling within BMW Group.

16) The business strategy models recommended within the framework provided some useful guidance but were used with caution because internal and external business situations are not the same.

17) The author encountered difficulties in gaining access to key information that influenced the strategy and developed a new approach in order to continue with the development of the strategy. The new approach involved the use of 'generic strategy themes' that helped to reduce or eliminate some of the key influences on the strategy.

18) Other new methods were also developed and used by the author such as the adaptation of the association diagram concept to assist with co-ordinating and communicating the link between research questions and data gathering methods.

19) The four stages within the framework appeared to perform their designed function adequately.

20) The six core contextual themes appeared to be adequately covered by the framework during the validation process but it was not possible to identify the framework's effectiveness in the case of the cultural theme for example.

21) Throughout the course of the validation process, improvement recommendations were made. These recommendations were then introduced into the improved framework that is explained fully in Appendix 1.

22) Use of the framework generated some peripheral benefits due to the involvement of the senior management and members of the TI-314 team. These benefits included creating awareness of the strategic potential for Rapid Manufacturing in the senior management, increasing the strategic thinking of team members of TI-314 and introducing more rigorous research approaches to data gathering through use of the survey process proposed in the framework.

23) A robust strategy was created for Rapid Prototyping & Tooling within BMW Group that was accepted by the senior management team and so the framework met its key success criterion.

C. The Research Process

24) Business Process Reengineering (BPR) was relevant to objective 1 of this research because it focuses attention on the processes within the business and hence on technology and people. BPR uses operational action plans to achieve its goals. BPR techniques departed from this research in that the Group Function framework was aimed at the development of synergies over time whereas BPR looks to achieve large-scale step change.

25) The research was conducted in a 'live' business environment and consequently faced some challenges in measuring the impacts of the research:

- Long term effects from the research fell outside the research time frame.

- Corporate change eventually occurred outside the acceptable limits of the change that could be tolerated by the research outcomes.

- Measure implementation proved challenging where measures were part of the greater business environment and not under the control of the researcher. For example the accounting systems of BMW Group and Rover Group retained embedded differences.

- The research involved both quantitative and qualitative measurements of change. In some cases, proxy measures were used because direct measurement of more general effects was not possible.

26) Corporate change had a significant impact on the research. On the positive side, the change drove the creation of the generic strategy theme innovation. On the more negative side, the split up of BMW Group meant that the changes implemented during the research could not be carried through to completion.

27) The research methodology had some similarities with 'action research'. The research was performed in a 'live' business situation, aiming to solve 'concrete' problems and enabling practical judgements to be made. The research was validated by the practical application of the research outputs, which in turn generated benefits that would ideally have been gained over the longer term. However, the research process departed from the action research model in that it

was conducted along more classical lines, involving in-depth literature research and involving the use of numerical data rather than depending upon the use of observational and behavioural data.

28) The strengths of the research process were that it was based on a conventional research methodology, which provided rigour. However the process also gained from the integration of elements of 'action research' providing direct real-time benefits and involvement of the researcher coupled with spin-off benefits within the business such as the introduction of rigorous research techniques within the affected teams. The weaknesses of the research largely related to the extended duration needed to fully prove the frameworks created and the risk of subjectivity in some aspects due to the direct involvement of the researcher.

D. Contributions and Innovations

29) The author contributed to the existing body of knowledge on strategic management by developing a new strategy creation framework that did not previously exist either within BMW Group or in the literature. The new framework provides practical strategy development guidance for the operational manager for the first time, filling a gap in the current literature. The literature on strategy development is very diverse, potentially confusing and is written for the corporate business situation. The majority of literature on strategy development focuses on singular views of strategy creation, orientating these views around particular business contexts. The new framework takes a more holistic approach by bringing together most of the key literature themes within a clear but flexible structure for internal strategy development. The availability of the new framework means that strategy development no longer need be the reserve of the board of directors because guidance now exists for others within the company. There is now a mechanism for practical 'bottom-up' strategy development.

30) The author devised and introduced the innovative concept of 'generic strategy themes' within the framework to help reduce difficulties relating to rapid change and uncertainty for both internal and external strategy development. Although some authors have proposed mechanisms for dealing with contextual change following strategy development, none have clearly and successfully identified and provided mechanisms for dealing change and uncertainty during strategy development. One of the attractions of the 'generic strategy themes' concept is that it can also help to 'future proof' the strategy from contextual change.

31) Sub-corporate managers of technology-orientated groups in a range of industries should be able to benefit from the framework. It will be most suited to strategy development for new technology introduction such as new CAD applications, new manufacturing technologies or perhaps any new technology that may have a significant impact on the whole business. The standalone explanation of the framework provided in Appendix 1 will form the basis for further dissemination.

E. Further work

32) Further work would beneficially include broadening the usability of the framework by describing it to different extents for different levels of user and

possibly even having short medium and longer training courses associated with them.

33) There are undoubtedly many improvements that could be made to the framework including a description of how to create a new framework for significantly different contexts to that covered within this research.

34) The framework will be used to develop different strategies within MG Rover.

35) Associated lines of further work could include:

- Further development and use of the generic strategy theme concept

- Further study into the best ways to involve the strategy implementers in the strategy development process

- Wider use of the Group Function framework, extending its use into different contexts

- Further research into the effects that different business and national cultures can have on the strategy development process.

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1 Introduction

This document describes a practical framework for strategy creation within a large company. It has been developed with a technology-based group in mind.

The following pages include:

1. A description of the four stages of strategy development

2. A brief overview of the general principles behind the framework

The strategy creation framework is not definitive and will require interpretation to match it to the individual circumstances encountered within the business and specific area concerned.

The framework is based on the strategy definition:

"A strategy provides a vision of the desired future, a set of clear objectives and a set of guiding principles from which the objectives may be achieved".

Throughout the framework description, references have been made to specific literature on strategy development for further understanding if required.

2 An overview of the process

This framework treats strategy development largely as a problem-solving exercise composed of:

- Problem identification

- Data gathering and analysis

- Iteration

- Devising solutions to the problems

Although it is assumed that members of senior management have requested the development of a strategy for the group concerned, the process is not purely driven and controlled. Allowances must be made for random inputs and aspects of the strategy 'emerging' as well as being developed deliberately (Mintzberg et al, 1998).

The framework assumes that the strategy is being developed for two main reasons:

1) So that it can be used to create a project that will gain financial approval

2) So that the resultant project will be implemented.

Both of these outcomes require top level support within the company and the involvement of the people who will have to implement the strategy.

The complete strategy development process is built up over the following pages in four sequential stages for ease of understanding. However it worth visualising the whole

process as the first two stages running sequentially and the third and fourth stages running concurrently with them from the start of the whole process as shown in Figure 1 below. The four stages are:

1) Initiation and rough strategy creation

2) Strategy development and selection

3) Approval of the refined strategy

4) Strategy implementation

The four stages have been numbered in the diagram. Stage 2 follows stage 1. Stages 3 and 4 effectively start at the same time as stage 1 due to their involvement of senior management and the implementation team. The most visible aspects of these two later stages occur once the strategy has been developed and hence they are numbered accordingly.
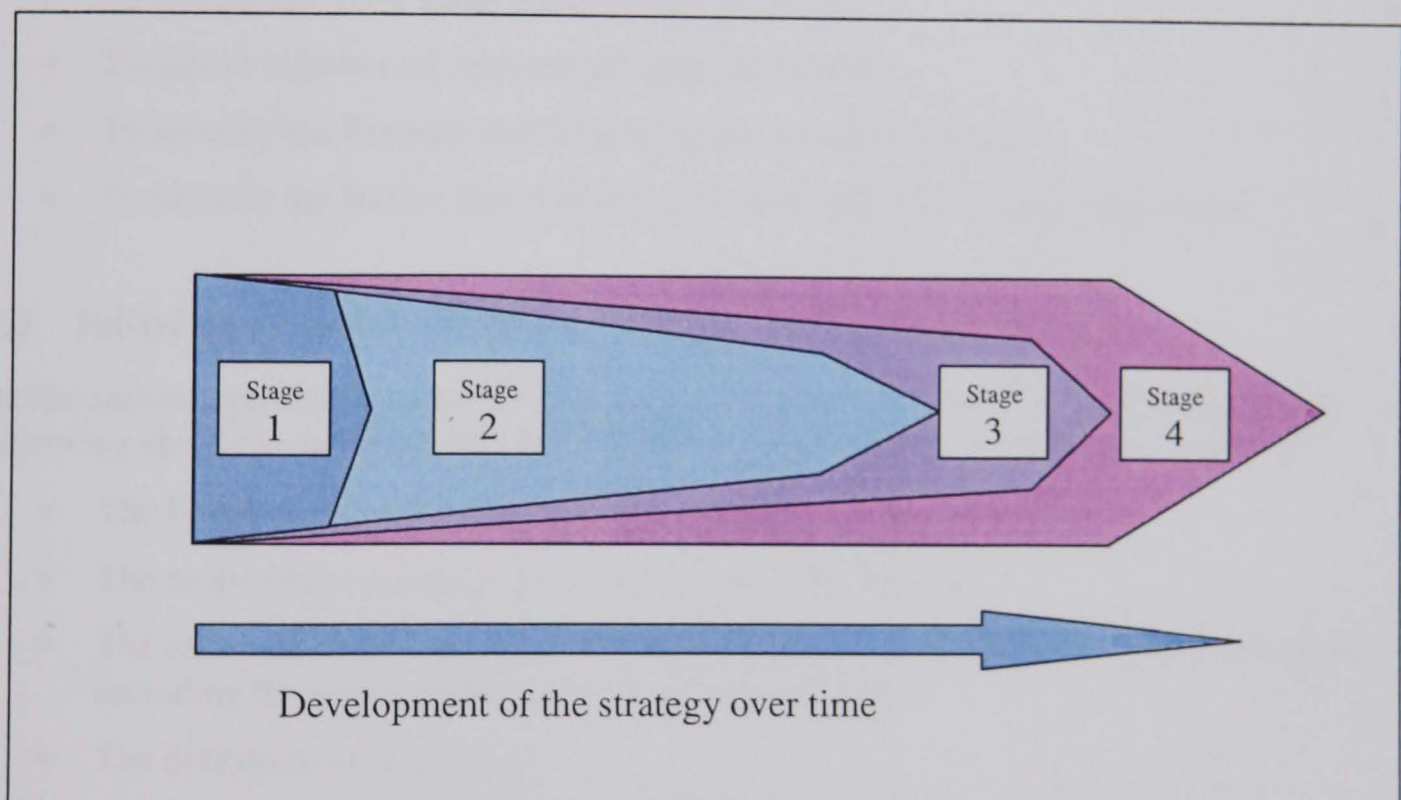
Figure 1. Showing the concurrence of the four strategy development stages.

3   Stage 1: Initiation and rough strategy creation

3.1   Overview

Stage 1 is shown diagrammatically in **Figure 2** below.

The blue blocks relate to team activity, the green blocks to the mainstream strategy development activity and the pink and red to corporate/ senior management activity. The first three red blocks show the corporate influences and activities that result in the

realisation that there is a gap between the corporate strategy and targets and the current performance in the relevant area. The need for a strategy is then the trigger for the strategy development process. Following the initial agreements between senior management and the strategy developers (the strategists), the rough Purpose, Vision, key strategy themes and strategy influences are generated. The outputs from this stage are created from the data gathering activities covering previous strategic activity and easily available information about the relevant internal and external environment.

3.2 Aims

The aims of this stage are:

- To set up the interaction between the strategist and senior management correctly from the start

- To initiate the early stage 3 and stage 4 activities

- To gather together all relevant existing information

- To identify the Purpose and Vision for the group concerned

- To identify the factors that will affect the strategy (the strategy influences)

3.3 Initial agreements about the strategy development process

At the earliest opportunity after the strategy development process has been initiated, the following should be agreed between the parties involved in the strategy development:

- The Purpose, Objectives and Outcomes for the strategy

- The scope of the strategy (its extent/ what it will include)

- The roles and responsibilities of the all those involved in the strategy development including the senior management and the strategist(s)

- The definition of 'a strategy'

- How the strategy creation framework will be used

- The way in which the process should be reviewed and progress monitored
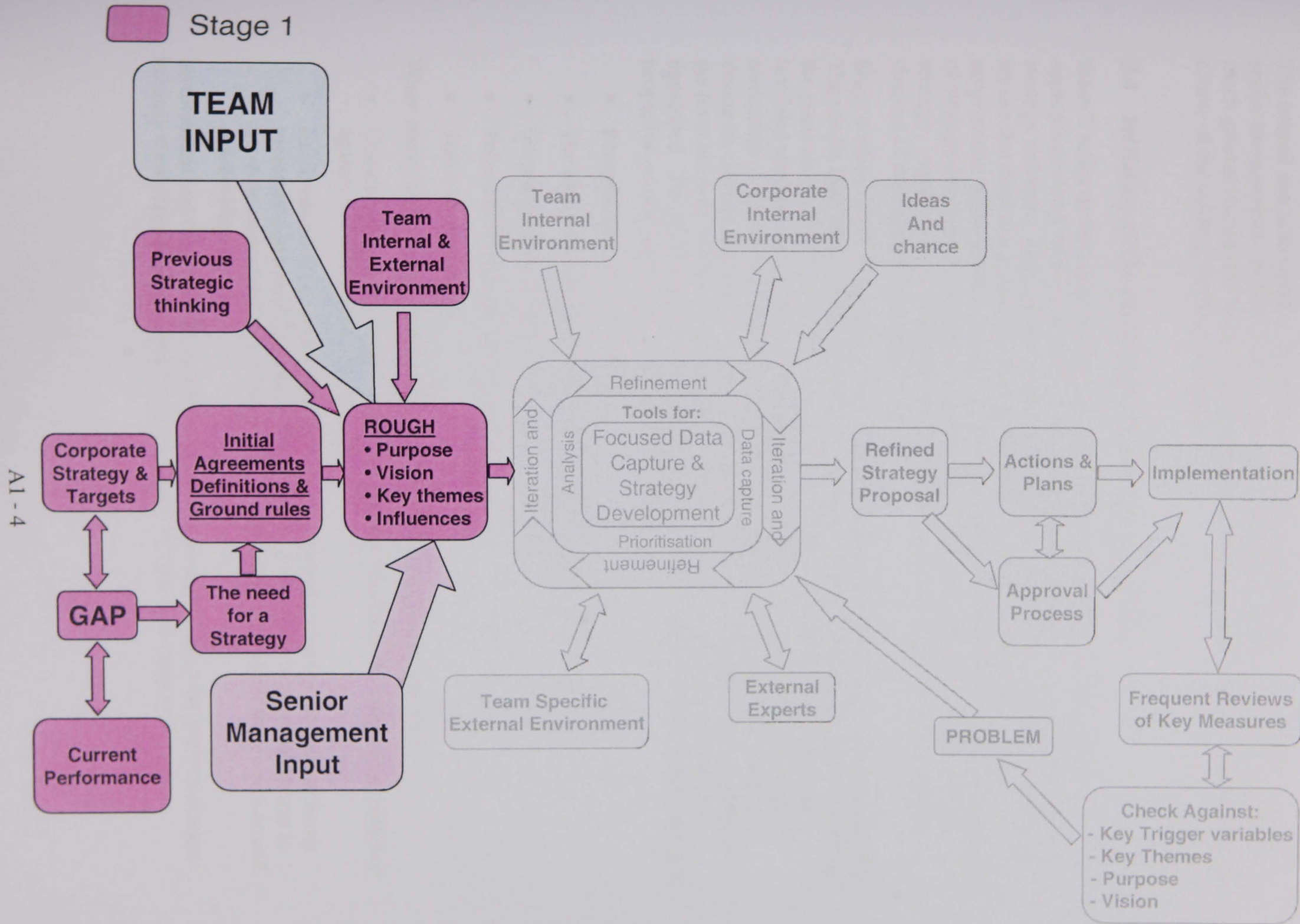
Figure 2. Showing stage 1 of the strategy development process

