# EVALUATION OF METHODS LINKING INNOVATION MANAGEMENT TO PRODUCT STRATEGY AT THE ROBERT BOSCH ENGINE-CONTROL-UNIT DEVELOPMENT PRODUCT UNIT

A Master's Thesis submitted for the degree of
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# PREFACE

“The best way to predict the future is to invent it.”
***Allan Kay***

These words originate from Alan Kay, who is one of the earliest pioneers of object-oriented programming. I have to agree on his statement but is predicting the future by creating inventions really as simple as it sounds? And, furthermore, do ideas or inventions already create value?

The answer is “no” because there is no end to new ideas in the world, but only as soon as they create customer value, they can be considered as an innovation.

The following paper deals with possible methods by which innovations can be managed. It is evident that continuous innovations are the key to a firm’s success. Nevertheless in order to guarantee success in the long run, innovations need to act in accordance with a firm’s strategic position, which provides the framework for an innovation strategy and consequently are also the basis for individuals / departments who aim to develop innovations. In contrast, the company’s environment affects the strategic position of the organization, this results in a loop – of strategic position, innovation strategy and innovations. But how do inventions or ideas actually emerge?

Often, it is the application of existing knowledge in a different manner that results in an innovative idea. Sometimes also one idea gives birth to the next and new technologies, processes and methods come into being.

This paper shows different methods from the literature which make it possible to spot new ideas. It is investigated how methods from the field of strategic innovation management as well as methods for product and service planning can be applied in an R&D department of the automotive supplier industry. The study tries to analyze to which extent the introduced methods can be supportive for the engineer’s daily business. It elaborates how innovation emerges and how the engineer’s creativity can be aligned with the corporate strategy.

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| | |
|---|---|
| B2B | Business to Business |
| BU | Business unit |
| C/AI | Central department for automotive integration |
| C/BES | Central department for Bosch Engineering Systems |
| C/CS | Central Corporate Strategies |
| C/CTI | Coordination Technology and Innovation |
| CE | Customer Engineering |
| CEO | Chief Executive Officer |
| C/HDP | Central Department for Human and Organizational Development |
| CIP | Coordination, Innovation and Process Efficiency |
| CPS | Corporate Planning Session |
| CR | Central research |
| DCU | Dosing Control Unit |
| DGS-EC | Diesel Gasoline Systems - Electronic Controls |
| DGS | Short form for DGS-EC |
| DS/ERC | Diesel System/Engineering Research and Development |
| DS | Diesel Systems |
| ECU | Electronic Control Unit |
| EPQ | Engineering Processes and Quality |
| GmbH | Gesellschaft mit beschränkter Haftung → German term for LLC (Limited Liability Company) |
| GS | Gasoline Systems |
| G2/PJ-BES | Bosch Engineering Systems |
| ICV | Internal Corporate Venturing |
| IG0 | Innovation Gate 0 |
| IG3 | Innovation Gate 3 |
| ISAA | Identify, Search, Analyze, Assemble |
| KPI | Key Performance Indicator |
| MKT | Marketing |
| MRD | Market Requirements Document |
| MWG | Minimum Winning Game |
| NE2 | Software and System Engineering |

| | |
|---|---|
| NPD | New Product Development |
| OEM | Original Equipment Manufacturer |
| PC | Passenger car |
| PDS | Product Development Strategy |
| PLBP | Product Line Business Planning |
| PU | Product Unit |
| QFD | Quality Function Deployment |
| R&D | Research and Development |
| ROI | Return on Investment |
| SLRP | Strategic Long Range Planning |
| SWOT | Strengths, Weaknesses, Opportunities, Threats → Strategic planning method for analyzing an organization and its environment |
| TR | Technical Review |
| USP | Unique Selling Proposition |
| VCU | Vehicle Control Unit |
| VP | Vice President |
| WIPL | Wirtschaftsplanung (English term: budget planning) |

# 1 Introduction

The product unit Diesel Gasoline Systems - Electronic Controls (DGS-EC) develops and manufactures power train control units in international collaboration and offers services for diesel and gasoline engines as well as for alternative power drives. DGS-EC, which currently employs approximately 5000 people, was founded in 2008 by merging the former engine control unit departments of the Robert Bosch business units (BU) Diesel Systems (DS) and Gasoline Systems (GS). The aim of the merger is to raise the synergies of the former almost independent engine control unit departments. In the long run the unification shall be applied for all vehicle control units offered by Bosch.

For a unified ECU solution a merger of development tools, methods and processes is mandatory. Consequently those tasks have been pursued by the DGS-EC process and tool departments in 2008 and 2009. In order to improve the long term product planning and for sustainable growth, an innovation process aligned to the department strategy shall be implemented. The proposed strategic innovation process shall cover product planning and succession management at the one hand and also give a framework to bottom up innovation activities at the other hand.

## 1.1 Problems and Aims of the Master Thesis

The aim of this thesis is to support the definition of a new strategic innovation process within Bosch's newly created product unit for engine control units. The thesis focuses on the early stage of the innovation process, namely the strategic planning and product planning stage. The author of the thesis, who is himself an employee of above mentioned product unit, was instructed to bring in insights from research and knowledge acquired during the course of his postgraduate studies.

The origin of the defined problem resulted from a SWOT analysis carried out by innovation representatives of various DGS-EC departments in February 2010. The analysis was intended to reveal the situation for the DGS-EC innovation management and the consequent action points. The detailed SWOT can be seen in Appendix 1. The following defined weaknesses are addressed during the course of the thesis. From the wide range of weaknesses the thesis addresses the following ones:

- What do we mean by innovation? Perceptions of employees about the term innovation are different
- Missing market-, product-, technology-, and innovation strategy
- Very few cost saving innovations

- Hit rate of successful innovations generated via idea portal is too low

Beyond the defined weaknesses, the actual situation regarding bottom up innovation activities have been evaluated by innovation representatives of various DGS-EC departments in a follow-up meeting on March 10th, 2010 (see Appendix 2). The outcome of the meeting showed that the employees are very unsatisfied with the company's environment for bottom up innovations. Although there are a lot of examples for successful bottom up innovations the necessary support from the organization is not always given as well as clear guidelines how to raise the necessary resources for the predevelopment activities do not exist. Especially when complementary assets, like expertise, tools or engineering support from outside departments are required, the constraints of this bottom up approach become visible. One engineer calls it the "submarine approach", the upper management is not informed about the specific innovation activities until successful results can be presented.

In order to overcome the mentioned shortcomings the following approach is proposed within the DGS-EC department:

1.) Improve top down innovation activities. With a well managed top down managed product development process the developed products will better meet customer expectations. This will reduce the necessary bottom up innovation rework.

2.) Provide the necessary resources for bottom up innovation activities. Due to the superior top down innovation process, the effort for the remaining bottom up innovation activities will be reduced. As a matter of fact a greater share of the provided resources can be allocated to the remaining bottom up activities which results in a better environment conditions.

3.) Link the bottom up innovation activities to strategic innovation and top down managed product planning process by defining search fields which frame the bottom up ideas. These should be aligned to the top down managed product development process.

## 1.2 Research questions

From the above mentioned points the following research questions can be derived:

- How to improve the product and service planning process at DGS? Which methods do exist for improving product and service planning?

- Which methods do exist for identifying search fields?

- How suitable are the chosen methods for product and service planning at DGS-EC and to which extent is it possible to control the product and service development by well managed top down innovation processes?

## 1.3 Structure of the thesis

This thesis is divided into 5 chapters. Subsequent to the first introductory chapter, chapter two deals with the principles of Strategic Innovation Management, as to be found in the literature:

First of all a definition of the terms innovation and invention, which are sometimes mixed up or misleadingly used, are given and the innovation process with all the different stages is explained. Subsequently the findings of Dietmar Vahs and Ralf Burmester regarding strategic innovation management and its stages (strategic exploration, strategic planning and strategic control) are reflected in more detail. For the strategic positioning different topologies are elaborated in a first step. Michael Porter for example identified two competences that he considered as most important: cost leadership versus product differentiation. Depending on the size and composition of the market which is intended to enter either cost leadership or differentiation might be the appropriate positioning strategy. Another approach for positioning was defined by Raymond Miles and Charles Snow. They developed a framework that addresses different ways in which organizations approach their product-market domains and develop processes and strategies for achieving competitive advantage in those domains. The different approaches depend on the speed with which organizations respond to changing market conditions.

For strategic positioning the approach of Constantinos Markides is explained, who emphasizes the consequent questioning and screening of one's own business (strategy) and environment. According to Constantinos Markides strategic positioning takes place across the three dimensions: Who, What and How. James Utterback demonstrates how efforts on product and process innovation correlate with industry life cycles. According to Dietmar Vahs and Ralf Burmester a strategic lever exists depending on the split of efforts on product innovation and process innovation.

Subsequently chapter two deals with the question how innovation occurs in a company. Antonio Davila classifies the different types of innovation according to the dimensions source of innovation and impact on strategy. There are different sources of innovation. Either the idea emerges from the management (top-down approach) or the idea comes from individuals or groups within the organization (bottom-up). With regard to the impact on the strategy it needs to be distinguished between incremental innovation (current business model) or

radical (new business model). The combination of those characteristics results in four types of innovation and control.

More information regarding the different types and descriptions of the distinct processes and controls are provided by Robert Burgelman, Rudolph Koch and Karl-Heinz Leitner.

Oliver Gassman, Javier Peres-Freije and Ellen Enkel follow the question how the dominance of management control systems influence resource efficiency and creativity.

Finally Dietmar Vahs and Ralf Burmester give insights on how search fields align bottom up innovation activities to strategic planning.

In chapter three concrete methods are described which can be applied for strategic innovation management and product/service planning at DGS. Special focus is applied to the question how search fields can be derived from the described methods. Most of the methods have been introduced in the course of the MBA program. Additional inputs are provided by Robert Cooper, Dietmar Vahs and Ralf Burmester.

Chapter four concentrates on the empirical evaluation of the applicability of the described methods for DGS. The described methods have been presented to the innovation representatives of various departments. The innovation representatives' feedback provided the necessary input for the evaluation and the recommendation (see chapter five).

# 2 Principles of Strategic Innovation Management

## 2.1 Innovation vs. Invention

**Invention** means solving technical problems. An invention often extends the boundaries of human thinking, hence, an invention is either accomplishing a known goal with new means or an unknown goal by known means or an unknown goal by unknown means.

**Innovation** is the conversion of ideas or inventions into new products, services or processes which can be successfully applied to the market.

From a business perspective invention is the conversion of cash into ideas. Innovation is the conversion of ideas into cash.

## 2.2 The Innovation Process

As illustrated in Figure 1 the innovation process starts with the idea generation or an invention. It needs to be stressed that an invention is only one part of the whole innovation process. An invention or an idea will consequently be evaluated, after successful evaluation it will be further on developed and tested. If the tested invention meets all customer expectations it will be realized, launched and distributed to all target groups[1].

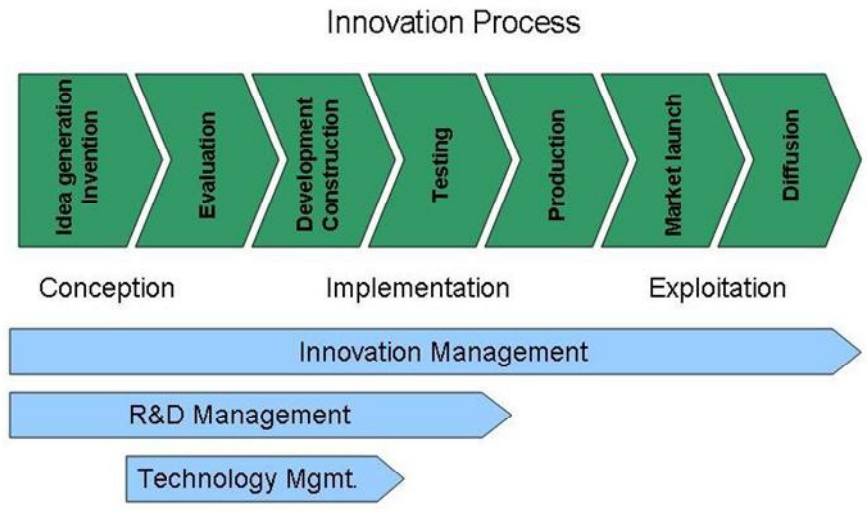



Figure 1: The Innovation Process [2]

The whole process from idea generation to diffusion needs to be well managed (=innovation management). The R&D management starts at idea generation and ends with the testing of

[1] Comp. Vahs D., Burmester R. (2005), p. 43

[2] Comp. Vahs D., Burmester R. (2005), p. 43

the idea / invention, whereas the technology management covers only the stages "Evaluation" and "Development / Construction".

## 2.3 Strategic Innovation Management

Strategic innovation management can be defined as a leadership discipline to strengthen creativity and innovation concerning future business opportunities[3]. In addition to the innovation management as illustrated in Figure 1, strategic innovation management also covers the field of strategic business planning.

In the literature different nevertheless similar structuring for strategic innovation management can be found. According to Vahs and Burmester strategic innovation management can be divided into the stages strategic exploration, strategic planning and strategic control[4]. Gruber has classified the field of strategic innovation into the areas corporate foresight, crafting an innovation strategy and developing and strengthening a firm's innovative capabilities[5]. Based on these inputs this master thesis is structured in the following way:

- Identification of the future industry environment - Corporate foresight
- Selection of a business strategy - Corporate planning
- Developing and strengthening a firm's innovative capabilities

In the following chapters those fields are elaborated in more detail.

### 2.3.1 Identification of the Future Industry Environment - Corporate Foresight

Gruber proposes to start strategic innovation management with corporate foresight. In the short term the deviation between the existing products and services and the actual customer demands may provide sufficient insights for innovation planning. For a long term strategic planning, a forecast of the future environment conditions is necessary in addition. Recognition of long term future business opportunities demands corporate foresight. Based on the outcome of corporate foresight it can be derived how the industry will change, if and how the value chains have to be adapted and if it is necessary to change the business concepts. A classification of foresight methods can be done according to Daheim[6] who differentiates between four paradigms:

[3] Gruber M. (2009), p. 11

[4] Comp. Vahs D., Burmester R. (2005), p.120

[5] Gruber M. (2009), p. 11

[6] Daheim (2008), p. 14

**Expert-based Foresight:** The future can be forecasted by collecting and comparing the opinions of (numerous) experts.

**Model-based Foresight**: The future can be calculated by appropriate computer models based on vast amounts of data and mathematical finesse.

**Trend-based Foresight:** Businesses can understand the future by anticipating the impact of trends on customers and markets.

**Context-based („Open") Foresight:** Businesses can shape future contexts and markets by anticipating the dynamic interaction between social, technical & economic forces.

According to Daheim the described paradigms have changed over the past decades. In the early 1960's, expert-based foresight methods were the first choice of most companies. In the 1970's, model-based and trend-based methods evolved and currently a shift to context-based foresight methods takes place. For the latter group the scenario analysis is a typical representative. The Delphi analysis, for example, is an expert-based method. The Extropolation – Retropolation approach is a combination of a trend analysis and a scenario analysis.

### 2.3.2 Selection of a Business Strategy - Corporate Planning

Based on the opportunities and threats identified at the process step "corporate foresight" the business strategy must be defined. Therefore two questions need to be answered:

- Which strategies are available for choosing (strategy topology)?
- How to select the appropriate strategy for my business (strategic positioning)?

In the literature the collection of different strategy types is called strategy topology. Thus this section is structured in strategy topologies and strategic positioning.

#### 2.3.2.1 Strategy Topologies

In the literature various strategy topologies exist. The most famous example is Porter's strategy topology. Miles and Snow classify strategies according to the speed that organizations respond to changing market and external conditions by altering its products and markets[7]. In the following sections those two strategy topologies are described in more detail.

[7] Comp. Miles R. E., Snow C.C. (1978), p. 361 ff

#### 2.3.2.1.1 Strategy Topology of Porter

Porter differentiates across the dimensions “Strategic target” and “Strategic advantage”. According to the dimension “strategic target” a company should choose between offering their products and services industry wide or selecting a particular segment only. The dimension “strategic advantage” is structured according to the types “Uniqueness perceived by the customer” and “Low cost position”. Based on those dimensions Porter derives the three commonly known strategy types: differentiation, overall cost leadership and focus. According to Porter the most profitable companies are those which position themselves exactly in one of those three strategy types[8].

#### 2.3.2.1.2 Strategy Topology of Miles and Snow

According to Miles and Snow four strategy types exist: the prospectors, the analyzers, the defenders and the reactors. **Prospectors** are the industry innovators. They are “first in” with new products and are the first ones who adopt new technologies. **Analyzers** are the fast followers. They carefully monitor the actions of the major competitors and react afterwards quickly in order to introduce superior (and often similar) products to the market. **Defenders** attempt to locate and maintain a secure position in a relative stable product or market area. Finally **Reactors** do only respond on strong external or market pressure.

Cooper continues the topology of Miles and Snow and mentions four strategic thrusts that impact performance and, hence, should be considered if a business intends to develop a new product strategy. Those four thrusts are the following ones:

- Technologically sophisticated: Characteristics of this thrust are the high-technology and R&D orientation. As a result technically complex new products are developed; new development technologies are proactively acquired; product ideas are proactively generated; innovative, venturesome products that offer unique features to customers are developed.

- Market oriented and market driven: Such businesses are strongly market orientated. They are proactive in market need identification and new product ideas are primarily market-derived.

- A focused new product effort: Such businesses develop new products which are closely related to each other. The products are generated by related development processes, tools and methods and related production methods. They are aimed at closely related markets, and the new products are closely tied to each other.

[8] Gruber, M. 2009, p. 21

- An offensive orientation: Such businesses are oriented for growth and gaining market shares. Active search efforts for new product ideas and proactive market-need identification are further characteristics.

Depending on the occurrence of those four thrusts in a corporation, Cooper has empirically found five classes of strategies that businesses elect for their product strategies. Ranked according to the achieved performance these five strategy types are described as follows:

- The differentiated strategy: These businesses boast a technologically sophisticated and aggressive effort, a high degree of product fit and focus, and a strong market orientation. They target attractive high growth, high potential markets where competition is weaker. Resulting new products are premium priced and feature a strong differentiation and competitive advantage. Their products meet customer needs better than competitive products. (Performance) Indicators for this strategy are the highest percentage of sales by new products, the highest success rate at launch and, hence, higher profits.

- The low-budget conservative strategy: This strategy is comparable to Porter's strategy of cost leadership. It is characterized by low R&D spending, development of copycats and undifferentiated products, focused and highly synergistic new product efforts, and new products that match the business's production and technological skills and resources, fit into the business's existing product line and are aimed at familiar and existing markets. Indicators for this strategy are high success and low failure and kill rates for new products. The percentage of new products is low and new products have low impact on the company's sales and profits.

- The technology push strategy: Businesses following this strategy apply a technologically driven approach with regard to product innovation. Their products are technologically sophisticated and innovative. Problematic for this type of strategy is that the new product efforts often lack a strong market orientation, and there is little fit, synergy, or focus on the types of products and markets exploited. Hence, it is not surprising that this type of business leads to mediocre performance results and profits are lower than for the first two strategies.

The remaining two identified strategies are not worthwhile since they are the worst performers. Those strategies are called the "not-in-the-game strategy" and the "high-budget diverse strategy". They lack on almost all thrusts described above. According to Cooper the

key for a successful strategy is the right balance between technological sophistication and aggressiveness, and a strong market orientation[9].

### 2.3.2.2 Strategic Positioning

This chapter covers - from the authors working experience - the most interesting principles for strategic positioning as it can be applied for a product unit like DGS. Initially, the principle of the market based view and the resource based view will be elaborated. Subsequently the terms product innovation and process innovation will be explained and how the effort split between the two types act as strategic lever. Finally the strategic positioning approach by Markides is introduced which explains how a positioning in a market can be carried out.

#### 2.3.2.2.1 The Market Based View and the Resource Based View

This section explains the two most important perspectives from which strategic positioning has to be carried out: the market based view or outside-in perspective and the resource based view or the inside-out perspective. The market based view addresses two questions:

- How attractive is the industry we are currently in or we propose to enter?
- How can we position ourselves within the industry in order to achieve competitive advantage?

The resource based view addresses the questions:

- How can internal resources and capabilities be exploited and protected?[10]

In most cases of strategy development the market based view can be derived by an industry analysis. A typical representative for an industry analysis is the Porter's five forces of competition analysis method. Porter considers five forces which interact within an industry. The five forces are the suppliers, the customers, the new entrants to the industry, the substitutes which might make the industry obsolete in worst case and finally the internal rivalry which exists already within the analyzed industry.

The resource based view can be derived by a company analysis. An example therefore would be a SWOT analysis which is usually applied at this stage to assess the internal resources and capabilities (Strengths and Weaknesses), and to judge the inside-out perspective (Opportunities and Threats).

[9] Comp. Cooper R. ( 2001), p. 361

[10] Gruber, M. (2009), p. 17

#### 2.3.2.2.2 Resource allocation between Product Innovation and Process Innovation

The empirical example in Figure 2 shall demonstrate the implications of a product's current stage in the product life cycle to an innovation strategy. The graph shows the number of OEMs in the U. S. automotive industry over the time period from 1895 to 1960. It shows an increase of firms till the early 1920's followed by a sudden drop (significantly before the economic depression in 1929). Utterback shows many industries where this pattern occurs like the typewriter industry, TV picture tube producers, the electronic calculator industry, the disc drive industry etc. He found that for all the examples the peak in the graph occurs at the emergence of the so called "dominant design". In the case of the automotive industry the dominant design is the all-steel closed body chassis, for the typewriter industry the dominant design is the QWERTY keyboard, etc.

The emergence of the dominant design correlates with product and process innovation efforts of a company. Product innovation is the generation of new or the improvement of existing products and services. Process innovation is the generation or improvement of processes. In literature, process innovation is related to improvement of processes and tools whereas companies usually separate the terms processes and tools. Before the occurrence of the dominant design the companies focus on product innovation activities since competition is based on functional product performance. [11]

At the fluid phase the product design is changed frequently, production processes are flexible and often inefficient; the applied tools are usually general purpose tools. Employees with high skills are required and R&D enjoys a high range of creative freedom.

At the transitional phase, increasing efforts on process innovations can be observed. The R&D efforts concentrate on those features which are defined by the dominant design whereas the processes become more rigid. At the transition phase the competitive lever is based on product variations.

Finally in the specific phase the competition is based on costs. Processes are efficient, tools are designed for special purposes and capital intensive, productivity and quality have reached a very high level. At this phase R&D focus in put on incremental innovations. [12] Firms focusing on cost leadership must intensify process innovation whereas functional differentiation can be achieved by focusing on product innovation.