A1 - 4

Stage 1

TEAM INPUT

Previous Strategic thinking

Team Internal & External Environment

Corporate Strategy & Targets

<u>Initial Agreements Definitions & Ground rules</u>

<u>ROUGH</u>
• Purpose
• Vision
• Key themes
• Influences

GAP

The need for a Strategy

Senior Management Input

Current Performance

Team Internal Environment

Corporate Internal Environment

Ideas And chance

Refinement

Tools for:
Focused Data Capture & Strategy Development

Iteration and Analysis

Data capture Iteration and

Prioritisation

Refinement

Team Specific External Environment

External Experts

Refined Strategy Proposal

Actions & Plans

Implementation

Approval Process

PROBLEM

Frequent Reviews of Key Measures

Check Against:
- Key Trigger variables
- Key Themes
- Purpose
- Vision

The overall aim is to create a strong dialogue and trust between the strategist(s) and the senior management. If the process is correctly established at the start then there will be a much greater chance that any necessary changes to the interaction can be made during the course of the strategy development process.

3.4   Initiation of the early stage 3 and stage 4 activities

Stage 3 relies on the approval of the strategy. The ongoing involvement of the appropriate senior management will have a bearing on their desire to support the final strategy outcome. Appropriate involvement of the senior management will also help to ensure that they understand the strategy and how it fits into the business. Their involvement is essential to provide the feedback and information that the iterative process of strategy development requires, as well as building their sense of ownership of the strategy. Appropriate involvement of the relevant senior managers will increase the chances of the strategy being approved.

Stage 4 relies on the development of a practical strategy and plans for its implementation. The people that will have to implement the strategy are the ones most likely to ensure that the plans are practical and hence able to be implemented. If the team members are involved appropriately in the strategy development, then they will develop a sense of ownership of the strategy and hence will be more willing to help share the workload during its creation and be more willing to implement it. It will be necessary to balance the level of involvement according to the individual and the way that the strategy is developed. The following are some suggestions of factors to bear in mind when selecting people for involvement in the strategy development:

- Personal aptitudes and interests
- The likely duration of the strategy development process
- Corporate understanding
- Tolerance to changes in direction
- Status of the strategy

When considering overall team involvement the following points may help:

- Communication of progress to the whole team should be maintained but balanced against the results and actual progress.
- Involvement of the wider team can increase once the strategy themes are being turned into practical outcomes. Involvement at this point will probably help to increase understanding and buy-in for the strategy and make it more realistic and achievable.

Involvement and buy-in of the senior managers is also important to the implementation because their support will be required after the project has been approved.

3.5 Gathering existing data together

There is likely to be information that can be assembled into the following categories:

- Corporate strategy and objectives
- Ideas for the Purpose and Vision for the group
- Influences on the strategy
- Research questions (problems to be solved, information to be found), some of which may already have solutions, others may not.
- Potential strategy themes i.e. solutions/ answers to the problems/ research questions
- Likely avenues for research
- Possible research methods

The information will have either 'emerged' as a natural strategy development process and/or been created through deliberate action.

3.6 Identification of the initial Purpose and Vision for the group

A Vision statement should provide a long-term direction that can be commonly understood and held by all the members of the team (Hamel & Prahalad, 1989). The Purpose statement gives meaning to the vision in more practical terms. The Vision and Purpose statements should be derived primarily from the corporate strategy and targets. Ideally, their development should include members of the team and the senior management. The Purpose of the group should identify the 'gap' that the group should and could fill within the organisation.

The aim at this stage should be to produce a rough statement of each that can be refined and tested throughout stage 2 of the strategy development process.

3.7 Determine the key strategy themes

During the early stages of the strategy development, you will start to have ideas about possible ways to shape the future for the group of interest. From among these ideas there will probably be some key ones that seem to hold true over time and others that are discarded as more facts become known. The ideas that you retain through the data gathering can form the basis for the key strategy themes – the core lines of thought around which the strategy is built. The key strategy themes should be tested through the course of the development process and are central to the data gathering process. You will test the key strategy themes by asking questions that are answered by the lines of research and data gathering.

3.8 Identify the strategy influences

The strategy development will be dependent upon the forces acting on it. The overall objective is likely to be the maximisation of business benefits resulting from the group or set of technologies concerned, looking for new opportunities and ways of working. The drive to maximise the business benefits will depend upon the strategy influences. The most obvious influences will be the corporate strategy and targets. There will be other influences such as:

- Funding possibilities

- Technology changes and new opportunities

- Demand for services

- Awareness of the group's capability

These influences on the strategy will have different levels of 'visibility' to the strategist. That is, it will be easier to access information about the status of some influences than others. Further complicating matters, some of the strategy influences will be changing over the course of the strategy development, although for the less 'visible' influences the changes may be hard to track. The problems with strategy influences will be dealt with in the description of stage 2.

3.9 Outcomes from Stage 1

The activity in stage 1 provides the basis for stage 2. With an initial idea about the Purpose, Vision, key strategy themes and strategy influences, it will be possible to organise the activities in stage 2 more directly.

4 Stage 2: Strategy development and selection

4.1 Overview

Stage 2 is the main strategy development stage that runs from a rough set of ideas and themes through to a refined strategy. The diagrammatic representation for stage 2 is shown in **Figure 3** below. The data gathering activities are split into four main groups:

- The internal environment for the team

- The internal environment for the company

- The external environment that relates specifically to the team (this is explained further below)

- Discussions with external experts

Allowance must also be made for the input of unexpected ideas and chance.
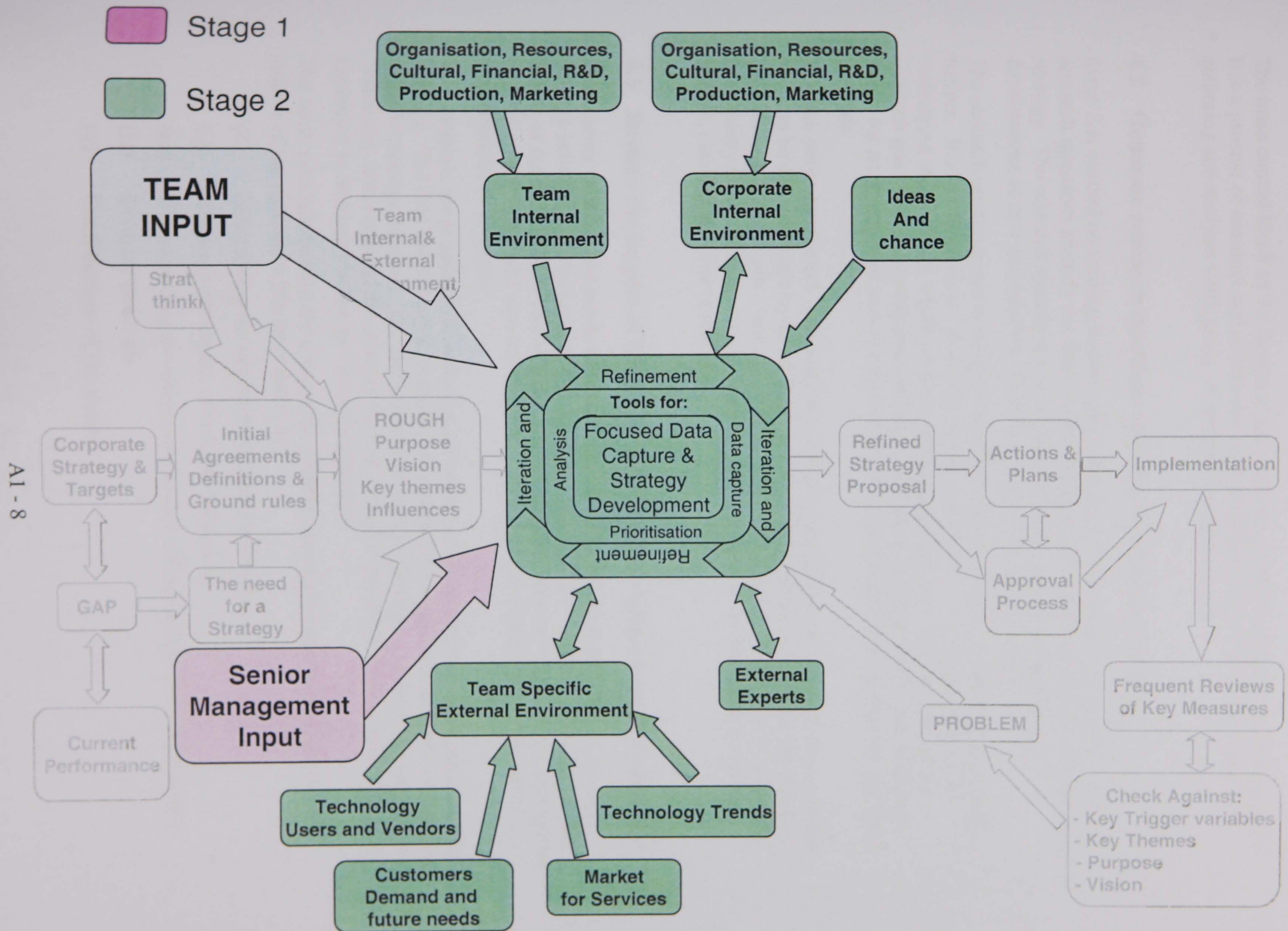
Figure 3. Showing stage 2 of the strategy development process

Legend:
- Stage 1
- Stage 2

Diagram labels:

TEAM INPUT

Organisation, Resources, Cultural, Financial, R&D, Production, Marketing

Organisation, Resources, Cultural, Financial, R&D, Production, Marketing

Team Internal Environment

Corporate Internal Environment

Ideas And chance

Strat thinki

Team Internal & External nment

Corporate Strategy & Targets

Initial Agreements Definitions & Ground rules

ROUGH Purpose Vision Key themes Influences

Refinement
Tools for:
Focused Data Capture & Strategy Development
Iteration and Analysis
Data capture
Iteration and
Prioritisation
Refinement

Refined Strategy Proposal

Actions & Plans

Implementation

A1 - 8

GAP

The need for a Strategy

Senior Management Input

Team Specific External Environment

External Experts

Approval Process

PROBLEM

Frequent Reviews of Key Measures

Current Performance

Technology Users and Vendors

Customers Demand and future needs

Market for Services

Technology Trends

Check Against:
- Key Trigger variables
- Key Themes
- Purpose
- Vision

The main central block in the diagram represents the strategy development process itself. It is a process of iteration and refinement of ideas based on the inputs from the data gathering and analysis work going on within the stage overall.

4.2 Generate research questions and link to research methods

Stage 2 is centred on finding answers and solutions to the 'research questions'. The research questions identify the lines of investigation that need to be followed to create the strategy. The research questions will evolve during the course of the strategy development as new information is found and new possibilities appear.

The research questions are developed from the strategy influences and the key strategy themes. If a key theme is to 'maximise the benefits from ....', then this will be the underlying theme of the whole strategy development process. The majority of the research questions will come from the main influences on the strategy. See Section 9 below for an example of research questions linked to research (data gathering/ analysis) methods.

The link between research questions and methods provides an overview of the work that needs to be done throughout the strategy development process. Changes in the strategy influences during and after strategy development can make it very difficult to complete the strategy at all. The creation of 'generic strategy themes', as described in the next section, can help to achieve that goal.

4.3 Reduce the impact of the strategy influences –'generic strategy themes'

The amount of work that needs to be done on strategy development is increased if the strategy influences vary significantly or if they are not easily 'visible'. Therefore if the effects of these influences can be reduced or eliminated, then not only will the strategy be easier to create but it will also have a greater chance of remaining valid in the future as the environment changes.

Two methods are proposed for reducing the impact of changes in the environment on the strategy. The first method aims to eliminate or reduce the impact of variables by devising 'generic strategy themes'. The second method aims to generate scenarios by reducing the 'unknown' influences on the strategy through extensive research. The second method is explained in Section 9 below as 'Scenario planning'.

The basic principle behind the concept of 'generic strategy themes' is that the overall impact of the influences can be reduced by:

    (i)   Neutralising the impact of variable influences

    (ii)   Reducing the impact of variable influences

    (iii)   Understanding the effects of variable influences and allowing for them

    (iv)   Do more iterations

    (v)   Combinations of the above

These points are explained further in Section 9 below.

4.4 Data gathering methods

There is a wide range of different ways of gathering data together. It is likely that more than one method will need to be used to achieve the desired results. The following methods are recommended for strategy development.

a) Surveys

By far the most important data gathering method is likely to be the judicial use of surveys. A survey does not need to be large-scale but of course the smaller the number of respondents involved then the lower the accuracy and validity of the information is likely to be.

In the sense intended for strategy development surveys can include:

- Customer interviews
- Customer questionnaires
- Structured interviews with internal and external experts
- Structured interviews with competitors or key members of other related groups and businesses
- Specific case studies

It is important to use a methodology for each survey undertaken. The methodology in Section 9 below is strongly recommended. Correct use of the methodology will increase the chances of the survey providing valid results. Ignoring the methodology almost invariably wastes time in the long-run.

b) Special studies

Again using the main principles of the survey methodology, special studies can be used for areas of specialist knowledge where a focused report is required. For example, an academic expert in a field could be commissioned to produce a report on his or her subject.

c) Other methods

The well-known technique of 'Benchmarking' is perhaps a form of survey. It involves understanding your own team first before attempting to target specific data about the group being Benchmarked (Millard, 1995)

Brainstorming can generate new ideas and has the added benefit of communicating the ideas within the group while also involving them in the strategy development process.

Conferences, literature and company visits are also important data gathering that can develop background knowledge within the team.

4.5   Business strategy concepts and tools

Once the data becomes available, it has to be analysed before it can be directly useful. This section and the following two propose some tools and concepts for data analysis, understanding and decision-making.

The first business-related strategy model is the **Porter 'Five Forces' model** (Porter, 1980) shown in Section 9 below. The model can be useful in helping to understand and communicate about the competitive environment that relates to an internal service group. As with all the models, concepts and tools, care must be taken when applying it to the situation. In the case of the Porter model, if an internal service organisation has a monopoly over its customer base, then the Porter model will not apply.

The external environment for an internal group will consist of the company internal and external environment as well as the specific external environment relating to the group itself. For a technology group, it is likely that details of the group-specific environment are not of direct relevance or interest to the business as a whole. In the same way, only a few of the company internal and external environmental issues are of direct relevance to the internal group. The thinking can be represented by Figure 4 below.
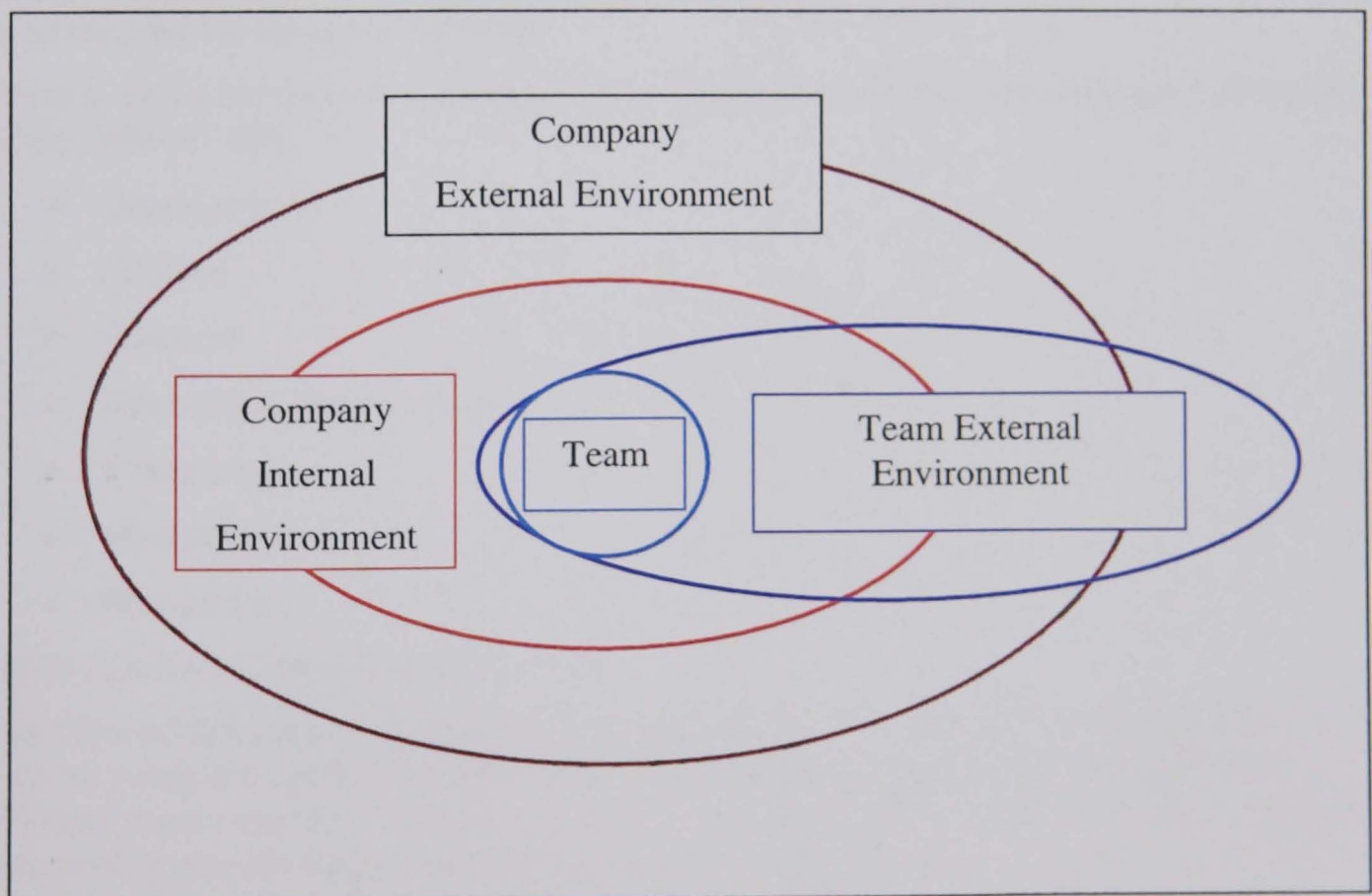

Figure 4. Showing a model of the relative internal and external environments for an internal group (team) within a large company

The **external environmental analysis** can be structured using the **BPEST** analysis, where the letters stand for:

- **Business**

- Political
- Environmental
- Social
- Technical

A more detailed listing is given in Section 9 below. It is likely that not all the five categories will carry equal weight for the internal group. So for example, the Business and Technical categories are quite likely to be of greater significance than the Political, Environmental and Social categories. The greatest influence on an internal group is likely to come form the corporate strategy and targets, which should reflect the corporate view of the external and internal environment for the company.

The market for the services provided by the internal group will probably break down into 'Market Segments'. Market Segmentation can help to enable the service group to focus its efforts on specific types of customers or activities. In the case of an internal group, there may not be any choice about the customers within the internal 'market', however it may be possible to focus on the strengths of the group and to identify weaknesses that need to be addressed. The analysis may also be beneficial in focusing the research effort in addressing the research questions.

There is also a business model list to help structure the **internal environmental analysis** (Cole, 1994:43-44):

- Organisational
- Cultural
- Financial
- Research & Development
- Production
- Marketing
- Resourcing

Again, the list is intended as an aid only.

Once the environmental analysis has started to provide an outline of the environment, it may be possible to perform a **SWOT/ TOWS** (Strengths, Weaknesses, Opportunities, Threats) matrix analysis. The advantage of this form of simple strategic analysis is that it can quickly provide direct ideas about lines of strategy. The process typically involves members of the team, so performing the SWOT/ TOWS includes people in the strategy development process and also communicates strategic ideas and thinking. The disadvantage of the process is that strengths, weaknesses, opportunities and threats are largely subjective (Hill & Westbrook, 1997). As with the other business-related strategy models and techniques, provided SWOT/ TOWS is used with care it can be beneficial to the strategy development process. An example of a TOWS matrix is shown in section 9 below.

4.6 Analysis and decision-making tools

The SWOT/ TOWS matrix provides a form of analysis of the environmental data. Other useful techniques include the well-known Fishbone analysis (Ishikawa, 1982), which provides a structured logical problem-solving approach.

Another well-known analysis tool is 'Portfolio analysis' (Dyson & O'Brien, 1998), perhaps most famously demonstrated by the 'Boston Box'. The technique can be used to identify different characteristics of different technologies and compare them against each other to assist with decision-making. An example is shown in Section 9 below. The scope of portfolio analysis makes it a very adaptable tool. Care must be taken not to take any single portfolio matrix on its own for decision-making. The matrix is only as good as the data that is used to construct it. A rigorous approach to gathering key data is therefore essential as with all the main analysis tools used.

4.7 Technology-related concepts and tools

There are three main tools recommended that relate to technology strategy:

- Trend analysis
- The technology S-Curve
- The industry lifecycle
- The technology decision process

Trend analysis is largely self-explanatory. Trends relating to particular aspects of a technology or set of technologies are tracked over time with a view to making some sort of prediction about how the performance will change in the future.

A concept that can assist in making predictions about the performance of technologies as they develop is the technology S-Curve (Twiss, 1974). As a general rule, technologies on average follow a performance development line that is roughly 'S'-shaped over time. Initially the performance develops slowly, building rapidly in mid life and then slowing down towards the end of its 'life'. The curve must be used with care though. Not all technologies will naturally follow the curve, they may for example be dependent upon the development of several other technologies. A step change in one of the 'sub-technologies' could make a step change in the technology of interest, taking it off the expected 'S' curve. A sketch of the S-Curve is shown in Section 9 below.

The second generalised model that can provide some guidance for technology decision-making is the industry lifecycle. Again this model can only be used for broad guidance due to the complexity of real-life circumstances. There are five broad stages in the industry lifecycle (Hisrich & Peters, 1984:386):

1) Introduction
2) Growth
3) Maturity

4) Saturation

5) Decline

The five stages roughly align with the categories of adopters of the new product (Kotler, 1988:440) as shown in Figure 5 below:
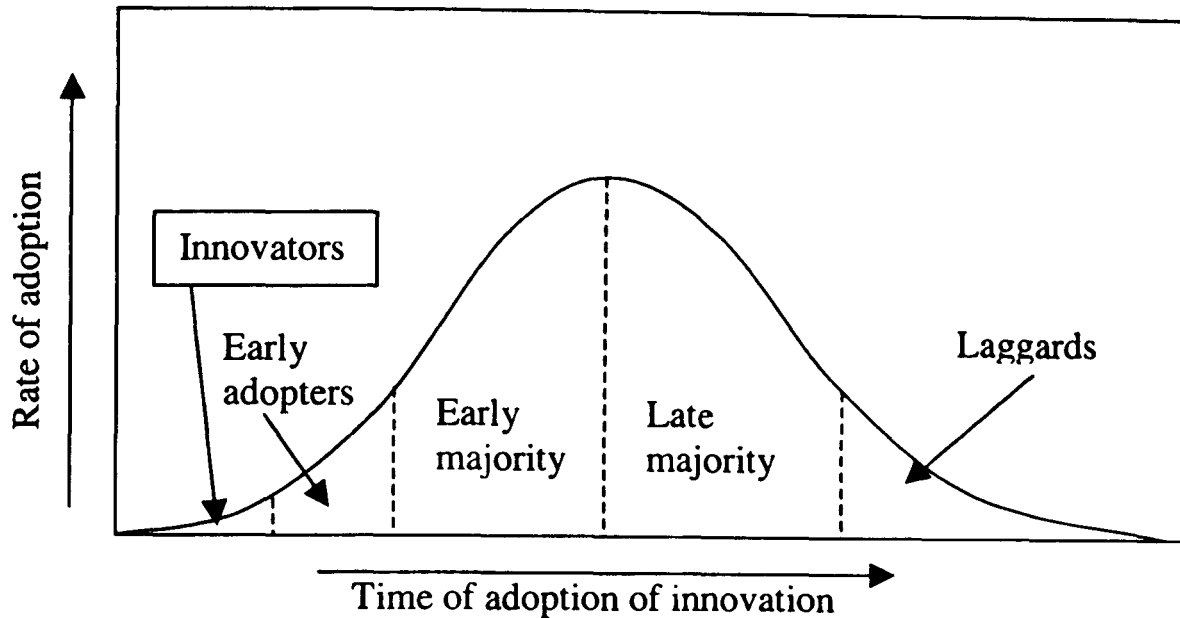

Figure 5. Showing the categorisation of adopters in the product lifecycle (based on Kotler, 1988:440)

The model may provide some guidance for the strategist because it can indicate how quickly a new product might become available in the broader marketplace. It can of course only provide a general indication of what might happen with a new product and should therefore be used with caution.

The final technology-related tool is shown as figure 15 in section 9 of this appendix below. The figure shows a technology decision process that links corporate strategy to decisions about individual technologies. The process takes into account limitations in funding, resources and other priorities within the business. It also allows for the introduction of new ideas. The process can either be kept for reference purposes or used when technology research or project decisions need to be made.

4.8 Activity relating to Stages 3 and 4

As with Stage 1, there will effectively be ongoing activity that relates to Stages 3 and 4 during Stage 2. By the end of Stage 2, the team should know the basic outlines of the strategy proposal and some key members of the team will be very familiar with it because they have contributed to it. Similarly, the senior managers involved will be familiar with the strategy and have built up a sense of ownership or 'buy-in' to the strategy. The scene should therefore be set for Stage 3, the approval process.

4.9 Outcomes from Stage 2

Overall Stage 2 will provide a refined strategy proposal for presentation to the senior management. The output from stage 2 will therefore be:

- A refined strategy proposal made up from:

    - Generic strategy themes that can be used to create a detailed proposal

    - A refined and accepted Vision and Purpose for the team

    - A clear understanding of the strategy influences

    - Presentation material that has been built up through the stage

    - Environmental analysis data that will be used to create the final proposal in Stage 3

The more visible aspects of Stage 3 can then start.

5 Stage 3: Approval of the refined strategy

5.1 Overview

Stage 3 is relatively simple compared to Stage 2 but of course no less important. The main elements of Stage 3 are shown in Figure 6 below. The refined strategy that has been developed in Stage 2 is now put forward for informal approval by the senior management before going on to the financial approval stage.

The informal approval may not be a sudden event, it is more likely to be a natural progression from the strategy development work that has been carried out in conjunction with the senior managers involved. Once the strategy has been informally approved, it will need to be converted into a form that can be assessed on a financial and general business basis. The actual format of the strategy and plans will be determined by the specific requirements of the senior managers involved. The senior managers may even take over at this point and take the strategy through the next stage themselves. It is possible that if a project is unsuccessful first time through, it may not get a second chance. Timing, tactics and content are therefore crucial to success.

Once the strategy has been given financial approval, Stage 4, the Implementation, will begin.