[11] Comp. Utterback, J. (1994), p. 30

[12] Comp. Vahs D., Burmester R. (2005), p. 72 ff

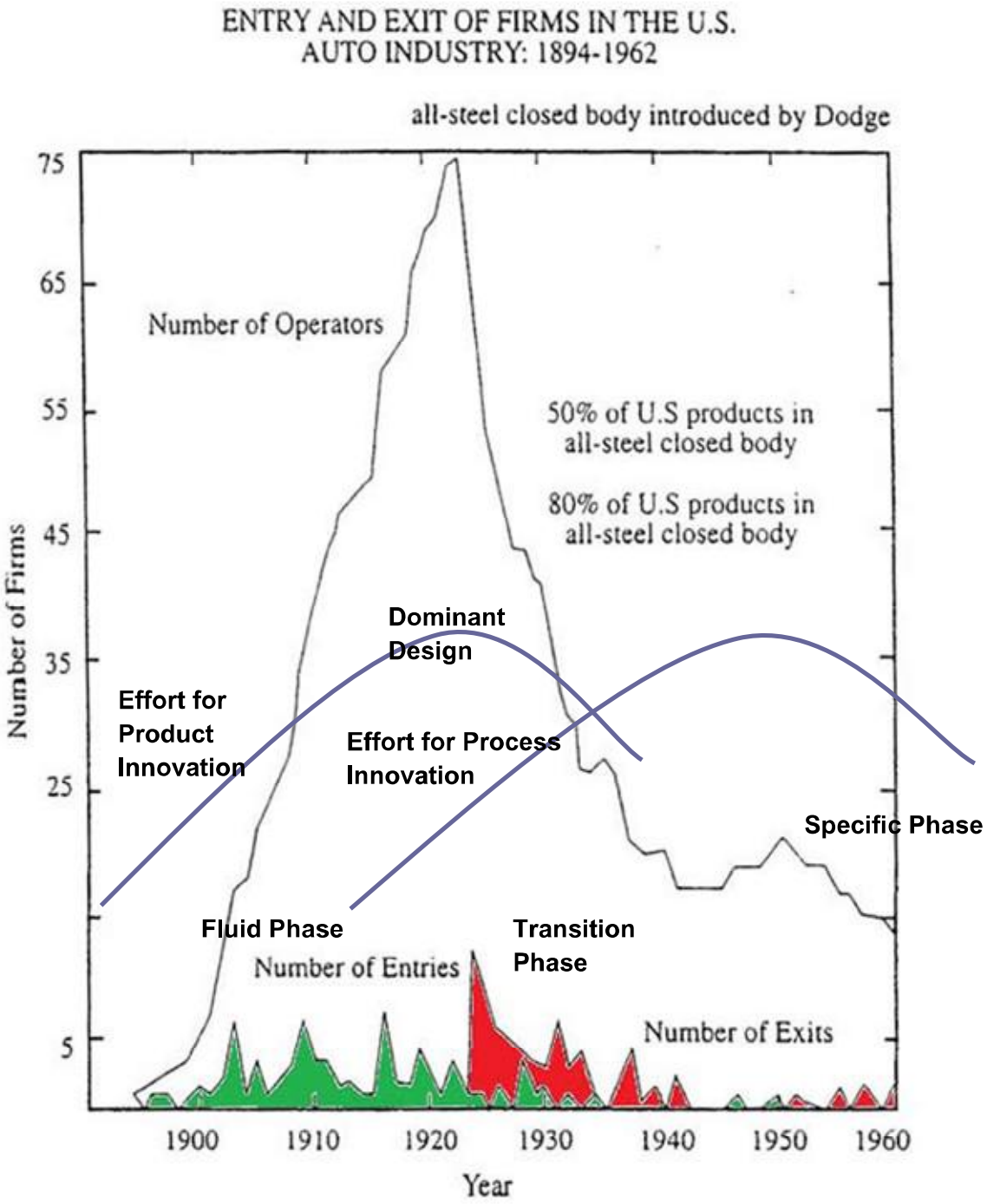



Figure 2: The automotive industry in the U.S[13]

#### 2.3.2.2.3 Strategic Positioning by Markides

Selecting an innovation strategy comprises the decision in which areas (markets) a company wants to compete with which products. According to this principle Markides proposes the following approach. He recommends starting with questioning your own business and analyzing all possible strategic positions. If necessary, he recommends redefining your business before you start to strengthen your current strategic position. Markides emphasises

[13] Comp. Utterback, J. (1994), p. 35

a less rigid strategic positioning by constantly monitoring environmental conditions and strengths and weaknesses. In order to question your own business, Markides recommends a four step exercise:

1. List all possible definitions of the business, e.g. for an automotive supplier this could mean: Are we a component supplier, a system supplier or are we in the engineering business?

2. Evaluate each definition according to a set of criteria: Who are the customers, and what do they need? Who are our competitors? Can we satisfy these customer needs in a unique or better way than our competitors? Is the definition of the market attractive? What will be the key success factors in that business? How do our competitors behave and what does that imply about how they have defined the business?

3. Choose one definition which gives your company the maximum leverage compared to your competitors.

4. Ask the questions – If our competitor redefined the business, what strategy would it be following? How can we prepare for it?

After defining the business a strategic positioning across the dimensions Who, What, How shall be carried out. By asking the question "**Who** is my customer", you think about who is the right customer for my business. For the automotive industry it could mean asking whether the right customer is the premium customer who requires a high end solution or a manufacturer in an emerging market who needs a low cost solution. Does the right customer produce combustion engines or shall we focus on electrified vehicle customers? Rethinking about the customer also means thinking about whether the company can serve its chosen customers better than the competitors as a result of the company's unique bundles of assets and capabilities. For an automotive supplier it could be the ability to offer a broad range of engine and vehicle engineering knowledge, being a global and reliable supplier for injection systems and offering superior process and project management. Similarly a supplier might identify reasons why some customer segments are served either not at all or less successfully.

The "**What**" dimension deals with the question what products and services should we be selling to our customers? Strategic innovation means continuously thinking about your customer needs, wants and priorities and therefore first developing new products, services or

better ways to satisfy those needs. It is mandatory to focus more on understanding your customers' business in order to satisfy their needs. [14]

The "**How**" dimension corresponds to the inside-out or resource based view. Markides recommends redefining the "How" to utilize the company's existing core competences and to create new products and services. By reusing and sharing established core competences of one business unit in other business units, new strategic assets can be built faster or improved in quality. The existing pool of core competences can be expanded as new business units might learn new skills.

Finally a company should start thinking in different ways. Instead of thinking "This is our customer, this is what he or she wants" we should ask "What are our unique capabilities, what specific needs can we satisfy and who will be the right customer to approach?". According to Markides every company should continuously rethink its strategic position. For a market entry firm that mental attitude can allow successful entrance into the market by breaking the rules of the existing business. Once your own strategic position is systematically analyzed in that way, you can move on to thinking about innovation management.[15] The Ansoff Product Market Growth Matrix is a strategic planning tool which is applied at that stage in general.[16]

### 2.3.3 Developing and Strengthening a Firm's Innovative Capabilities

This is the stage where the innovation strategy is implemented. Based on the innovation strategy it can be determined which capabilities and resources are needed to remain competitive and to carry out the necessary investments. For the implementation of an innovation strategy, an appropriate management control system is necessary. The design of the innovation management control system depends on attributes like the type of industry, project uncertainty and product strategy.

Developing and strengthening a firm's innovative capabilities means also to know how innovation occurs in a company. An overview of the different types of innovation in a company is given by Davila. According to Davila the types of innovation control can be classified into the dimension source of innovation and impact on strategy[17]. Source of innovation means: does the idea emerge from the management (Top-down approach) or

[14] Comp. Markides C. (1997), p. 9-23

[15] Comp. Markides C. (1994), p. 19-22

[16] Comp. Cooper R. (2001), p. 375

[17] Comp. Davila A. (2000), p. 383-409

does the idea come from the organization (Bottom-up). The impact on the strategy is either Incremental (Current business model) or Radical (New business model). The combination of these characteristics results in four types of innovation and control as illustrated in Figure 3. The classical NPD stage gate process is an example for quadrant 1 whereas the "submarine approach" is in quadrant 2. It is also possible that both types coexist in a firm. For example the management driven new product and product succession planning is an example for quadrant 1 (or quadrant 3). In the following section some examples for the four types will be introduced.

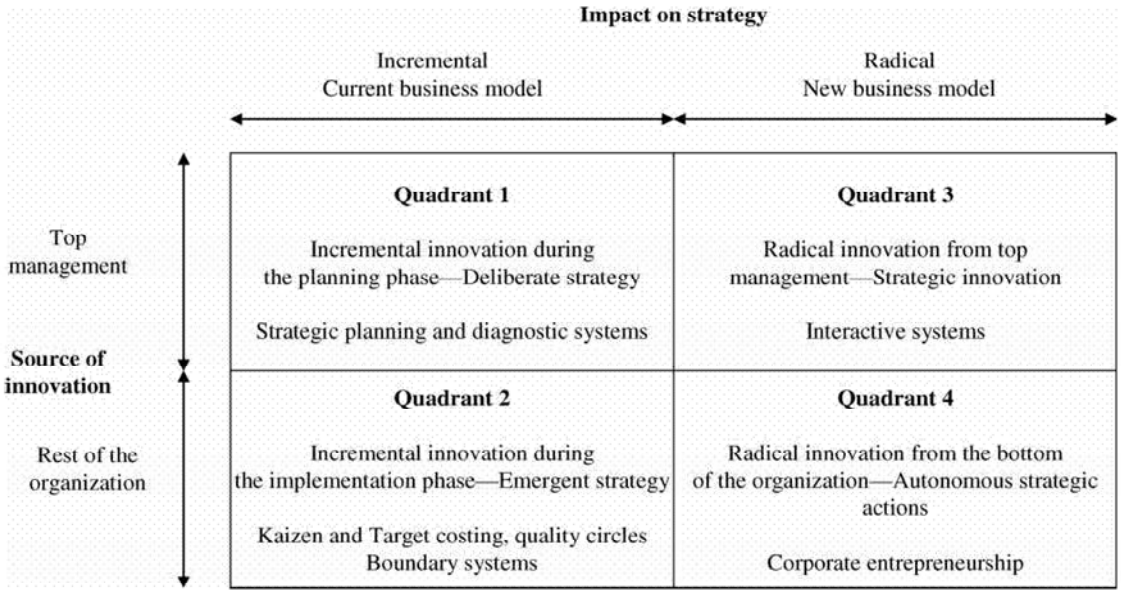



**Figure 3: Types of innovation and control**[18]

**Quadrant 1** (Top down, business model unchanged): As example for quadrant 1 an incremental top down strategic planning process established at Intel and Pixim, Inc[19] is described by Burgelman[20]. The starting session of the strategic planning process is an annual program called Strategic Long Range Planning (SLRP) where the company's top leadership is discussing and debating the firm's goals and objectives of the subsequent 3 years. The SLRP is followed by Product Line Business Plan (PLBP) implementation meetings where a set of products are proposed and where the resources are allocated. Each product is supported with a Market Requirements Document (MRD) and a Product

[18] Davila A. (2009), p. 299

[19] Pixim, Inc, founded in 1999, is providing semiconductors for digital imaging devices

[20] Comp. Burgelman R. (2009)., p 151

Requirements Document (PRD). The MRD is provided by the marketing function and contains the following information:

- Identification and discussion of the target markets and the business opportunities
  - Market size and dynamics
  - Customer demographics
  - Competition
  - Areas of differentiation
  - Summary of key specifications and must haves
  - Feature priorities
  - Key partnership requirements
  - Timelines for demos, samples and products
- Outlines key selling features for target markets
- Includes financial projections
- Cross functional approval

McVie describes the process flow used at Pixim to generate MRD. The process is shown in Figure 4 and contains the following five activities:

- Definition of the scope of the project. This task starts basically with gathering the corporate objectives of the CEO and the technical limitations from engineering. The next step is to ask for input from Engineering, Sales, System development (Imaging), Application Engineering, Business development and other executives for data/questions requested of OEMs, end users and market analysts. The outcome of activity one is a question list for OEMs and end users which must be approved by the CEO, System development, Engineering and Sales. The creation of the question list is supported by external consulting.
- Gathering data from OEMs and end users. The interviews are conducted with at least five OEMs and ten to 500 end users. The aim of the interviews is to gather sound and usable information. Hence, end users and market analysts are required to verify the end user needs and the intended volumes and the interviewer focuses on quantifying the attributes.
- Writing the MRD. The MRD includes an executive summary, a market analysis based on the collected information, required key technologies and features ranked by importance, summary of key specifications, key features weighted by priority, key technologies and partnering, complementary assets and timelines. On demand a follow up with OEMs and end customers is carried out to collect missing data.