5.2 Key requirements for success in Stage 3

The main requirements for success as listed out below:

- Involvement of the senior management from the beginning gaining their:

    - Feedback

    - Support

- Understanding of the technical issues (by ensuring that the key points are absolutely clear)

- Gaining an understanding of the corporate issues from them

- The use of simple and clear graphics to communicate the strategy themes

- Gaining the support of the implementation team by increasing the level of involvement

Success will finally be measured by first gaining informal approval of the refined strategy and then by gaining financial approval for the project.
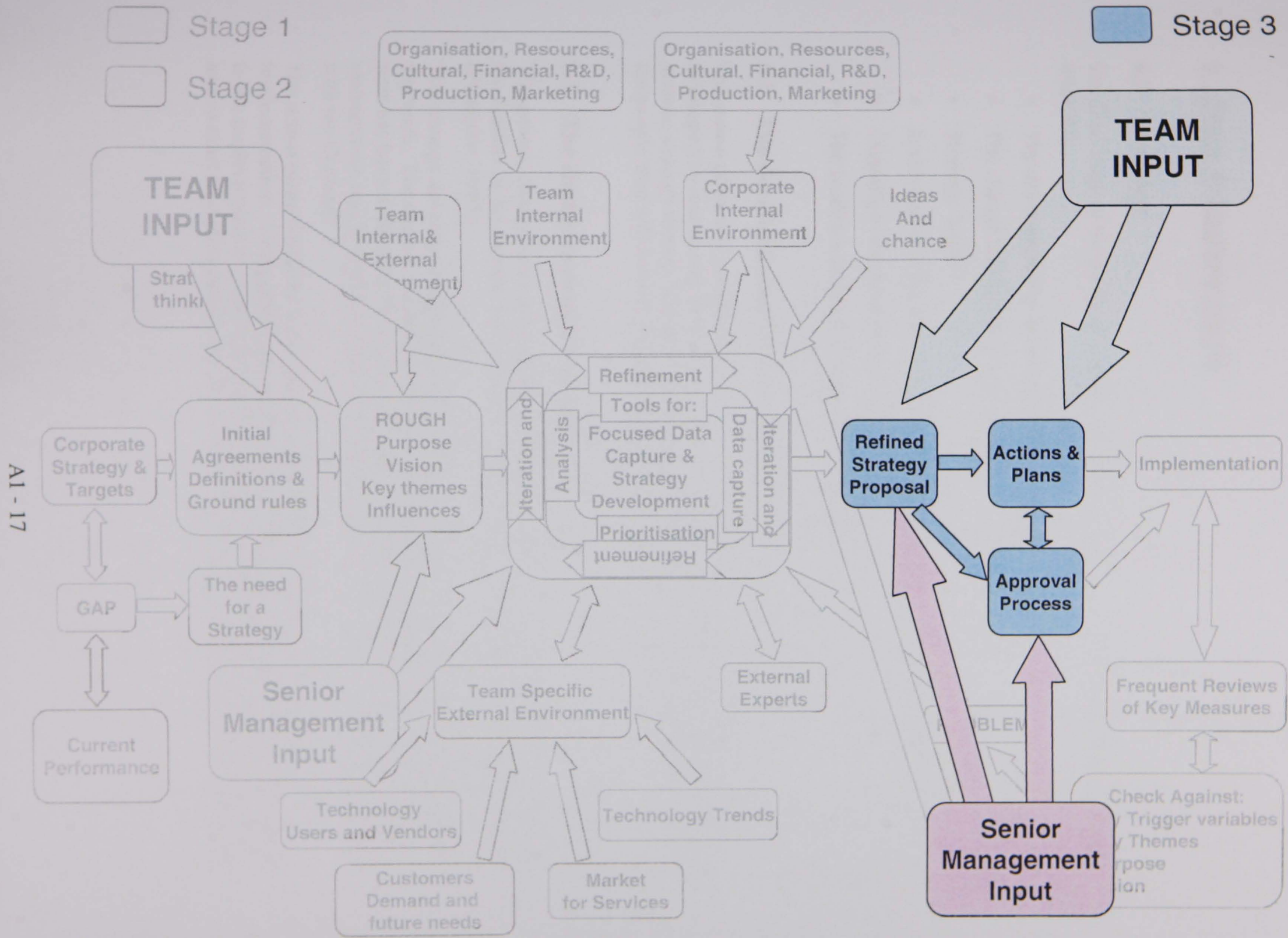
Figure 6. Showing stage 3 of the strategy development process

Stage 1

Stage 2

Stage 3

Organisation, Resources, Cultural, Financial, R&D, Production, Marketing

Organisation, Resources, Cultural, Financial, R&D, Production, Marketing

TEAM INPUT

TEAM INPUT

Strat thinki

Team Internal & External ronment

Team Internal Environment

Corporate Internal Environment

Ideas And chance

Corporate Strategy & Targets

Initial Agreements Definitions & Ground rules

ROUGH Purpose Vision Key themes Influences

Refinement Tools for: Focused Data Capture & Strategy Development

Prioritisation

Iteration and Analysis

Iteration and Data capture

Refinement

Refined Strategy Proposal

Actions & Plans

Implementation

GAP

The need for a Strategy

Approval Process

A1 - 17

Senior Management Input

Team Specific External Environment

External Experts

Frequent Reviews of Key Measures

Current Performance

Technology Users and Vendors

Technology Trends

PROBLEM

Check Against: Trigger variables Themes rpose ion

Senior Management Input

Customers Demand and future needs

Market for Services

6 Stage 4: Implementation

6.1 Overview

The final stage of the process is shown in Figure 7 below. The important features of this stage are:

- The development of actions plans for the implementation
- The change management approach
- Strategic Intent
- Involvement of the senior management team and the implementation team
- Ongoing environmental monitoring
- The feedback loop for keeping the strategy alive

6.2 The development of actions plans for the implementation

The action plans will effectively drive forward the strategy. The action plans will be developed by combining the environmental information gathered during Stage 2 and the generic strategy themes. The action plans are most likely to be practical and achievable if the people who will have to implement them are involved in their creation.

6.3 The change management approach

The generic change management approach takes into account the Context of the situation, the Process of the change, the Content of the change and the interplay between the three (Pettigrew, 1985).

The strategy development process provides the key elements for the change management approach. The current situation is clearly understood (the Context), the desired future state has been defined by the vision and some of the key strategic themes. The change management task is to plot a course between the two (the change Process in conjunction with the Content).

The action plans would be well suited to a project management approach to their implementation. Using project management principles will provide control and structure to the implementation. It is important that the flexible nature of the strategy is retained and so must take precedence over the control desired in a project management approach.

Figure 7. Showing stage 4 of the strategy development process

A1 - 19
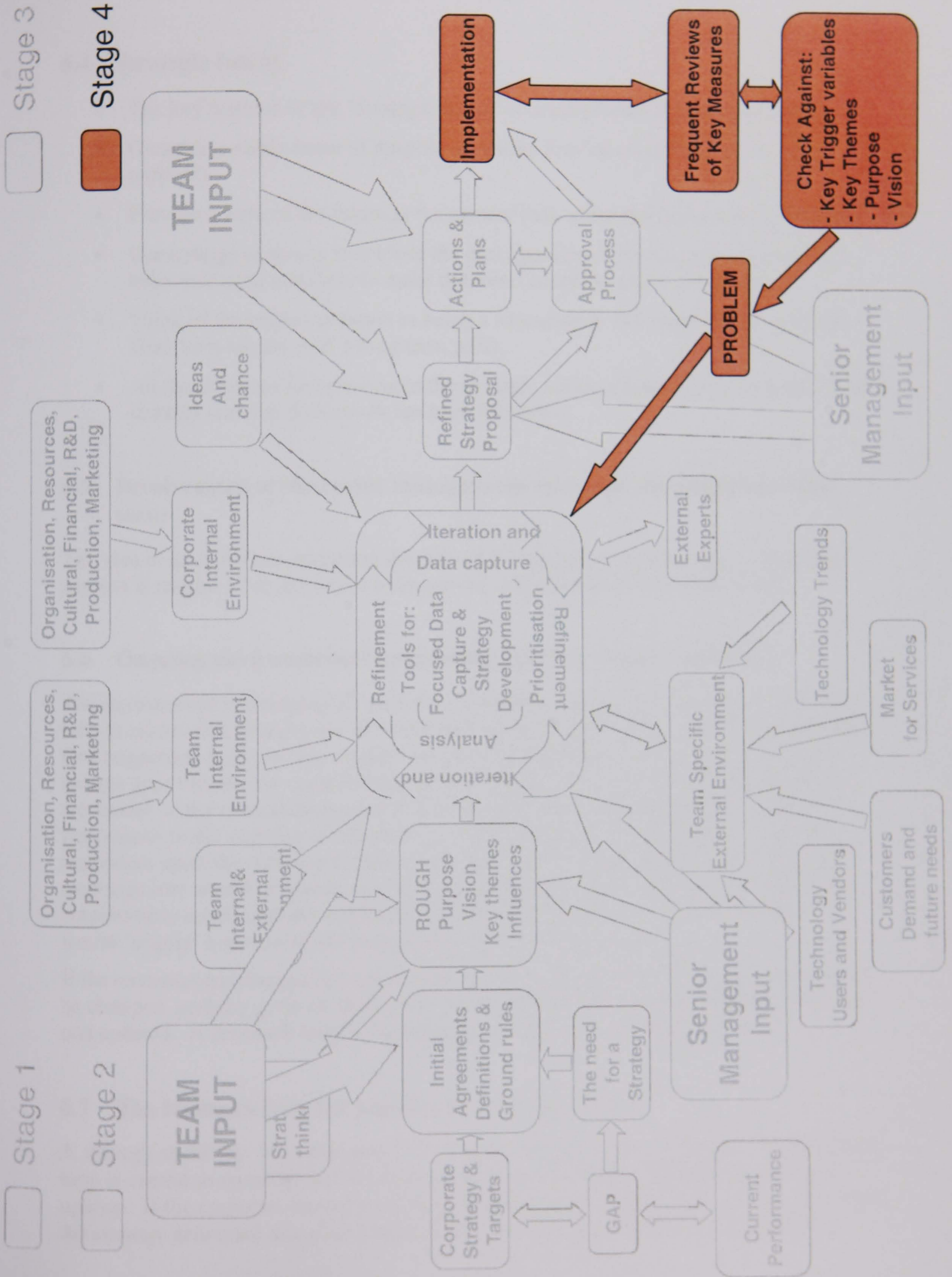
6.4 Strategic Intent

- The key features of the 'Strategic Intent' concept (Hamel & Prahalad, 1989) are:

- Generate a stable sense of purpose over time Provide clear direction (vision and purpose)

- Provide a view of the future in the present (talk about the future within the team)

- Use a range of means to achieve the ends (generate a flexible environment and empower team members to make decisions based on their own expertise)

- Think of the implementation as being a Marathon in 400 metre sprints (provide short term targets with a long term goal).

- All the elements for adhering to the strategic intent concept will be in place if the strategy creation framework has been followed.

6.5 Involvement of the senior management team and the implementation team

The idea of involvement continues throughout the strategy implementation. Ongoing support is needed from the senior management and commitment from the team.

6.6 Ongoing environmental monitoring and 'key trigger variables'

The environment is changing all the time, continuous monitoring of key measures will help to ensure that changes are observed and can be included in the short term planning. One suggestion is to use 'key trigger variables' to highlight when an environmental change goes outside the control limits of the existing plans. The 'key trigger variables' are factors in the normal business environment that are deliberately chosen for their importance to the viability of the strategy. For example, if the strategy was heavily dependent upon the currency exchange rate between two specified countries, then the exchange rate would be chosen as a key trigger variable. The exchange rate would be continuously monitored and compared against carefully chosen limits that if passed would 'trigger' a review of the strategy or elements of the strategy.

If the environment changes are big enough, it may mean that more than the plans need to be changed, perhaps some or all of the generic strategy themes will have to be reviewed and updated. A feedback loop is therefore essential to keep the strategy 'alive'.

6.7 The feedback loop for keeping the strategy 'alive'

A strategy should be adaptable and flexible to be able to survive over time. The feedback loop is central to ensuring that the strategy does not 'die' due to ignorance or lack of upkeep. If the corporate strategy and targets remain relatively constant, it is possible that the strategy generated using the strategy creation framework will have a long 'life'.

Ongoing data gathering, active monitoring of the key trigger variables and a preparedness to confront radical change are likely to be important ingredients for maintaining the life of the strategy for as long as possible.

7   The whole strategy development process

The whole process is shown together in Figure 8 below. The involvement of the senior management and the implementation team is shown by the large arrows running the whole length of the diagram. The pink arrow shows the senior management involvement and the blue arrow the team involvement. The rest of the diagram has been explained throughout the previous sections.