- The MRD release process. In opposite direction to the project scoping process the release process is executed. First the outcome of the market research is reviewed by the marketing vice president, followed by the VPs of Engineering, System development, Application Engineering and Business development and finally the Sales VP and the CEO. For each review a duration of three days is planned. At the end of the process a session is organized where the MRD is presented and reviewed with regard to ROI, if there are product delays or if key features are missing and how this MRD relates to the firm's current roadmap.
- Changing an MRD post signature. This is an exception state for the case where an engineering or market change necessitates a significant alteration in the product. In that case marketing must make a change in the MRD and get signatures from all people who signed the original MRD[21].

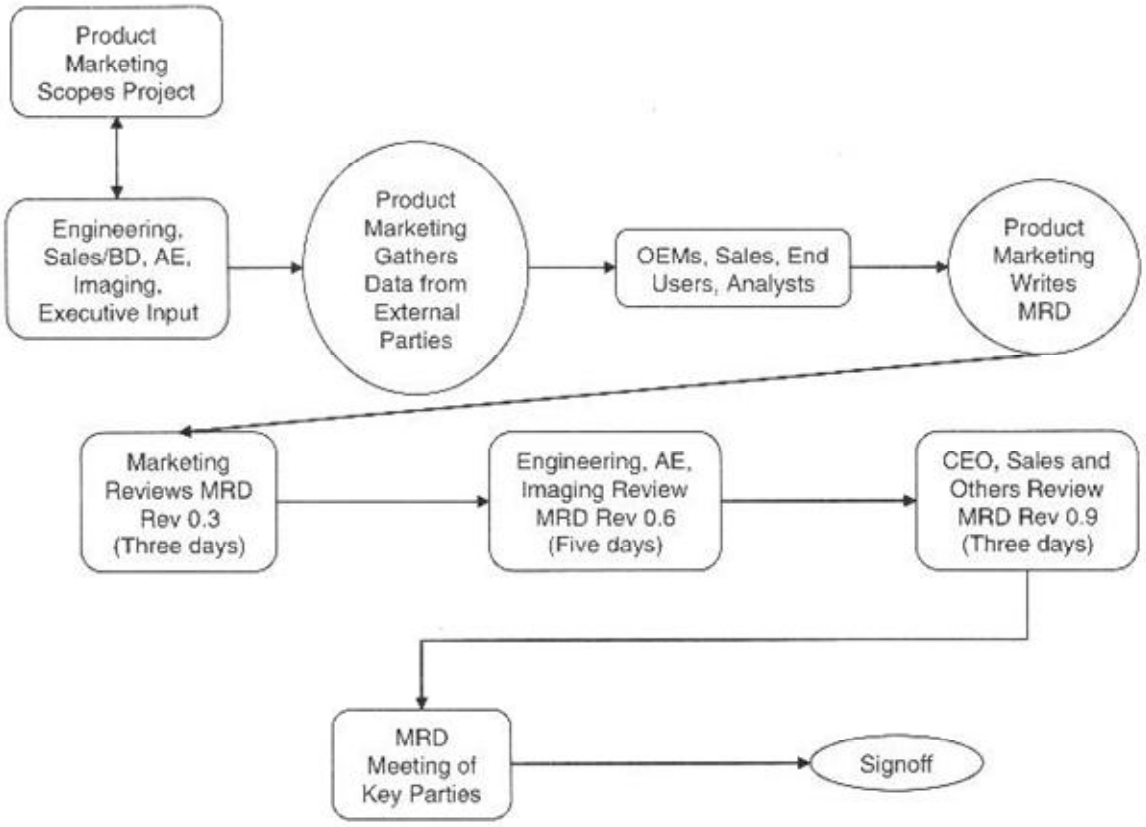



**Figure 4: MRD process flow at Pixim[22]**

**Quadrant 2** (Bottom up, business model unchanged): Compared to top down innovation models, research on bottom up innovation activities is rarely available. The available theories

[21] Comp. Burgelman R. (2009), p 78

[22] Burgelman R. (2009), p 78

are rather descriptive models which might be due to the less structured nature of bottom up innovators. The application of a bureaucratic bottom up innovation process would be a contradiction itself. An empirical study about bottom up innovation activities in the Austrian semiconductor industry was made by Koch and Leitner. Figure 5 shows such a typical bottom up innovation process. Typical process elements which might restrict the activities like gates or necessary deliverables do not exist. Approaches for providing an organizational structure for bottom up innovation activities are company suggestion systems, incentive schemes and patenting rules. But indeed such systems are often bypassed by typical bottom up innovation activities[23].

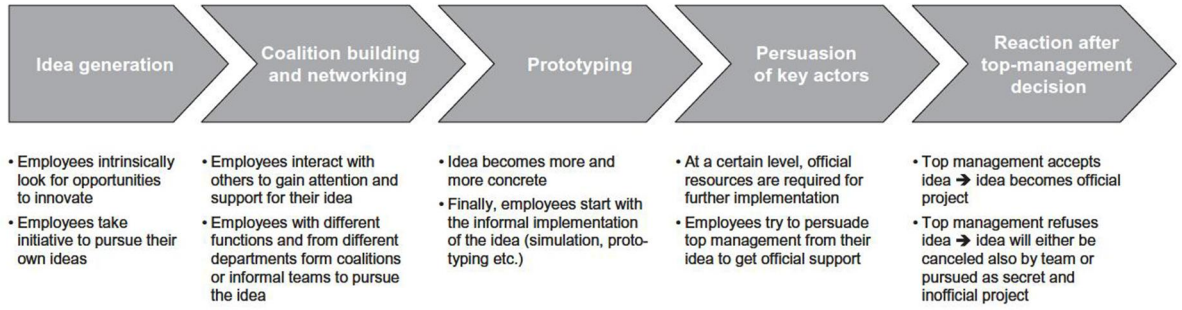



Figure 5: The Evolution of a Self-Organized innovation[24]

**Quadrant 4** (Bottom up, impact to the business model): This is the area of internal corporate venturing (ICV). A process model for ICV in the diversified mayor firm is described by Burgelman. That model of corporate, new venture development describes the activities of top management and group leader/venture manager in four stages. Similar to quadrant 2 a product idea emerges in a definition phase. A product championing process defines the first minimum winning game (MWG)[25] which means developing the first application with the best sales potential by considering the limited development resources. In an impetus phase the venture manager concentrates his efforts on the commercialisation of the new product or system (Strategic Forcing). This process is supplemented by a process called Strategic Building with the aim of the agglomeration of new businesses, the transfer of related projects from other parts of the organization and/or acquisition of small companies with complementary technologies. Organizational championing is the transition to the third phase called Strategic Context. In this phase strategic positioning within the corporation takes

[23] Comp. Koch R., Leitner K.H. (2008), p. 216 ff

[24] Comp. Koch R., Leitner K.H. (2008), p. 219

[25] Comp. Burgelman R. (2009), p. 143

place. Hence, this phase is described as a political activity since top management must be probably convinced of adapting the corporate strategy in order to accommodate the new venture. The final phase is called Structural Context where the new venture is either incorporated as a new business unit or a spin off is created[26].

The examples for quadrant 1 and quadrant 2 show how differently the innovation processes need to be managed. Innovations which emerge from quadrant 1 are usually strongly controlled by the management. For example during the stage gate process of the product development cycle the management receives detailed information regarding the development progress at every gate. As a matter of fact the management is in the position to react immediately if any deviation from the desired outcome is observed. In contrast to the management control system of quadrant 1, the management control system of quadrant 2 is developed weakly and the management's efforts are concentrated on providing the environmental conditions for the innovation processes rather.

The question regarding which management control system performs better is controversy. Various examples exist which consider strong management control systems as very important[27] as well as studies which regard dominant management control systems as irrelevant or hindering, especially for R&D settings[28]. As empirically analyzed by Koch and Leitner, informal and self-organized bottom up innovation activities are essential for a firm's innovative strength since it often supports the top down managed product development process. Grassman et al. have visualized this situation in Figure 6 as a three dimensional space in which a R&D management control system can be positioned[29]. It can be positioned between the two extremes creativity and resource efficiency. The Contingency Hypothesis suggests that positioning should depend on the organizational setting's context which contains external factors like industry environment and internal factors like the company's strategy. Peres-Freije and Enkel have demonstrated that innovation control systems in fast moving industries are positioned in the creativity corner in contrast to companies in slow changing industries where the innovation control system is positioned in the resource efficiency corner[30]. For each company the implemented management control system must contain the right mix of resource-efficient and creativity enhancing activities.

[26] Comp. Burgelman R. (1983), p. 223-244

[27] Comp. Clark, Fujimoto (1991)

[28] Comp. Abernethy, Brownell (1997), p. 233-248

[29] Comp. Gassmann, O., Sandmeier, P., Wecht, C.H. (2006), p. 46-66.

[30] Comp. Perez-Freije J., Enkel E. (2007), p. 11-24

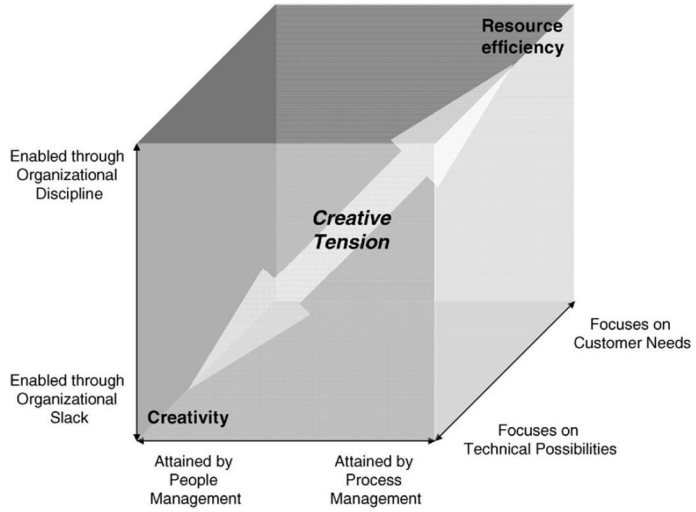



**Figure 6: Dilemma of R&D Management Control System**[31]

In the German literature of Vahs and Burmester search fields (translated from the German term "Suchfelder") are proposed in order to align bottom up innovation ideas to the innovation strategy. The aim of search field generation is to provide a framework for ideas which enter the innovation process and to increase consequently the hit rate of successful ideas. Search field generation is carried out prior to idea generation and constitutes the link to the strategic planning process. According to Vahs and Burmester possible origins of search fields can be customer problems revealed by a market analysis as well as new technologies. Hence, both the market and the field of technology must be considered for search field generation.

Figure 7 visualizes how search fields interact within the innovation process. They can be derived either from the core processes for product planning (strategic planning, new product planning, life-cycle management) or technology management. According to Vahs and Burmester the innovation management acts as central element in between those core processes. Based on the collected search fields innovation ideas are generated and pre evaluated regarding business potential. Together with the available technologies the innovation ideas are managed in a central database for innovations and technologies. According to the literature, this database provides well considered innovation ideas which can further be developed to a new or improved product or service. [32]

[31] Gassmann, O., Sandmeier, P., Wecht, C.H. (2006), p. 46-66

[32] Comp. Vahs D., Burmester R. (2005), p. 140

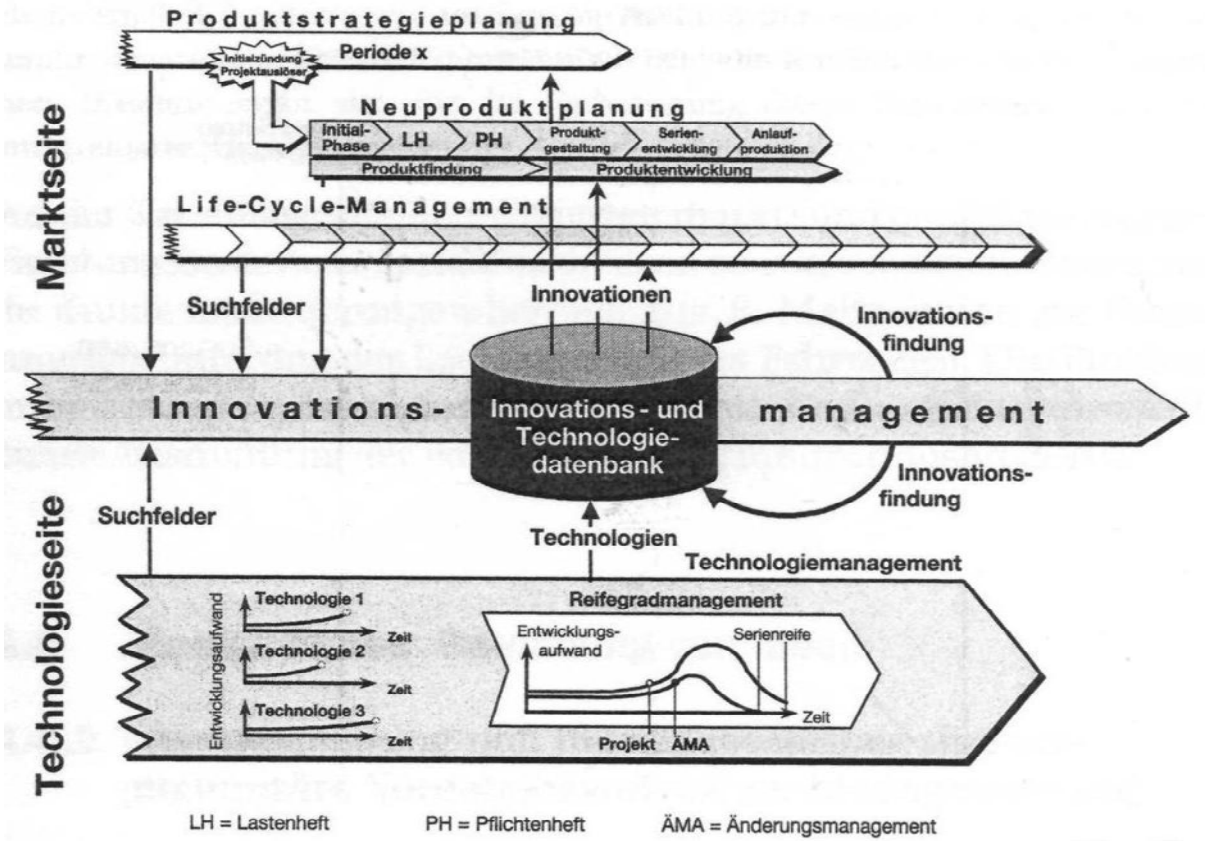



**Figure 7: Innovation between market and technology and interaction with search fields**[33]

[33] Vahs D., Burmester R. (2005), p. 141

# 3 Implementation of Strategic Innovation Management at DGS-EC

The following chapter is structured in the following way: In a first step a general organizational overview of the Bosch automotive technology division is given. In addition information regarding the integration and handling of innovation subjects on a corporate level within the Bosch organization is provided. Subsequently Bosch's central instructions regarding innovation management are outlined which serve as basis for the identification of suitable methods for strategic innovation management and product/service planning.

As a next step the methods in the area of strategic innovation management are identified and the possible applications for DGS-EC are formulated. Based on this evaluation the most promising methods are selected and presented to the board of DGS-EC innovation representatives. By using a questionnaire the feedback of innovation representatives was collected. Based on their feedback it could be assessed which and to which extent the introduced methods are suitable for implementation into the DGS-EC innovation process.

## 3.1 Organizational Environment

The location of the DGS-EC product unit in the Robert Bosch Automotive Technology division is illustrated in Figure 8. In addition the following central departments of Robert Bosch GmbH are relevant for innovation management processes.

- C/HDP, this is the Central Department for Human and Organizational Development. It is responsible for CIP (Continuous Improvement Process).
- G2/PJ-BES, which stands for Bosch Engineering System. G2/PJ-BES is a project team who deals with engineering methods.
- C/CS is the central department for strategic methods.
- C/CTI, the Central Department for Organizational Planning and Technology which provides the guidelines for the Technology Review (TR).

In addition the Diesel System department for Engineering Research and Development Coordination (DS/ERC) provides best practice examples for implementation of innovation processes in the automotive division. One example is the "Technologie Quadrant", which is a method for technological planning.

For innovation-related inputs at DGS-EC the following two central departments are relevant:

- C/AI is the central department for automotive integration. C/AI coordinates cross functional development activities.
- CR, the central research department, is engaged in technological planning and pre development.

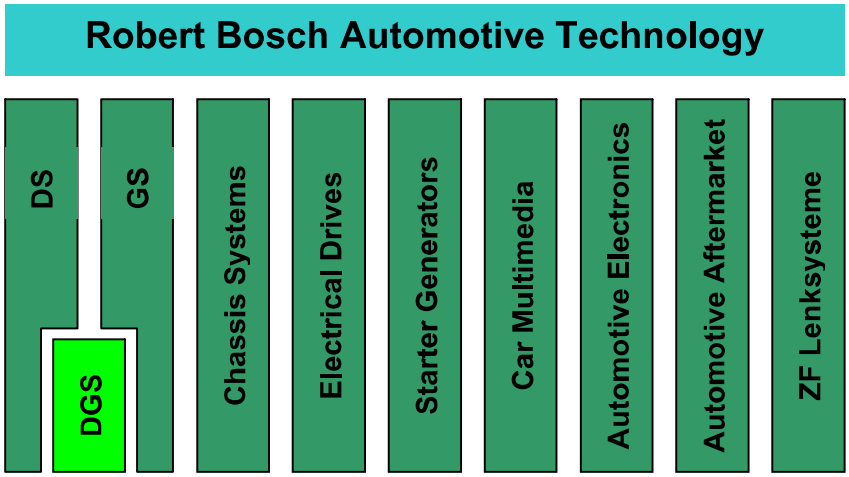



Figure 8: Organizational overview of the Robert Bosch Automotive Division

## 3.2 Corporate Guidelines for Innovation Management

The company of Robert Bosch has committed to Innovative power as one of its core competences. According to Bosch corporate philosophy innovative power is induced by systematic, focused, guided and sustainable innovation management. According to Bosch corporate standards, the innovation process is interconnected to strategic planning. A committed best practice guideline how to interconnect strategic planning with an innovation process is provided by C/PJ-BES. As illustrated in Figure 9 the strategic planning process is positioned in front of the innovation process. Strategic planning divided into three stages which are Strategic Analysis, Strategic Forecast and Strategic Choice. Strategic Analysis comprises state of the art methods for an environmental analysis (e.g. Porters five forces) and company analysis (e.g. strengths and weaknesses). It contains the identification of core competences manifested in the Bosch House of Orientation as follows:

- Strategic far-sightedness
- Innovative strength
- Efficient processes
- Quality and reliability
- Global presence
- Human resources development

According to the corporate instructions Strategic Forecast is the second stage of strategic innovation management. Most departments are using the scenario analysis for the identification of future opportunities and threats. Based on the outcomes of Strategic Analysis and Strategic Forecast strategic options for the future can be defined and prioritized (Strategic Choice). The mile stones for the strategic planning process are constituted by the Corporate Planning Session (CPS), the Product Development Session (PDS) and the Technology Review (TR). Depending on the outcomes from CPS, PDS and TR product roadmaps are created and search fields are defined.

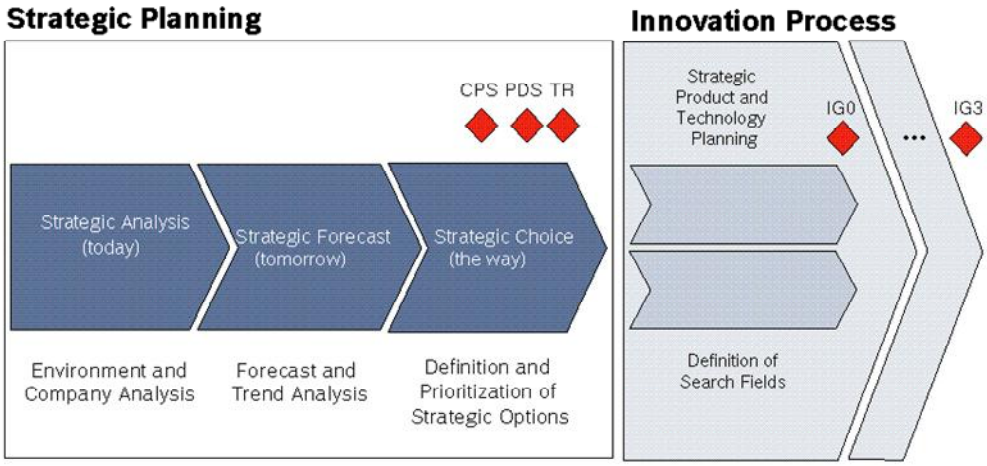



Figure 9: C/BES Best Practice for a Strategic Innovation Process

## 3.3 Identification of Methods

Methods have been selected which cover the fields of strategic innovation management and product/service planning. For strategic innovation management the overview as illustrated in Figure 10 was used as a guideline for the identification of the methods[34]. An additional criterion for the selection of a method is its recommendation in any corporate guideline provided by the central departments. Based on the variety of methods presented during the course of the author's MBA program and on the corporate guidelines regarding innovation management a pre-selection of methods could be accomplished. Also Cooper's recommendation to focus on methods which can be applied in order to improve the market orientation was considered.

[34] Comp. , Vahs D., Burmester R. (2005), p. 120

| Strategic Phase | Strategic Exploration | Strategic Planning | Strategic Control |
|---|---|---|---|
| Method | • Environment analysis<br>• Company analysis<br>• Value chain analysis<br>• Industry analysis<br>• Competitor analysis<br>• Risk opportunity analysis<br>• Benchmarking<br>• Strategic foresight<br>• Gap analysis | • Space Analysis<br>• Product market matrix (Ansoff Matrix)<br>• TOWS (SWOT) analysis (including SO, WO, ST and WT strategies)<br>• Misfit analysis<br>• Strategic board | • Product market portfolio<br>• Technology portfolio<br>• Vulnerability analysis |

**Figure 10: Phases and methods of strategic innovation management**[35]

Based on the innovation process illustrated by Vahs and Burmester in Figure 7 an innovation process for DGS-EC was designed which visualizes the processes for strategic innovation management and product planning, and the specific areas for which the search field identification is required. This (idealized) innovation process for DGS-EC is illustrated in Figure 11. In contrast to the Vahs and Burmester representation, the process for technology management is located next to the strategic product planning process which shall emphasize the technology orientation of the company (Invented for life principle). The processes for corporate foresight and corporate planning are visualized in the strategic product planning bar. In addition search field methods which cover the market side (voice of the customer) and search fields covering the technology side are listed. In between product and technology management the applied milestones for strategic planning are visualized in chronological order (the point of time is given in brackets):

- CPS (November) which stands for Corporate Planning session. That meeting is carried out once a year for each BU where each product unit plans its activities.
- TR (February) which stands for technology review is carried out in order to the technological planning. During that session it is decided which technologies are provided internally and which technologies are provided externally (e.g. university, supplier…).
- PDS (April) which stands for Product Development Session. The meeting, which is carried out on product unit level, was introduced in order to decide about product strategies.

[35] Comp. Vahs D., Burmester R. (2005), p. 120

- The budget planning (July) which is carried out in order to allocate the financial resources to departments and activities for the next year.