8   Conclusion

There is no single way to create a strategy, each different situation will have its own individual attributes. This strategy creation framework provides guidance for the development of a strategy for a technology-centred service group within a large company. Although the definition of this context appears to be quite tight, there will be a wide range of different contexts that match that description. The framework should therefore be adapted to match the needs of the circumstances that prevail, it is the end result that is important not the framework itself. Good luck.
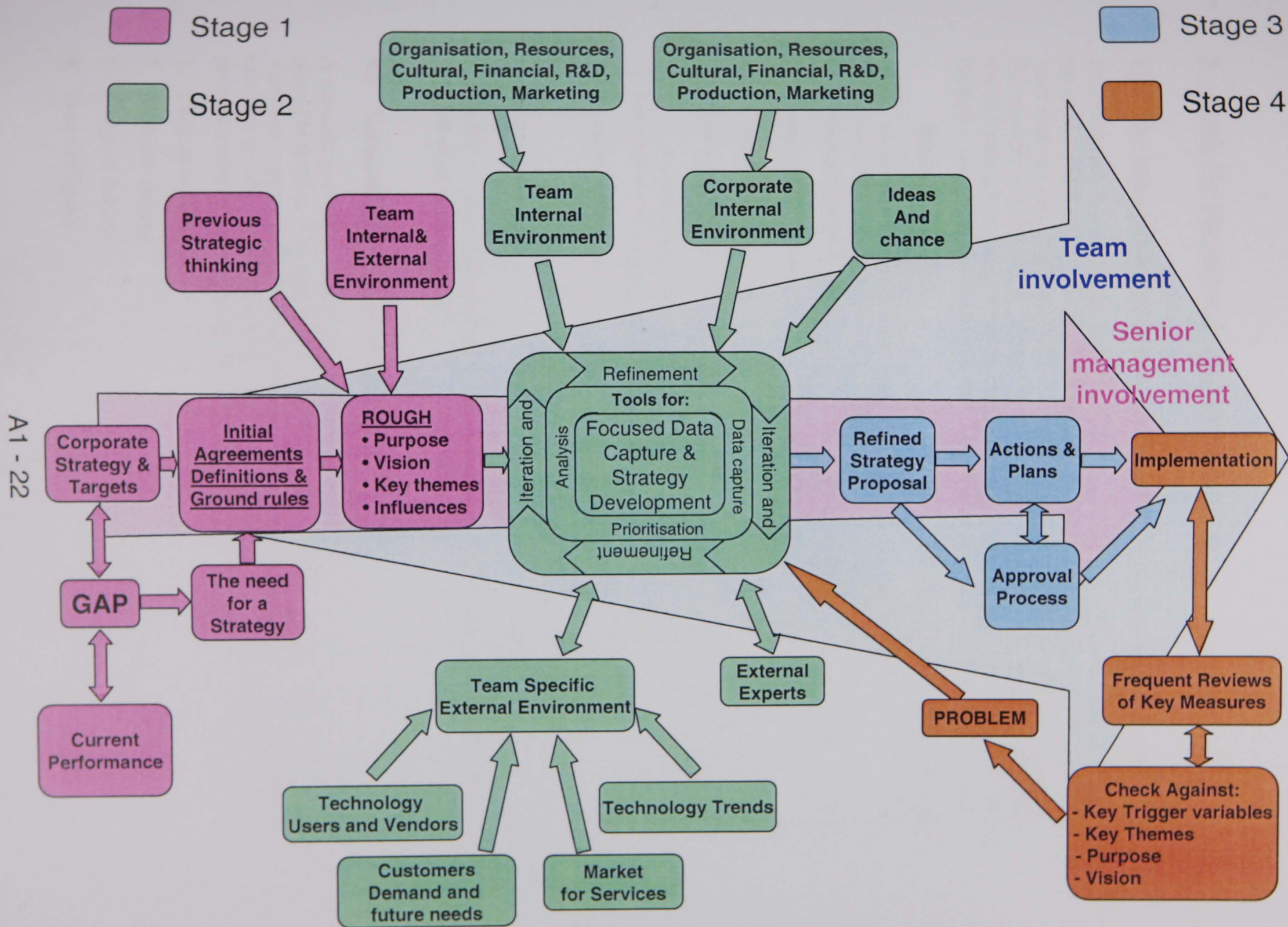
Figure 8. Showing the complete Strategy Development Process

9 Tools for the strategy creation framework

9.1 The linkage between Research Questions and Research Methods

The following 'association diagram' shows an example linkage between Research Questions and Research Methods (data gathering and analysis methods). There can be more than one data gathering/ analysis method associated with each research question. For example looking at the example table, information about the potential demand for Rapid Casting was sought through both the UK and German customer surveys as well as through a specific Rapid Casting survey and by looking at past output from the team.
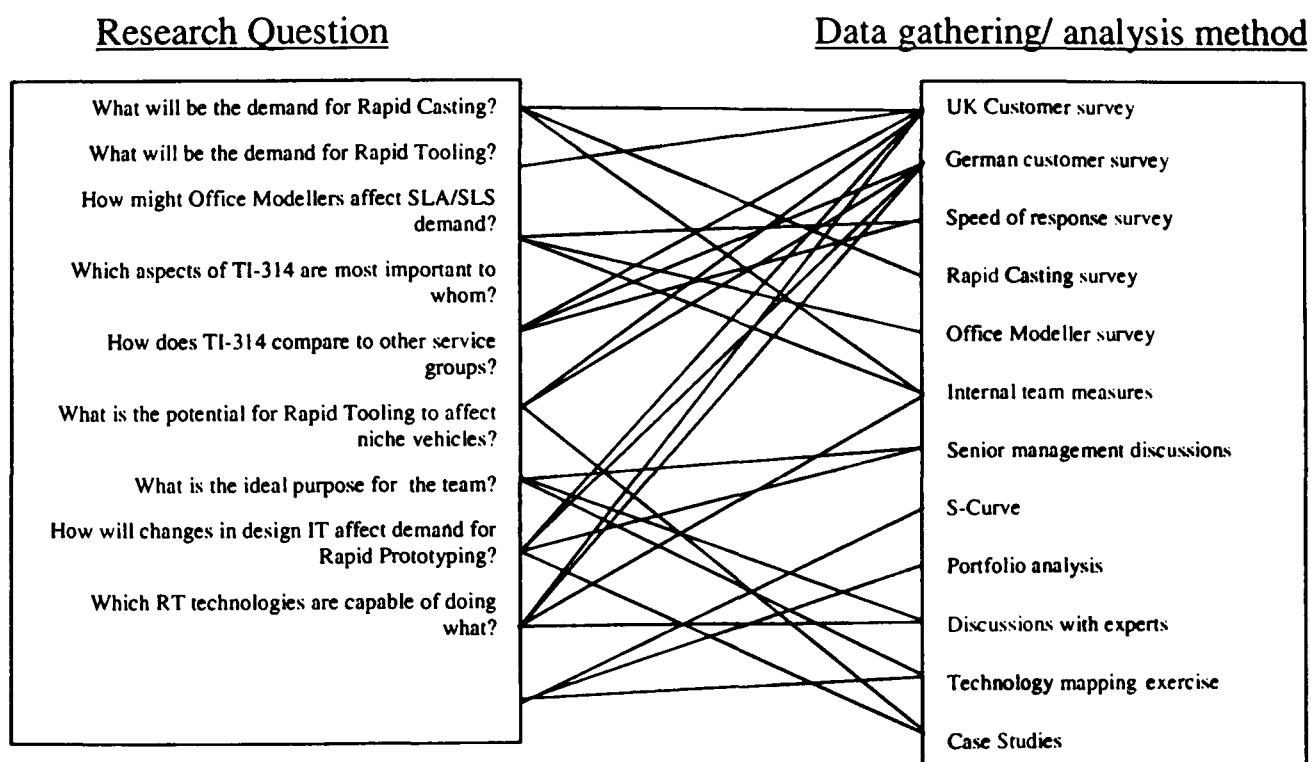

Research Question — Data gathering/ analysis method

Research Question box:
- What will be the demand for Rapid Casting?
- What will be the demand for Rapid Tooling?
- How might Office Modellers affect SLA/SLS demand?
- Which aspects of TI-314 are most important to whom?
- How does TI-314 compare to other service groups?
- What is the potential for Rapid Tooling to affect niche vehicles?
- What is the ideal purpose for the team?
- How will changes in design IT affect demand for Rapid Prototyping?
- Which RT technologies are capable of doing what?

Data gathering/ analysis method box:
- UK Customer survey
- German customer survey
- Speed of response survey
- Rapid Casting survey
- Office Modeller survey
- Internal team measures
- Senior management discussions
- S-Curve
- Portfolio analysis
- Discussions with experts
- Technology mapping exercise
- Case Studies

Figure 9 Demonstration of research questions linked to data gathering and analysis methods association diagram

9.2 Scenario planning (Courtney et al, 1997)

A scenario provides a contextual description of how the present will evolve into a set of plausible futures. The approach is considered more reasonable than attempting to predict what will happen in the future (Schnaars, 1987:105-114). Extensions of this approach take into account the context of the situation. For example, Courtney et al (1997), propose a strategy methodology based on four levels of uncertainty about the future:

1. Clear enough future

2. Alternate futures

3. Range of futures

4. True ambiguity

Within these four categories they suggest different approaches for devising strategies. Scenarios can be generated for levels two and three to help to determine likely outcomes and responses. In each case there are three types of move that can be used:

1. Big-bets (a significant gamble)

2. Options (allowing for a range of different possibilities)

3. No-regrets (the action will certainly pay-off whatever happens)

Courtney et al argue that although a changing environment may have a number of factors within it that appear to be unknowable, with the right analysis, many can in fact become known. Any remaining unknowns are referred to as the 'residual uncertainty' (69). The level of uncertainty then determines the scenario planning approach used.

9.3   Generic strategy themes

Options for reducing the impact of variable influences on the strategy:

1) **Neutralise the impact of variable influences.** It may be possible to find 'generic strategy themes' that neutralise the impact of one or more of the variable influences.

2) **Reduce the impact of variable influences.** If the rate of change of a variable can be roughly estimated and the way in which it is changing understood, then it may be possible to reduce the effect of that variable. It may also be possible to identify a generic strategy theme that can reduce the impact of the variable influence.

3) **Understand the effects that the influences can have and allow for them.** If the way in which the variable influence affects the strategy can be understood, then either strategic options can be created that reduce the impact of the variable influence or makes it possible to allow for it in some other way. The maximum likely ranges of the variables should also be understood so that the extents of possible effects can be determined more easily.

4) **Do more iteration.** If none of the above can be done, or if they do not have sufficient effect, then it may be necessary to increase the number and frequency of iterations performed during the strategy development. Additional iterations would focus on those influences that have most effect on the strategy outcomes and have changed the most between iterations. Performing more iteration has the disadvantage of needing more research and analysis and hence using more resource. If key influences have a low visibility, then increasing the number of iterations may not help towards strategy creation.

5) **Combinations of the above.** It may be appropriate to use some or all of the above options across the range of variable influences if required.

The following association diagram shows an example of the linkage between strategy influences and generic strategy themes.
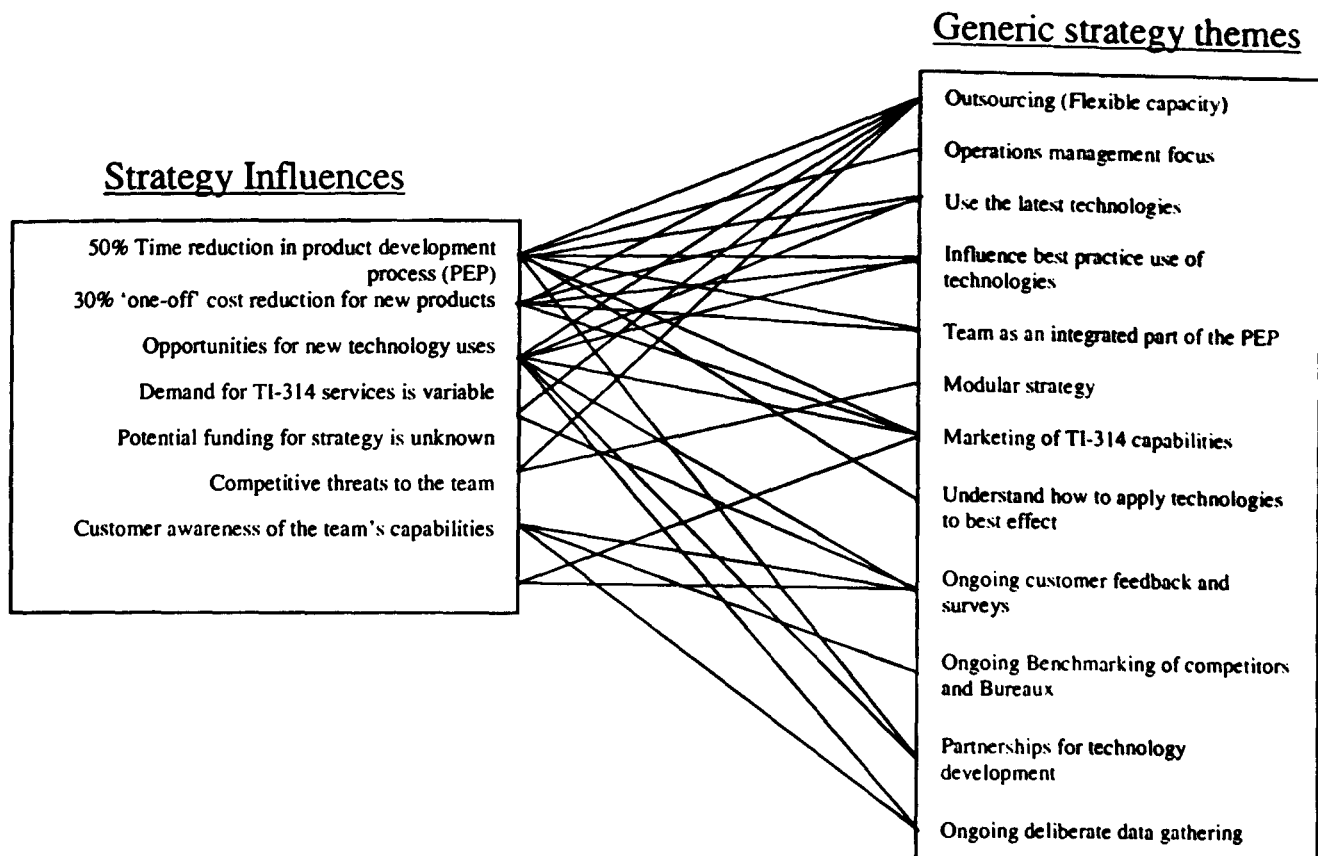
Generic strategy themes

Strategy Influences

50% Time reduction in product development process (PEP)
30% 'one-off' cost reduction for new products
Opportunities for new technology uses
Demand for TI-314 services is variable
Potential funding for strategy is unknown
Competitive threats to the team
Customer awareness of the team's capabilities

Outsourcing (Flexible capacity)
Operations management focus
Use the latest technologies
Influence best practice use of technologies
Team as an integrated part of the PEP
Modular strategy
Marketing of TI-314 capabilities
Understand how to apply technologies to best effect
Ongoing customer feedback and surveys
Ongoing Benchmarking of competitors and Bureaux
Partnerships for technology development
Ongoing deliberate data gathering

Figure 10. Showing an example of the linkages between Strategy influences and generic strategy themes.

9.4 The recommended methodology for carrying out surveys

The following process is an adaptation of the process proposed by A.N.Oppenheim (1992).

1. **Define the aims of the survey and the 'hypotheses' to be tested.** The aims must be clear and understandable.

2. **Look for previous work in the field** and **discuss the hypotheses with** appropriate and accessible **experts** in the field.

3. **Refine the hypotheses** and review the survey aims.

4. **Design the survey allowing for limitations** on time and resource. If the limitations may lead to the survey being invalid, then it should be abandoned at this point.

5. **Decide which of the hypotheses will be tested.** What measures will be used to test the hypotheses? The purpose of the survey is to end up in a position where the hypotheses can be clearly proven or disproved.

6. **Decide on the survey method to be used.** Interviews and questionnaires are the most common. There are many issues to understand before completing the design of the interview question set or running of the questionnaire. Oppenheim's book covers these issues very well.