During the management sessions the launch of new products or engine control unit generations, indicated in the green bars, are initiated. On the left hand side the methods are listed which can be applied for strategic innovation management and product/service planning and which can provide the desired search fields. The color indicates which process is related to the specific process. In the following section the listed methods are described in detail.

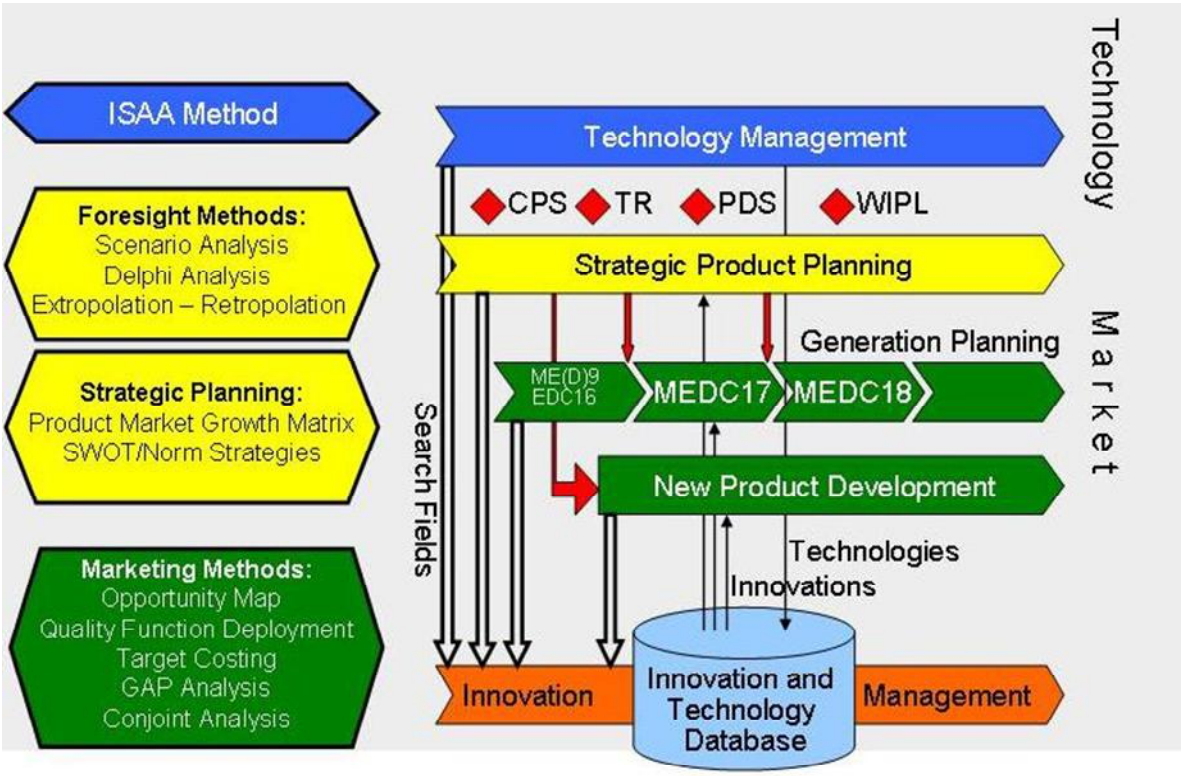



Figure 11: Strategic innovation management, product planning, and search field generation[36]

### 3.3.1 Foresight Methods

The analyzed foresight methods which might be applied at DGS-EC are the scenario analysis, the Delphi analysis and the Extropolation-Retropolation approach. The scenario analysis is a method recommended by the central department C/CS. The remaining methods originate from external sources.

[36] Comp. Vahs D., Burmester R. (2005), p. 141

#### 3.3.1.1 Scenario Analysis

Scenario analysis or scenario planning is a process of analyzing possible future events (time frame usually 5 to 10 years) by considering alternative possible outcomes (scenarios). It can be applied to the following objects:

- Products, product categories
- Technologies, technological fields
- Business units
- Companies
- Entire industries and markets

The aim of the scenario method is to systematically cover all possible scenarios and to pick those which most likely occur. In order to generate search fields from the generated scenarios a follow-up SWOT analysis needs to be carried out[37]. The scenario method itself is rather complex, hence, it is recommended to seek process support by an experienced consultant or moderator. Complementary to the method software tools exist like Parmenides Eidos™.

The scenario method comprises four steps:

1. Framing the scope: Defining the scope and delineating the scenario environment. The questionnaire must be clearly defined and understood by all participants. Applied for DGS-EC the problem description could be as follows: Technology- and product scenarios for engine control units in 2020?

2. Exploring the scenario environment: Identifying the key influencing factors driving the scenario environment. As illustrated in Table 1 a four step approach can be applied in order to find the key influencing factors.
    - Defining the relevant environment for the object
    - Partitioning the environment into segments
    - Identifying all influencing factors
    - Selecting the key influencing factors

[37] Comp. Konrad H. C/HDP Robert Bosch (2009)

| | Influencing factor | Segment |
|---|---|---|
| 1 | Exhaust gas legislation | Politics |
| 2 | Processor | Technology |
| 3 | Energy management | Technology |
| 4 | Components (Technology and Market) | Market |
| 5 | Applied technological methods (Controlling, governing, models) | Technology |
| 6 | Diesel Image | Market |
| 7 | Average fleet consumption | Politics |
| 8 | Legislation in general (Traffic, Taxes) | Politics |
| 9 | Propulsion-, combustion-, injection-, exhaust gas treatment technologies | Technology |
| 10 | Business model | Market |
| 11 | Software technology | Technology |
| 12 | Methods and tools, IP protection | Technology |
| 13 | Bus systems, network | Technology |
| 14 | Manufacturing technologies | Technology |
| 15 | Main board technologies | Technology |
| 16 | Fuels | Technology |
| 17 | Sensors and Actors | Technology |
| 18 | Core competences, HR | Market |
| 19 | Resources | Market |
| 20 | Demands on reliability, repair service, maintenance, diagnosis, electro magnetic robustness | Technology |

**Table 1: Influence factors (drivers) for control units**[38]

a) At this step each influence factor (driver) is evaluated regarding the dimensions "impact to the object" and "probability of appearance". Influence factors with low

[38] Comp. Engineering Processes and Quality Department DGS-EC/EPQ (2009)

impact and low uncertainty are irrelevant facts and can be excluded consequently. The same can be applied for low impact and high uncertainty influence factors, also called “Fuzzy peripherals”. The relevant influence factors are those with high impact to the object. Those which will happen with high certainty are the inevitable occurrences and thus the future planning will be done according to it. The critical factors are those with high impact and high uncertainty. Since those influence factors are likely not to be considered for future planning their appearance might be coherent with future difficulties.

b) In addition a mutual impact assessment of each driver is necessary. Very often influence factors correlate with each other, which will reduce the number of possible combinations. The influence matrix, also called the Active – Passive Matrix, is useful for identification of key factors with a high impact on the scenario environment. Here the impact of each influence factor to the other influence factors is rated on a scale from 1 (= No or Very Weak Direct Influence) to 4 (= Strong Direct Influence)[39]. By adding up all row and column values respectively, the active sum indicating how a specific driver influences all other drivers and the passive sum indicating how a driver is influenced by other drivers can be calculated. Based on the active sum a ranking of the drivers can be carried out. The scenario analysis judges drivers without any active influence as less important. Hence, those drivers are not considered in step 3. Nevertheless a reasoning of the selected/not selected drivers in combination with the outcome of step 2a is useful.

[39] Comp. Garvin and Levesque (2006), p. 30-33

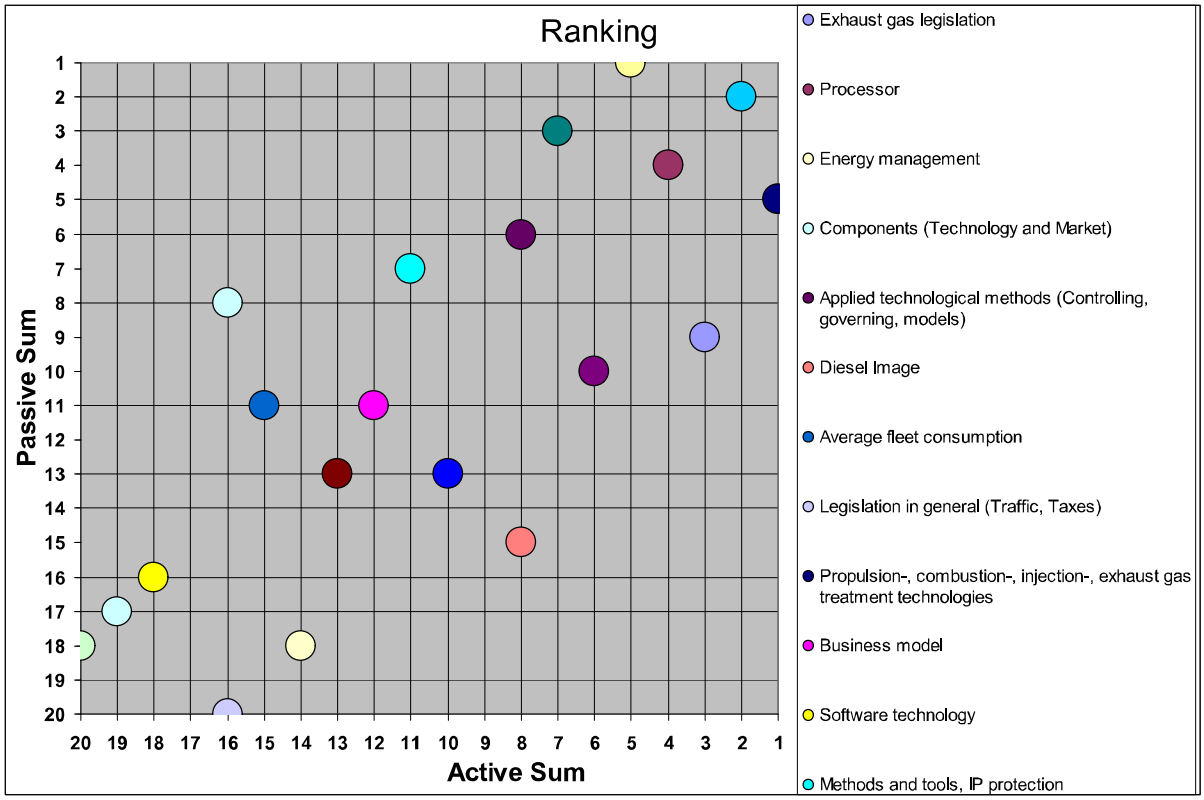



**Figure 12: Ten key drivers identified for control units**[40]

3. Creating Scenarios: Combining projections of key influencing factors, clustering projections to a limited number of projections.

   The problem which still needs to be solved by step 3 is the high number of (mutual depending) drivers whose future change might be difficult to predict (due to a high number of possible combinations). The idea is now to reduce the high number of possible combinations to a lower number of independent scenarios by resolving the dependencies.

a) Firstly projections for possible outcomes of key influencing factors are developed. For example, very often an outcome which leaves the key influencing factor unchanged is one possible projection. Any outcome which changes the key influencing factor provides the second projection and on demand an opposite outcome can be defined which provides a third projection.

b) Subsequently bundles can be created by combining alternative projections of key influence factors. Usually projections are combined which mutually support each other. By creating bundles the number of possible combinations and hence the

[40] Comp. Bosch EGS-EC/EPQ

number of possible scenarios can be reduced. To enable the assembly of the projections into bundles, the application of a consistency matrix (column: all existing projections, row: all existing projections) is helpful where the degree of mutual support can be systematically assessed for each projection pair. If a computer aided scenario tool is used step 3b can be skipped.

c) Defining the scenarios: Scenarios are formed by selecting projections of influence factors which are likely. By considering the consistency matrix combinations of influence factors which exclude each other will be avoided. If one projection is assigned to a scenario the whole bundle of projections must be added to the same scenario (classical method). Computer support makes it possible to calculate the consistency for each possible combination of projections. The consistency can be simply calculated by calculating the average of the related nodes in the consistency matrix. This provides the most likely scenario which has the highest value of consistency.