7. **Piloting**. Running valid pilots of the questionnaire or interviews is essential to avoid major problems. This stage must <u>not</u> be missed out!

8. Make **changes and corrections** to the survey materials from the pilot runs.

9. **Design the sample for the survey** - who or what exactly is going to be surveyed? It can be very difficult and expensive to cover a whole population. Decide what the extent of the survey might be. Select a suitable population to ensure that the hypotheses are tested fairly and that the answers gained are valid. What will be the effects of the groups or people missing from the sample?

10. **Run the survey**. Make sure that the data collection is well organised and is kept up to date. Bear in mind who is going to collate the data and do the analysis.

11. **Processing the data**. Preparing the data for analysis.

12. **Analysing the data**. This may involve statistical analysis.

13. **Test the hypotheses** originally set up from the analysed results.

14. **Write the report.**

9.5   Business Strategy Concepts and Tools

The **BPEST** mnemonic (based on Cole, 1994:41) provides a useful checklist for External Environment analysis. The list is as follows:

- **Business**
  - State of the Industry
  - The market
  - Competitors
  - Suppliers
- **Political**
  - Legislation
  - Support for enterprise
  - Taxation
  - Political changes in other markets
- **Economic**
  - Interest rates
  - Employment levels
  - Inflation
  - Exchange rate
  - Shareholder confidence
  - Terms of trade
- **Social**
  - Skill levels
  - Population changes
  - Consumer confidence
  - Spending patterns

- **Technological**
  - Developments in:
    - IT
    - Industrial applications
  - Materials

A large part of the 'Business' aspect of the external environment can be gained through the market/competitor analysis models of Michael Porter. Porter (1980:4) takes the view that a business lies within a competitive environment that can be defined by the '5 forces' model shown in figure 11 below.
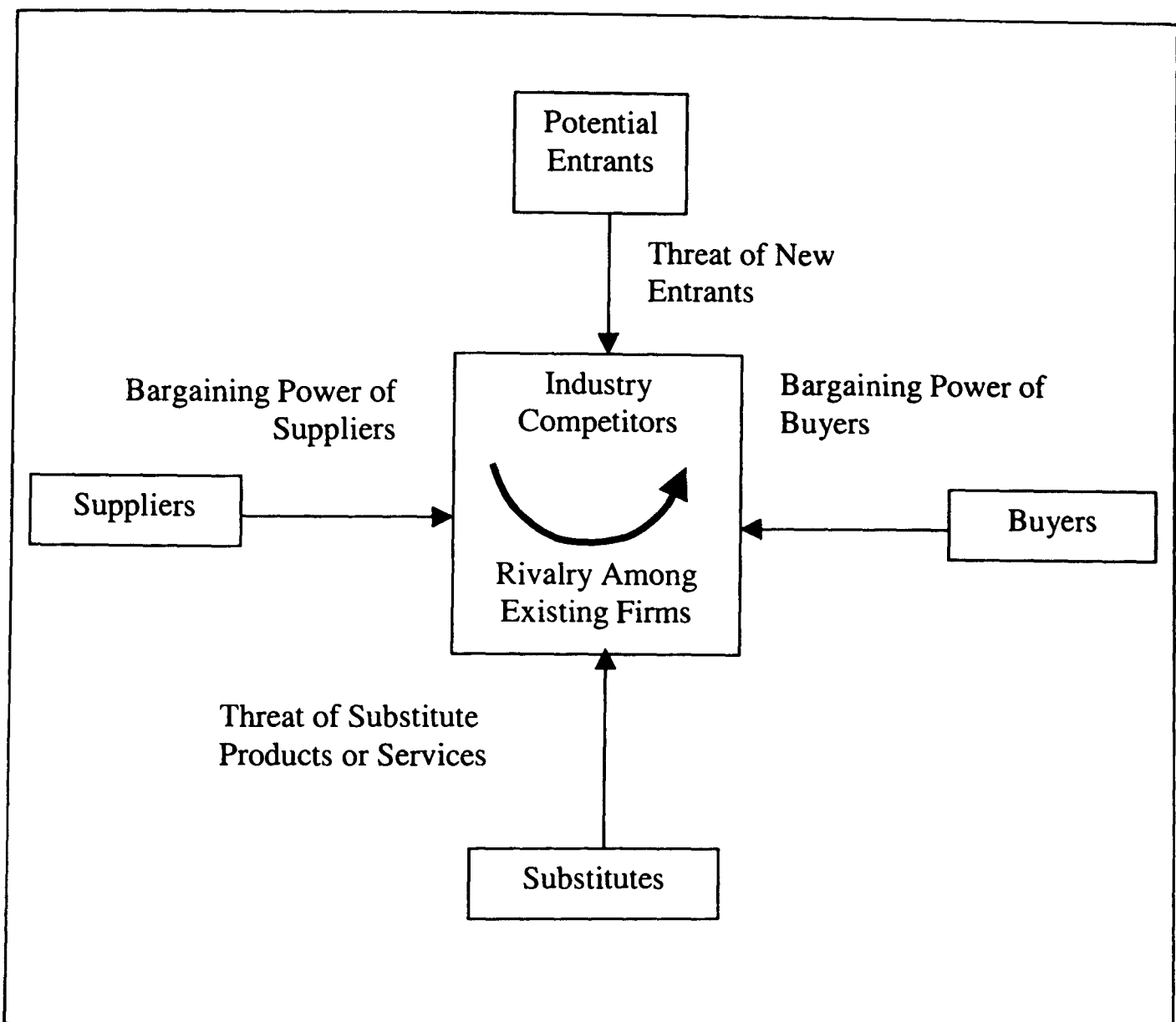
```
                    ┌─────────────┐
                    │  Potential  │
                    │  Entrants   │
                    └─────────────┘
                           │
                    Threat of New
                    Entrants
                           │
                           ▼
                    ┌─────────────┐
Bargaining Power of │  Industry   │  Bargaining Power of
Suppliers           │ Competitors │  Buyers
        ┌──────────┐│             │┌──────────┐
        │Suppliers │├──►   ⤾     │◄┤  Buyers  │
        └──────────┘│ Rivalry Among│└──────────┘
                    │Existing Firms│
                    └─────────────┘
                           ▲
    Threat of Substitute   │
    Products or Services    │
                    ┌─────────────┐
                    │ Substitutes │
                    └─────────────┘
```

Figure 11. Showing the Porter Five Competitive Forces model (Porter, 1980)

The five forces model is based on an 'outside-in' or 'positioning' approach to strategy. a firm shapes itself to compete within its business environment, responding to external developments. "...the key for developing strategy is to delve below the surface and analyse the sources of each." [of the forces]. The five forces are:

A1 - 27

- The entry of new competitors

- The threat of substitutes

- The bargaining power of buyers

- The bargaining power of suppliers

- The rivalry among the existing competitors

The Porter model may be useful when looking at the competitive environment for a service group within a large company. As with all the business-related strategy models, the Porter model should be used with caution because the internal circumstances may not match the model exactly. For example, if the internal service group has a monopoly over the services with the business, then the Porter model is unlikely to be applicable because it is based on the environment being competitive.

The **SWOT/TOWS** matrix can be used to identify some strategic options in a relatively short space of time. In the example shown below in figure 12, an internal technology service group, Rapid Prototyping and Tooling, have been assessed according to the Strengths, Weaknesses, Opportunities and Threats that relate to them. From these observations, a set of strategic options have been generated that align with the interplay of:

- Internal Strengths vs. External Opportunities

- Internal Weaknesses vs. External Opportunities

- Internal Strengths vs. External Threats

- Internal Weaknesses vs. External Threats

The resultant strategic themes can provide a basis for further strategic thinking. The risk with this approach is that the Strengths, Weaknesses, Opportunities and Threats are all subjective and so should only be used for general guidance.

Figure 12. SWOT/ TOWS analysis for Rapid Prototyping and Tooling

	Internal Strengths 1) RPT technologies knowledge 2) Integration into the business 3) Research relationship with WMG 4) Lamination expertise	Internal Weaknesses 1) Location (UK) 2) Funding for equipment and new technologies 3) Skills mix: more higher skilled people required 4) Commitment of team (UK) 5) Capacity restrictions
External Opportunities 1) Rapid Casting 2) Rapid Manufacturing technologies 3) Niche vehicles 4) IT /Internet developments	**S-O strategy** 1) Drive forward integration of Rapid Casting 2) Become leaders of Rapid Manufacturing development and integration within the company 3) Create new opportunities for niche vehicles through Rapid Manufacturing 4) Use IT tools to improve marketing and customer contact	**W-O strategy** 1) Use IT to overcome location weaknesses 2) Involve team members in strategy development 3) Focus on Rapid Casting and Rapid Manufacturing in the future
External Threats 1) Suppliers being increasingly responsible for prototype parts 2) Virtual reality 3) Service Bureaux prices and expansion	**S-T strategy** 1) Use integration into the business to 'leverage' the expertise and influence how company suppliers use RP&T technologies 2) Focus on being the RP&T technology experts for the company, integrating best practice 3) Combine lamination with other RP&T technologies to provide a unique service in the business	**W-T strategy** 1) Arrange to have control over outsourcing to service Bureaux 2) Look for new applications arising from the early CAD data produced through the virtual systems 3) Use external service Bureaux to provide services that cannot be brought in-house

One use of **Portfolio Analysis** is to compare specific attributes of a range of related technologies. The following diagram illustrates the relative cost and time characteristics of four different imaginary Rapid Tooling technologies A, B, C and D.
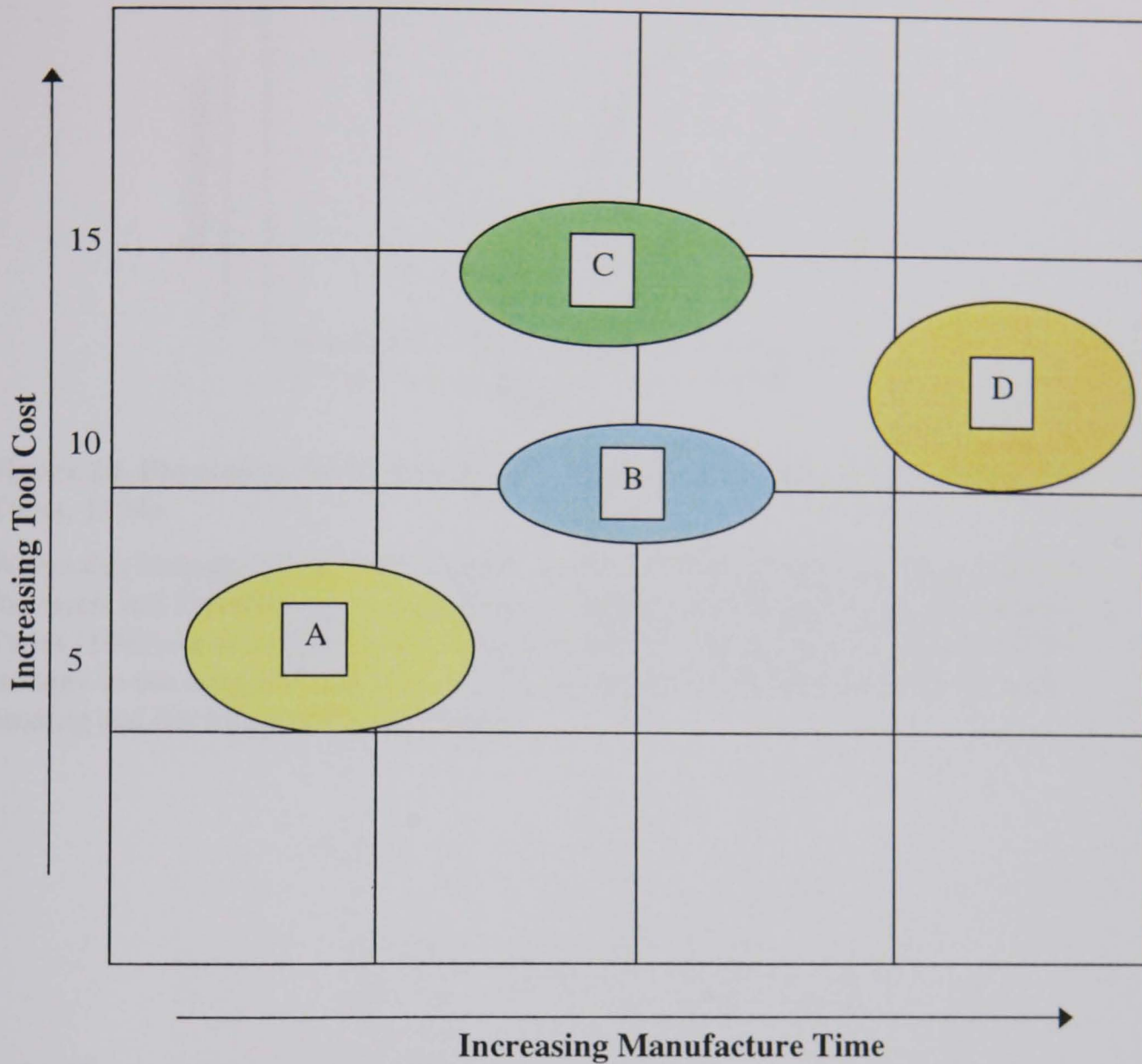

Figure 13. Showing an example of a portfolio matrix

In the example, technology C appears to have a cost disadvantage compared to technology B. If the two technologies are similar in every other way, then technology B might be a better choice than technology C. However, technology C may be able to produce more parts per tool than technology B, making technology C the better choice in some circumstances.

Portfolio analysis is a useful analysis and decision tool but the results of one matrix must not be taken in isolation. The matrices are most beneficial as part of a more comprehensive approach to decision-making.