4. Developing strategic plans: Drawing implications and strategic options for all scenarios, defining early warning signals indicating which scenario may become reality.

   A spreadsheet containing a set of scenarios having the highest values of consistency (columns) and strategic options in combination with an action plan (rows) can be developed. Each strategic option can now systematically be assessed against coverage of the various scenarios. Finally for each scenario the degree of readiness can be derived and visualized (red = not prepared to green = prepared).

#### 3.3.1.2 Delphi Analysis

The Delphi method is an expert based forecast method and was developed in the 60's by the RAND Corporation (The name Delphi derivates from the Oracle of Delphi). The method was initially developed for warfare applications but is now broadly used for business applications. The main characteristic of the Delphi method is that the experts can provide their judgments in an anonymous way and their identity is not revealed until the end of the decision making process. This avoids the negative effects of face-to-face panel discussions like overweighting the opinion of dominant, persuasive persons, hence, allowing all participants to freely reveal their opinion and solves therefore the usual problems of group dynamics like bandwagon effects.

The Delphi method is an iterative process as illustrated in Figure 13. Usually a panel director (project leader or moderator) must be assigned with the coordination and the evaluation of the answers. The first process step is the formulation of the problem followed by the

selection of the experts which is the most critical step. Next a questionnaire must be developed which allows a quantitative comparison of the expert answers. Subsequently an iterative process is initiated where the questionnaire is distributed to the experts and the answers are collected. After each round the project leader calculates the median and interquartile for each question and prepares the answers for distribution to the experts in the successor round. In addition the experts can add their self-assessment of own expertise to each question. During each round the experts have the opportunity to revise their opinions, to comment on other deviating opinions, comment why an opinion was revised or counter on others' comments. The process is repeated until the overall judgments have converged to a stable result.

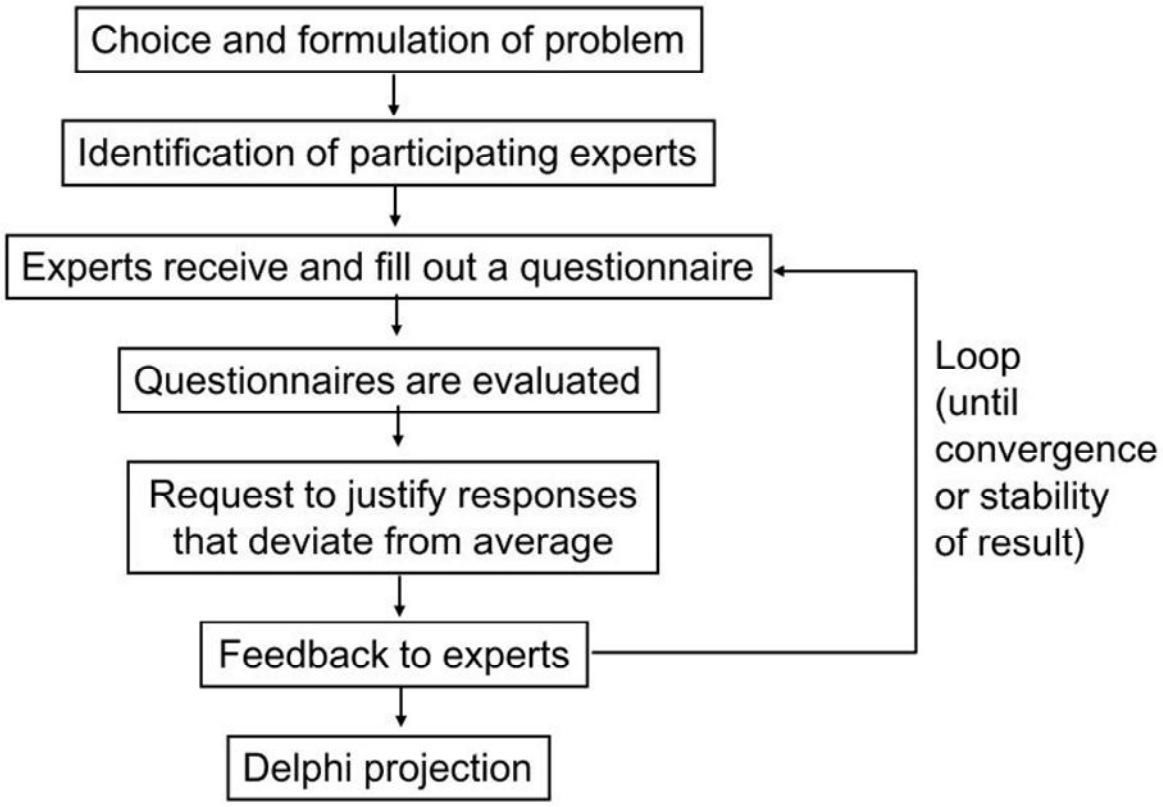



Figure 13: Delphi analysis process[41]

The Delphi method is applied for long term forecasting, in order to reveal future trends or scenarios.

For DGS-EC it could be applied for questions like market share of electrified vehicles in ten years or the future dominant design of an electrified vehicle's control unit architecture (single

[41] Gruber M. (2009), p. 24

control unit – multiple distributed control units), hence, all fields where the future forecast lacks sufficient information.

#### 3.3.1.3 Trend Based Strategic Foresight – Extropolation - Retropolation

A commonly used method for predicting future developments is the extrapolation of present developments into the future. In literature this method is also called Extropolation or Road Mapping. One example which shows an application for the electrified vehicle industry is illustrated in Figure 14. In the example the Lithium-ion battery costs from the years 2006 to 2009 were used in order to predict (extrapolate) the cost evolution until 2020. Based on that information a cost comparison regarding fossil fuel powered engines can be made which is one of the key dimensions in predicting the future market shares of electrified vehicles. One of the disadvantages of this method is that it is not feasible for disruptive developments.

Retropolation is supposed to eliminate this shortcoming. By this technique a future scenario is projected back into the present. By means of back projection the search fields shall be identified which enable the way into the future. Future scenarios can be developed by applying the methods described above like the Delphi method or the Scenario Analysis. The latter method contains the generation of strategic actions or search fields already and hence covers the process of Retropolation.

Strategic planning shall be a combination of both Extropolation and Retropolation in order to achieve reliable future visions. Siemens has applied this method to business fields such as energy transportation and distribution, lighting and communication for forecasting the upcoming 10 to 15 years [42].

[42] Comp. Siemens (2005), p. 28

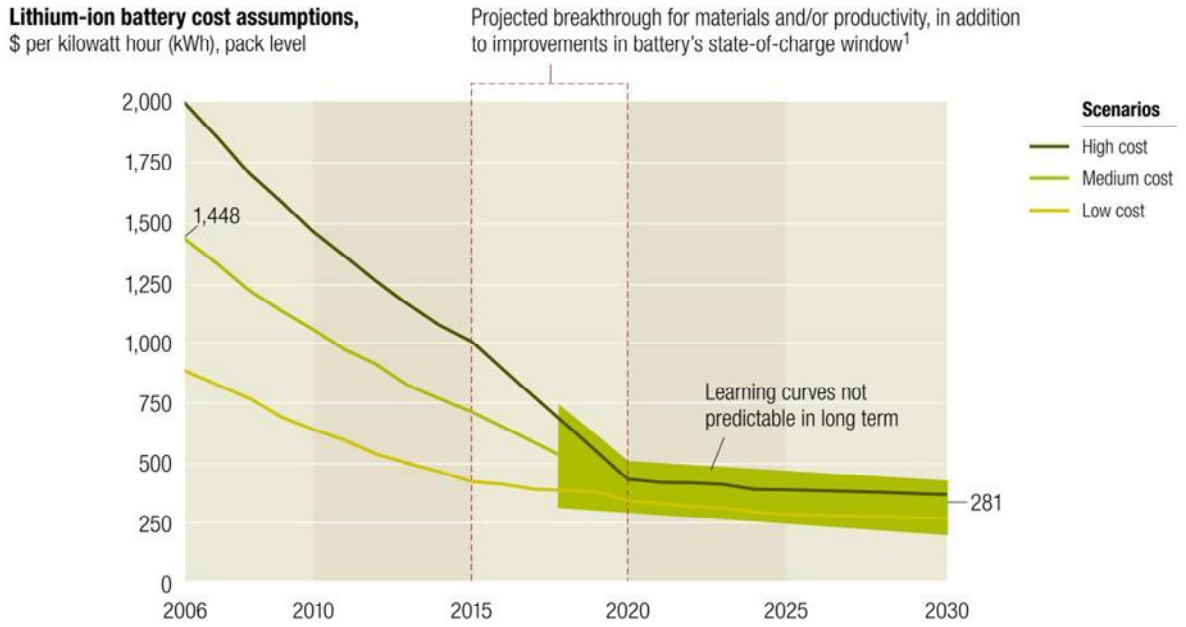



Figure 14: Example for Extropolation demonstrated on the cost development for lithium-ion batteries[43]

### 3.3.2 Strategic Planning Methods

Strategic planning is the second step after a prediction of the future has been carried out. For strategic planning two methods will be analyzed, the Product / Market Growth Matrix and the SWOT analysis in combination with the norm strategy method. Both of the methods are recommended by C/HDP.

#### 3.3.2.1 Product / Market Growth Matrix

The Ansoff Product / Market Growth Matrix is a systematic approach for the implementation of a growth strategy. The basic idea is that besides winning the customers of a competitor a company can grow either by introducing new products or by expanding to new markets. Those types of expansions can be visualized in a two dimensional diagram as shown in Figure 15. Entering new markets with existing products is called market development and if new products for existing markets are introduced we talk about product development. Launching new products at new markets is called diversification. Market penetration can be achieved by winning customers of competitors, non-users or by convincing existing customers to increase the usage of your products. The higher the distance of the intended product-market combination is from the field market penetration, the higher the risk for a product to fail. Hence, diversification contains the highest risk and needs to be considered thoroughly. The decision regarding the direction in which growth should happen must be made in the strategy development phase. Depending on the direction, search fields for innovation activities can be derived.

[43] Hensley R., Knupfer S., Pinner D. (2009) , p. 89

| | | Product | |
|---|---|---|---|
| | | Existing | New |
| Market | Existing | Market Penetration | Product Development |
| | New | Market Development | Diversification |

Figure 15: Ansoff Product- Market Growth Matrix Figure [44]

In an extended version of the product / market matrix the dimension product is extended by the category modified product. For the dimension market the area new market is specified into geographical market and target group.

A description for how to assess the elements in the product / market segment matrix is given by Cooper. Cooper starts with a product / market matrix as well. On the dimension product he lists all existing and proposed products and product families. On the dimension market all the existing market segments are listed systematically. This representation results in a matrix in which each product can be assessed against each market segment. Cooper calls the elements of the matrix product arenas. Some product arenas can be ruled out immediately as infeasible, the remaining sets are evaluated and priorities are established. The top-priority or "star" arenas are chosen for more intensive product development efforts.

In an advanced version the product arenas are represented by three dimensions. The market dimension is represented by customer groups and the product dimension is converted into the dimension customer functions served. The third dimension is represented by the technologies required for each product arena. As a general rule the product arenas can be defined by the dimensions "Who" - Customer groups, "What" – Applications and "How" - Technologies (Compare chapter 2.3.2.2.3). The cube covering the existing customer groups, applications and technologies is called home base. The product arenas located outside the home base represent potential business fields. For reducing complexity it is also possible to reduce to two dimensions by combining the "What" and "How" dimension into a single dimension product line.