The **technology development S-Curve** can be used to help provide some guidance about the possible future course of development of a technology based on its past performance development. The concept must be used with care though because the technology being studied may not follow the curve.
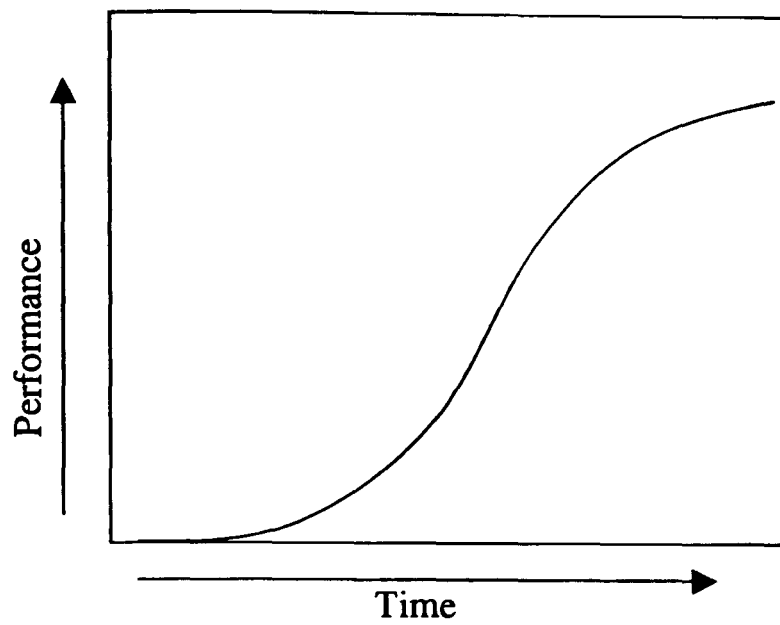
Figure 14. Illustrating the technology development lifecycle or S-Curve (based on Twiss, 1974).

Where the strategy relates more directly to the creation of a technology portfolio or Research and Development strategy, the technology decision process provided by Twiss (1992) as shown in Figure 15 may be useful. The process links technology strategy to the corporate strategy and also to appropriate limitations in resources, funding and the effects of other projects.
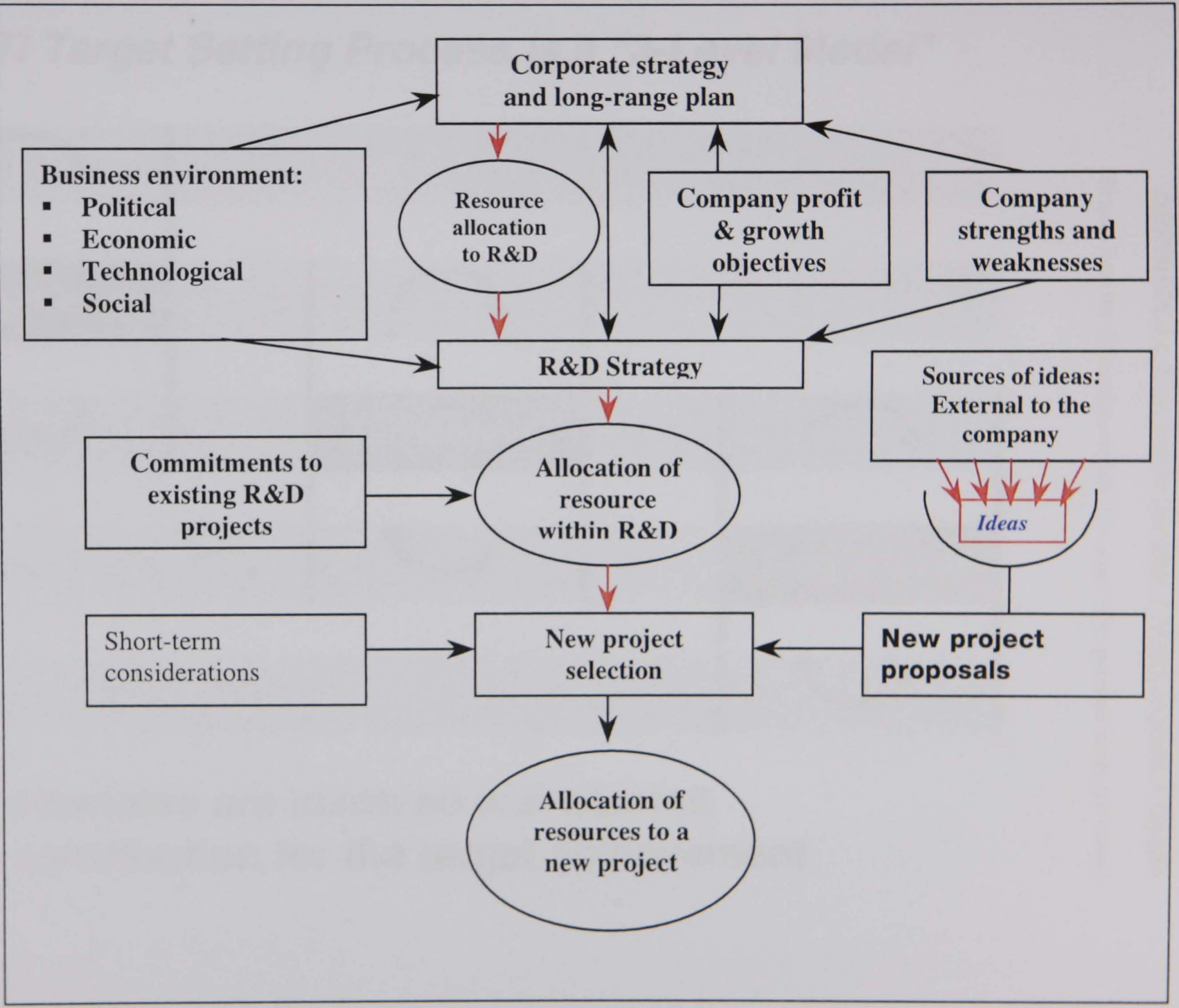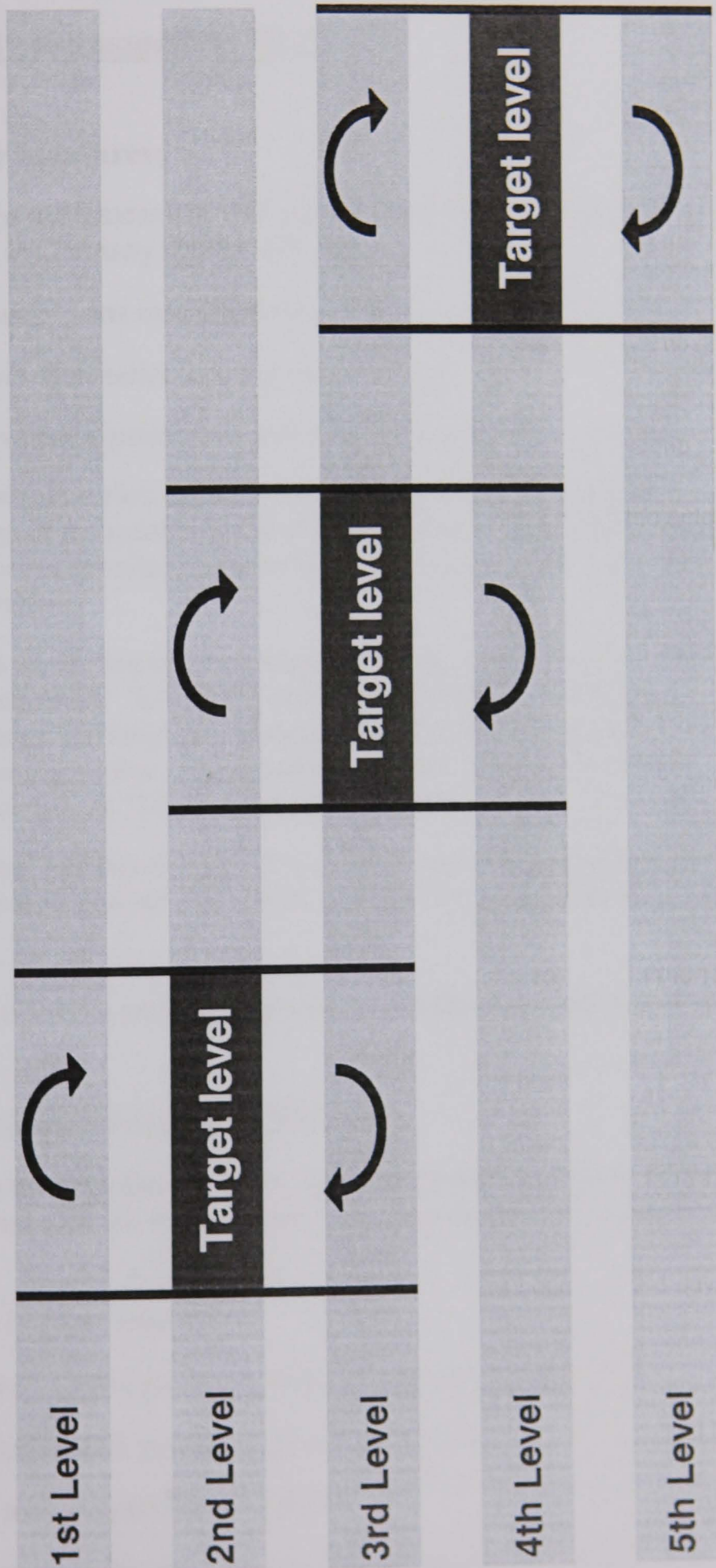
Figure 15. Showing the Technology decision process according to Twiss (1992) by courtesy S Windsor.

The diagram contains the following elements:

Corporate strategy and long-range plan

Business environment:
- Political
- Economic
- Technological
- Social

Resource allocation to R&D

Company profit & growth objectives

Company strengths and weaknesses

R&D Strategy

Sources of ideas: External to the company

Ideas

Commitments to existing R&D projects

Allocation of resource within R&D

Short-term considerations

New project selection

New project proposals

Allocation of resources to a new project

The TI Target Setting Process is a "3-Level Model"

1st Level

2nd Level — Target level

3rd Level — Target level

4th Level

5th Level — Target level

All Associates are involved and commit their contribution for the target achievement

Appendix 3 - Group Function financial analysis

Productivity assessment of TI-314

Productivity measures:

There are three main measures that were considered to calculate the productivity of the TI-314 teams in Germany and the UK:

- Number of parts manufactured per man

- Volume of material used per man per year

- Total value of parts generated per man per year

Since the Group Function exercise was a retrospective assessment, it was only possible to take advantage of the measures that were already in place. The number of parts produced had been recorded consistently by both teams for the previous 5 years and so this simple measure was viable.

Neither of the remaining two measures had consistent records and so they could not be used nor extrapolated. So that the performance of the two teams could be directly compared, one of the indirect proposals from the Group Function review was to develop a common costing system. The common costing system was included in the German team's 1999 corporate 'Target Setting' exercise.

The parts count was therefore used to compare the productivity of the two functions but the measure has its limitations, which are listed in the following section.

Measuring relative productivity between the UK and Germany

Challenges faced in measuring productivity

Although the total numbers of parts were closely monitored there were a number of differences that affected this measure. Between the two teams, there were differences in the:

- types of parts produced

- number of parts produced from a single geometry

- number of parts produced from a single tool

- sizes and complexities of parts

- equipment types and balance of technologies between SLA and SLS

- casting methods employed

- Stage of process and skill development of the two Polyurethane part (PU) moulding functions

The actual impact of these differences cannot be retrospectively estimated. However, it is possible that these differences may average out over the year.

Differences in the team roles

There were also some role differences between the UK and Germany. Most significantly, the UK team handled the customer interface work separately. Of the three-man Customer Group function in the UK, two worked full-time on RP and PU moulding related work.

All PU work is preceded by planning relating to the manufacture of RP parts. In the German team the customer interface work is carried out by the RP function. The productivity of the two RP functions has therefore been calculated by including the two Customer Group function members in the RP function numbers for relative productivity.

The following calculations aim to identify the relative productivity of the relevant parts of the two teams.

Calculations of productivity:

	UK/D	Total units made, 1998	Number of heads	Number of units per head	Difference relative to other function
RP parts	UK	5400	10	540	+0.75%
	D	2144	4	536	-0.75%
PU moulds	UK	520	8	65	-1.5%
	D	132	2	66	+1.5%

If the number of RP parts made and the number of PU moulds made by the two teams can be taken as a suitable measure of productivity, then they appear to have a similar productivity level. Taking into account the challenges identified in section 1.2 above, then the productivity differences between the two teams are probably well within the margins of error involved.

Although the process has significant imperfections, other options are not viable until additional measures are put in place. Consequently, the two teams can be assumed to have a similar level of productivity for RP part and PU mould manufacture.

Cash flow analysis

Aim of the cash flow analysis procedure

To identify the financial viability of option (b), section 3.4.4.2, 'replacement of the German RP + PU capacity by increasing the size of the UK operation'.

Assumptions

1) All costing information is based on data supplied by the Rover Group and BMW Group financial departments for 1998/9 and by TI-314 internal budget figures for the full year 1998.

2) Manpower costs include:

   ▪ Employee salary

   ▪ Direct employee accountable costs to the business i.e. those costs that would move with the employee

   ▪ Materials costs per employee are averaged over the year. Materials costs also include consumable items such as lasers as they depreciate on a pro-rata basis according to their use.

   The costs used in the calculations exclude overheads and fixed costs such as building rental and existing machine leases (which would move along with the machine to the other country and is therefore a constant) because these will remain the same after the personnel and equipment are transferred.

3) All relevant existing equipment in Germany would be transferred to the UK.

4) Productivity is approximately the same in the UK and Germany. However there could be an increase in productivity in this proposal due to economies of scale and increased flexibility. As a result of the better productivity, 6 German heads could potentially be replaced with 5 UK heads. In this case, the material costs would remain at the same level as for 6 German heads.

5) The relevant costs per employee have been calculated using the total number of people in the relevant elements. In the case of the UK team, the material costs per employee have consequently been calculated against 18 heads, which includes the 2 members of the Customer Group to make the calculation equivalent to the German team material cost calculation.

6) Net Present Value (NPV) and Internal Rate of Return (IRR) calculations will be used to assess the viability of the exercise on the same basis as a project. The BMW Group standards are an IRR of 26% and a discount rate of 8% to 10% for comparison purposes (both figures are based on standards used within BMW Group. These standards involve an in-depth knowledge of the way in which BMW Group is

financed and the risks attached to the market investments. Since this data is not available, the standard numbers will be accepted by the author. The discount rate is consistent within other market-based figures but the rate taken for the IRR is high compared to other businesses but it is consistent with the BMW Group policy and profitability).

7) In the period between late 1998 and mid-2000, the pound/ Deutschmark exchange rate varied approximately between 2.7DM and 3.2DM to one pound. These two exchange rates are therefore used in the calculations to ensure that the range of possible outcomes is covered.

Data used in the calculations

Employment costs in the UK and Germany

The salary-related data was supplied by BMW Group and Rover Group finance departments, based on average costs during 1999 for engineering employees in the UK and Germany. Materials and other direct Rapid Prototyping financial information is based on the figures for the whole of 1998 in the UK and Germany.

Employment costs for the UK team

Average cost per engineering employee per year including overheads	= £34,000
Excluding overheads	= £29,500
Materials and consumable items cost per employee	= £27,500
Total cost for each relevant employee including overheads	= £57,000 p.a.
Total cost for each relevant employee excluding overheads	= £51,152 p.a.

Overheads are excluded from the calculations because they remain at the original location, therefore allowing for errors at +/- 10% the range of **UK employee-related costs** used for the calculations are **in the range £46,936 to £57,367**.

Employment costs for the German team

Cost per employee per year including overheads	= 157,500DM
Excluding overheads	= 130,000DM
Materials and consumable items per employee	= 86,000DM
Total cost for each relevant employee including overheads	= 243,000DM p.a.
Total cost for each relevant employee excluding overheads	= 216,000DM p.a.

Allowing for DM variations between 2.7 and 3.2 to one pound and the error allowance of +/- 10%, the equivalent **German employee-related costs** in pounds lies **in the range £60,750 to £88,000.**

<u>Cost impact of increasing the size of the UK team</u>

Changes to the facility	= £400,000 (based on quotes in 1998)
Cost of lost output	= £320,000 (based on internal estimates Vs. equivalent outsource costs)
Equipment movements and purchases	= £100,000
Total	**= £820,000**

<u>Parameter ranges used for the calculations</u>

The aim is to identify the most likely case for the project to delete the German RP and PU elements and replace them by UK-based employees. If the most likely case fails, then no further calculations need to be made. If it is successful, then further calculations may be made if appropriate.

The most likely case to succeed as a project will be where the difference between the UK and German employment costs are greatest. Consequently the lowest UK salary will be subtracted from the highest German employment cost, producing the greatest difference:

The lowest UK employment cost is	£46,940 per employee
The highest German employee cost is	£88,000 per employee
The difference used in the calculations is therefore:	£41,060 per employee

Two cases have been calculated. The first assumes that 6 German employees are replaced by the same number of UK employees. The second case assumes that 6 German employees are replaced by 5 UK employees.

Calculation method

Two methods of calculation have been used, NPV and IRR. In both cases, the calculation has been carried out first with only the employment costs being considered. Secondly the calculations have been run including the opportunity costs, in this case, the loss of the opportunity to introduce Rapid Casting within the German design process.

Results from the calculations

Net Present Value calculations

All calculations are excluding overheads. Calculation run over a 10 year period.

	Action	**NPV at 26%**
Employee costs only	**6** German heads replaced **by 6 UK**	£52,000
	6 German heads replaced **by 5 UK**	£111,000
Allowing for lost opportunity of Rapid Casting introduction	**6** German heads replaced **by 6 UK**	(£641,000)
	6 German heads replaced **by 5 UK**	(£582,000)

Internal Rate of Return calculations

All calculations are excluding overheads. Calculation run over a 10 year period.

	Action	**IRR**
Employee costs only	**6** German heads replaced **by 6 UK**	37%
	6 German heads replaced **by 5 UK**	43%
Allowing for lost opportunity of Rapid Casting introduction	**6** German heads replaced **by 6 UK**	No value
	6 German heads replaced **by 5 UK**	No value

Cash flow calculation to compare the use of outsource vs. in-house RP capacity

If the German RP and PU teams were deleted and their equipment sold, the cash flow would be as follows:

Value of German equipment if sold in 1998	1.2m DM
Cost of outsourcing all output from RPZ	2.7m DM
Employment cost per year	1.3m DM

The result is a negative NPV at 26% over a ten year calculation period.

Appendix 4. Actions arising from the Group Function analysis stage

1) Assess whether the demand for prototype part provision can be satisfied by TI-314 more efficiently than through the existing supply routes or departments within the company where a TI-314 element does not currently exist.

2) Each team is to identify the circumstances, including the relative costs of alternatives, under which the sharing of skilled labour would apply in each direction and how such arrangements would be made.

3) Each team is to identify their core activities and compare the capabilities between the two groups. Where appropriate, temporary personnel exchanges should be used to reduce the imbalances and remove gaps as appropriate.

4) When one of the groups develops a new capability, the new knowledge must be transferred to the other team to bring them up to the same level where appropriate.

5) Benchmark equipment and facilities within each group and against external groups if possible, then identify the most suitable for the tasks being performed and set that as the standard for both groups. Create a plan to bring both groups up to the same standard.

6) When new equipment or technologies are identified, these should be tested by only one of the groups first. If the new technology is beneficial, then both groups should take up the new technology where appropriate.

7) Identify opportunities for common purchasing decision-making principles and negotiations. Identify opportunities for common maintenance agreements for similar equipment.

8) Each team must identify opportunities for common materials purchasing arrangements and negotiations, especially for specialist applications.

9) Identify all databases where common usage can produce a reduction in the total workload to generate them and/or the same total input can produce an improvement in the overall standard or functionality. Devise an action plan to gain maximum benefit from a practical combination of their content in each case.

10) Each group is to identify their main contacts and partnerships along with the role of that relationship. The two groups should then compare these lists and identify where mutual benefit can be gained by more than one group using the same relationship.

11) Each group and element is to identify the nature and content of each of the relevant activities shown in Table 6 and compare this with the other relevant elements. The comparison should include the inputs, outputs, processes used, principles of operation, decision processes used and any other content that appears relevant. Where there is scope for commonality an action plan should be generated to achieve it.

12) Those elements that do not have activities on the list in Table 6, should examine the list and identify any activities that would be of potential benefit and assess their potential for inclusion.

13) Where common activities exist, the relevant elements should identify the potential for sharing the work at all stages through the activity to take advantage of any economies of scale, both within the same country and between the UK and Germany.

14) Where variations in workload exist, each element must look at the potential for workload sharing between elements and countries. Where the result reduces the total cost or lead times, then action plans should be created to set up viable workload sharing operations.

15) Every TI-314 team activity should be assessed for the potential to have a direct or indirect impact on the time to supply prototype parts to customers. Where a potential improvement can be made to an activity, related activities should also be assessed to highlight any knock-on effects that may occur from any improvements or changes made.

Appendix 5. Descriptions of the RP&T Group Function activities

1. Customer Requirements capture

The first stage in every job that is undertaken by TI-314, is to fully understand the customer's requirements. The process may be carried out on the phone, by fax or in person.

2. Process selection

Once the customer's requirements have been fully understood, the team members in TI-314 must decide upon the best process or processes to use to meet the customer's requirements.

3. Workload planning and scheduling

During the early stages of taking a job on, the capacity and timing will have to be assessed to ensure that the job can be completed in the right timing to meet the customer's needs. If a job is accepted, it will be planned into the workload schedule.

4. Materials purchasing

Each of the manufacturing activities requires materials. Each element will order their own materials in most cases, however some of the work is shared across the whole group.

5. Quality standards

Each manufacturing activity requires standards to ensure consistent output. Most of the standards relate to the ISO 9001 requirements

6. Marketing

This is the generation of awareness of Rapid Prototyping & Tooling activities within the company and also to outside companies and suppliers. A range of different media and methods are used, ranging from answering simple questions and tours of the facilities, through to Newsletters and a group Webpage.

7. Long range workload planning

Each new vehicle programme goes through a protracted period of forward planning. During the planning period, groups such as TI-314 are invited to propose the workload levels that they expect for the programme and hence a budget figure for the work.

8. Consultancy to internal customers

For the more complex activities, such as Rapid Tooling, Rapid Casting and multi-part Rapid Prototyping, the customer will require in-depth advice and discussion to determine the possibilities for achieving their requirements.

9. Outsourcing

When a job cannot be carried out internally, it may be contracted out to external suppliers or service Bureaux for completion.

10. New technology data capture

A key part of the research activity is to capture information about potential technologies for the future. The new technology data capture is carried out by most of the key personnel within each team.

11. Photo library contribution

The photo library is used primarily for marketing purposes. A photo is taken when a job is being worked on or is finished using a digital camera and then added to the photo library database.

12. CAD data preparation

Every job carried out by TI-314 is based on CAD data. The data has to be checked and then converted into a special data file format called an "stl" or "Stereolithography file". The stl file is then used in preparing the parts for use on the Rapid Prototyping machines. CAD data preparation also has to be carried out before jobs can be CNC programmed.

13. Stl file verification

The "stl" file (as mentioned in 12 above) is the industry standard data file format. It is similar to the format used for finite element analysis, as it is composed entirely of computer generated triangles.

14. RP part set-up

The "stl" file is 'sliced' by computer software according to the requirements of the Rapid Prototyping team member. The part is the orientated before being sliced and then used to build the Rapid Prototype part.

15. Machine maintenance

Due to the expensive and complex nature of the equipment in TI-314, maintenance contracts are set up to maintain them.

16. CNC programming

Computer Numerical Controlled (CNC) machines are used during the manufacture of tooling and patterns for laminated panels. CNC programming is carried out by the Rapid Tooling team in the UK and the Lamination team in Germany.

17. Model finishing

Once a model has been built, it has to be worked on to bring it up to a standard of finish suitable to the task. In some cases, mainly for parts that have a high visual finish requirement, the model may require several hours of skilled work to achieve the desired finish.

18. Machine selection and purchase

The equipment used in TI-314 is expensive and complex. Due to the rapidly changing nature of the technologies used, the selection of equipment is very important. There is the potential to improve of the value of machine purchase deals by combining the activities of the UK and German teams.

19. Vacuum casting

Polyurethane (PU) parts are used in prototype vehicles for live functional tests. The parts are formed in a Silicone mould that is cast around a model pattern. Vacuum casting describes the casting process used in removing the air from the mould cavity and then casting the part by pouring the Polyurethane into it. Vacuum casting produces high quality parts that can have a wide range of properties.

20. RIM moulding

Resin Injection Moulding (RIM) is very similar in most respects to vacuum casting described above. The main difference is that the Polyurethane is forced into the mould cavity, expelling the air. A smaller range of properties can be achieved from RIM moulding materials than by vacuum casting.

21. Tool design

Every part on a vehicle is made from a tool. Tool design is carried out in TI-314 using the intended part CAD data.

22. Silicone mould manufacture

The vacuum casting and RIM processes use silicone moulds to manufacture the final components.

Appendix 6 - Procedure for all Surveys

The overall process that will be followed for all TI-314 surveys is shown below. It is an adaptation of the process shown in A.N.Oppenheim (1992).

1. **Define the aims of the survey and the 'hypotheses' to be tested.** The aims must be clear and understandable.

2. **Look for previous work in the field** and **discuss the hypotheses with** appropriate and accessible **experts** in the field.

3. **Refine the hypotheses** and review the survey aims.

4. **Design the survey allowing for limitations** on time and resource. If the limitations may lead to the survey being invalid, then it should be abandoned at this point.

5. **Decide which of the hypotheses will be tested.** What measures will be used to test the hypotheses? The purpose of the survey is to end up in a position where the hypotheses can be clearly proven or disproved.

6. **Decide on the survey method to be used.** Interviews and questionnaires are the most common. There are many issues to understand before completing the design of the interview question set or running of the questionnaire. Oppenheim's book covers these issues very well.

7. **Piloting.** Running valid pilots of the questionnaire or interviews is essential to avoid major problems. This stage must not be missed out!

8. Make **changes and corrections** to the survey materials from the pilot runs.

9. **Design the sample for the survey** - who or what exactly is going to be surveyed? It can be very difficult and expensive to cover a whole population. Decide what the extent of the survey might be. Select a suitable population to ensure that the hypotheses are tested fairly and that the answers gained are valid. What will be the effects of the groups or people missing from the sample?

10. **Run the survey.** Make sure that the data collection is well organised and is kept up to date. Bear in mind who is going to collate the data and do the analysis.

11. **Processing the data.** Preparing the data for analysis.

12. **Analysing the data.** This may involve statistical analysis.

13. **Test the hypotheses** originally set up from the analysed results.

14. **Write the report.**

Appendix 7 - BMW/ Rover Rapid Prototype Survey

1 | Name:

2 | Job title:

3 | Project Team:

CoC:

4 How many people are employed in your area:

| < 10 | 11 to 15 | 16 to 20 | > 20 |

5 | What type of parts are designed by your department:

6 On average how many RP models are
are ordered by your department per month:

| <10 | 11 to 15 | 16 to 20 | > 20 |

7 How many RP parts do you request per month from the following sources:

a) BMW/Rover

| <10 | 11 to 15 | 16 to 20 | > 20 |

b) External suppliers

| <10 | 11 to 15 | 16 to 20 | > 20 |

8 Typical use of RP models requested by your department:

| visual | functional | technical | |

9 Would you please rank the following attributes
into your order of preference:

Delivery time of model	
Model surface finish	
Model dimensional accuracy	

10 Would you use the following catagories to expand upon the properties that you would expect from
a RP model ordered by your department:

Physical strength

Dimensional accuracy

Surface finish

Resistance to environmental conditions

11 Does the time taken to deliver RP models slow down
your departments design process?

| yes | | no | |

12 What time span would you require for model delivery?

4 hours		<1 week	
1 day		>1 week	
2 days		<2 weeks	
>2 days		>2 weeks	

13 Approximately how many RP models do you request for visual purposes per month?

< 10		11 to 15		16 to 20		> 20	

14 Have you previously heard of either:

         a) The Z-Corps process

yes		no	

         b) Actua (Thermojet) process

yes		no	

15 Would the model size limit of 10" x 8" x 8" for a Z-Corp or Actua build limit your use of these processes?

yes		no	

16 Would you accept a Z-Corp model that was built in sections and bonded together?

yes		no	

17 Would you consider replacing SLA and SLS models with Z-Corp and Actua models?

yes		no	

18 Under what circumstances would you replace SLS and SLA with Z-Corp and Actua?

19 Approximately what proportion of SLA or SLS models would you replace with Z-Corp models?

25%		50%		75%		#	

20 Approximately what proportion of SLA or SLS models would you replace with Actua models?

25%		50%		75%		#	

21 Approximately how many Z-Corp models would you require per month?

<10		11 to 15		16 to 20		> 20	

22 How long would you be prepared to wait for a Z-Corp model?

4 hours		1 day		2 days		> 2 days	

23 Approximately how many Actua models would you require per month?

<10		11 to 15		16 to 20		> 20	

24 How long would you be prepared to wait for a Actua model?

4 hours		1 day		2 days		> 2 days	

Thank you for your assistance with this survey.

Ivor Davies, WMG, March 2000