[44] Konrad H. C/HDP Robert Bosch (2009)

Figure 16 is an example for a three dimensional product arena approach for DGS. The "Who" dimension comprises the already existing customer groups passenger cars (PC), heavy duty and two wheelers. The passenger car group could be defined more specifically in customers from developed countries (Europe, US, Japan, Korea) who either follow a differentiated strategy or those who focus on cost savings. Outside this home base new customer groups could be defined for the emerging markets. For the "What" dimension the existing product groups for combustion engines (ECU) and exhaust gas treatment (DCU) can be extended by a product group for electrified vehicles (VCU). For the "How" dimension an illustration of the control unit generations would make sense in case of DGS. The definition of the product arena VCU for emerging markets (e.g. China) would be a very challenging task.

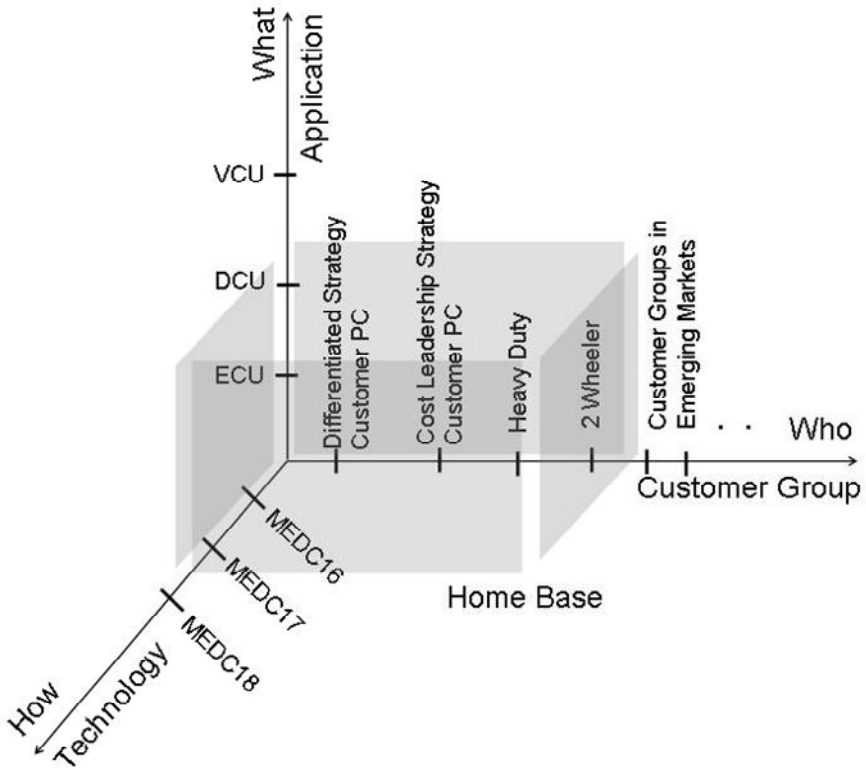



**Figure 16: Arena Dimensions for DGS**[45]

The next step is the selection of the right arenas for which Cooper proposes a single must-meet criterion and two should-meet criteria. The must-meet criterion is: Does the arena fit into the business's mission, vision and overall strategy? The should-meet criteria are similar

[45] Comp. Cooper R. (2001), p. 378

to the market portfolio approach where every product arena is assessed according to the dimensions arena opportunity and competitive business strength. Products score high on the arena opportunity dimension if they feature large, growing and high potential markets, which are characterized by technological elasticity and feature high tech products based on leading edge technologies. Business strength focuses on the business's ability to successfully exploit this arena. Arenas score high here if they are built on the core and distinctive competencies that fit the business's marketing and technological strengths and resources well and that offer the business a solid opportunity to gain product advantage or achieve product differentiation. Figure 17 summarizes the composition of those parameters.

I. Arena Opportunity

1. Market attractiveness:
   - Size of the market in the arena 5
   - Number of potential customers in the product arena 9
   - Long term potential markets in the arena 11
   - Growth rates of the markets in the arena 17

   Sub-total: Market attractiveness 42

2. Technological opportunities:
   - Technology level of products sold in this arena (high tech = good) 12
   - Nature of technologies in this arena (leading and state of the art technologies = good) 19
   - Technological elasticity (opportunity for developing additional new products in this arena: e. g. will a dollar spent yield high returns in terms of additional new products sales and profits) 27

   Sub-total: Technological opportunities 58

Total for Arena Opportunity 100

II. Business Strength

1. Ability to leverage your technological competences, strength & experience
   - Degree of fit between production processes used in this arena & the production processes & skills of your business 11
   - Degree of fit between R&D skills & resources required in this arena & the technical skills/resources of your business 14
   - Degree of fit between engineering/design skills/resources required & your engineering/technical skills and resources 4

   Subtotal: Technological leverage 29

2. Ability to leverage marketing competences, strength & experience
   - Degree of fit between the sales force and/or distribution channel system required for this arena & those of your business 8
   - Degree of fit between the communication to the customer activities required in this arena & those of your business 14

   Subtotal: Marketing Leverage 22

| | |
|---|---|
| 3. Strategy leverage - potential for gaining for product advantage or differentiation: Envision the products that you would/could develop in this arena | |
| • Potential for impact-the magnitude of the product impact on customers (e.g., on their operations, costs, workflow, etc.) | 18 |
| • Potential for differentiation - will new products here be unique (differentiated) from competitive products | 20 |
| • Potential to meet customer needs better than competitive products | 11 |
| Subtotal: Potential for leverage via product advantage | 49 |
| Total for Business Strength | 100 |

**Figure 17: Characteristics of High-Performance New Product Arenas** [46]

Arena opportunity and business strength can be mapped into a two dimensional graph as illustrated in Figure 18. By dividing both axes business strength and business opportunity into two halves we get four areas. The right upper area shows the arenas where investments can be recommended in contrast to the arenas in the lower left area which should be ruled out. The "high risk bets" are in the upper left area. They represent high opportunity arenas where the business has no exploitable strength. Investments in that area should be considered very carefully as well as the "conservative bets" located in the lower right area. These are opportunities to be pursued at little risk but also with little returns.

In order to quantify or rank these opportunities a 45-degree line was drawn in the example illustrated by Cooper. The greater the distance of the arena to the 45-degree line, the higher should be the priority of its implementation.

[46] Cooper R. (2001), p. 373

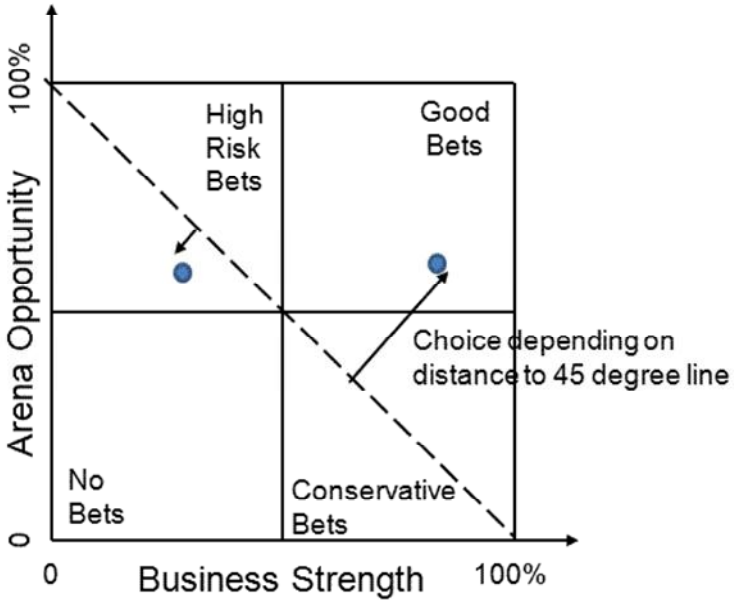



Figure 18: Arena Assessment and Assigning Priorities[47]

Based on the opportunity prioritization a resource allocation can be derived. At DGS-EC the corresponding management meeting for the resource deployment decision is the budget planning (WIPL). For the resource allocation the following key dimensions shall be considered:

- Across the arenas: Consider all arenas depending on the attractiveness and the priority with regard to financial resource allocation as defined above.
- Types of project: Referring to DGS-EC a type of project can possibly be the development of a new platform function, improvements of existing functions or quality/efficiency improvement programs.
- Project newness: Tie-breaking decisions are made depending on the distance to the home base. New products for new customer groups will require a higher amount of resources than modifications of existing products for already existing customer groups.
- Technologies or technology platforms: The resource allocation is made depending on the product's stage in the life cycle.

[47] Comp. Cooper R. (2001), p. 384

- Stage or phase of development: It needs to be distinguished between early stage projects (like feasibility studies, demonstrator or pilot customer projects), serial developments and serial maintenance projects[48].

The allocation of resources can be monitored for each key dimension separately and constitutes therefore a useful KPI for controlling the innovation process.

#### 3.3.2.2 SWOT Analysis

The SWOT analysis is a general tool for the determination of Strengths, Weaknesses, Opportunities and Threats. It is a tool which is usually applied for company analysis (=internal view vs. external view like environment analysis). The strengths, weaknesses, opportunities and threats from the inside-out view are collected by a group of persons (e. g. by a brainstorming session) and visualized as illustrated in Figure 19. Crucial for a successful and appropriate preparation is the differentiation between strengths and opportunities and weaknesses and threats. Opportunities and threats are future events, strengths and weaknesses are related to the company's current situation.

| | Positive | Negative |
|---|---|---|
| Today | Strengths | Weaknesses |
| Future | Opportunities | Threats |

**Figure 19: The SWOT Analysis[49]**

The SWOT analysis does not give any direct evidence for strategic actions or search fields (comp. Marchazina). Hence, a derivation of norm-strategies is useful as illustrated in Figure 20. Hereby a matrix is created by defining the opportunities and threats as columns and strengths and weaknesses as rows. It is useful to list and enumerate the strengths, weaknesses, opportunities and threats found by the SWOT analysis. Now the four matrix elements constitute the norm-strategies strengths-opportunities (SO), strengths-threats (ST), weaknesses-opportunities (WO) and weaknesses-threats (WT). A SO strategy can now be developed if the existing strengths are used for exploitation of opportunities. A ST strategy exists if available strengths are used to prepare for threats. For SO strategies the implementation recommended by C/HDP differs from the implementation according to Macharzina. According to C/HDP the strategic action is the reduction of weaknesses in order

[48] Comp. Cooper R. (2001), p. 373 ff

[49] Comp. Vahs D., Burmester R. (2005), p. 124

to be able to exploit opportunities. The strategic action in the case of Macharzina is to take the opportunities in order to eliminate the weaknesses. Finally the WT strategy is the reduction of weaknesses to be less/not vulnerable to any risk. In addition it is useful to list which S, W, O, and T are related to the defined strategy. An example for a SWOT analysis in combination with derived norm-strategies and also wrong decisions which might result can be found in Appendix 3.

| | **Opportunities** | **Threats** |
|---|---|---|
| | List all Opportunities<br>O1: …<br>O2: …<br>… | List all Threats<br>T1: …<br>T2: …<br>… |
| **Strengths** | **SO Strategies** | **ST Strategies** |
| List all Strengths<br>S1: …<br>S2: …<br>… | Using strengths for exploiting opportunities<br>SO1: …($O_n$ exploit. enabled by $S_m$)<br>SO2: …<br>… | Using strengths to be prepared for threats<br>… |
| **Weaknesses** | **WO Strategies** | **WT Strategies** |
| List all Weaknesses<br>W1: …<br>W2: …<br>… | Reduce weaknesses by taking opportunities<br>… | Reducing weaknesses which constitute a risk<br>… |

**Figure 20: Deriving Norm-Strategies from the SWOT Analysis**[50]

### 3.3.3 Voice of the Customer Methods

The voice of the customer methods represent a collection of tools for systematical evaluation of customer demands. Those methods are represented by the outcome driven innovation process, the Kano Model, the Gap Analysis or Gap Model, the Quality Function Deployment and the Conjoint Analysis. Some of the described methods must be applied in combination in order to derive the desired search fields.

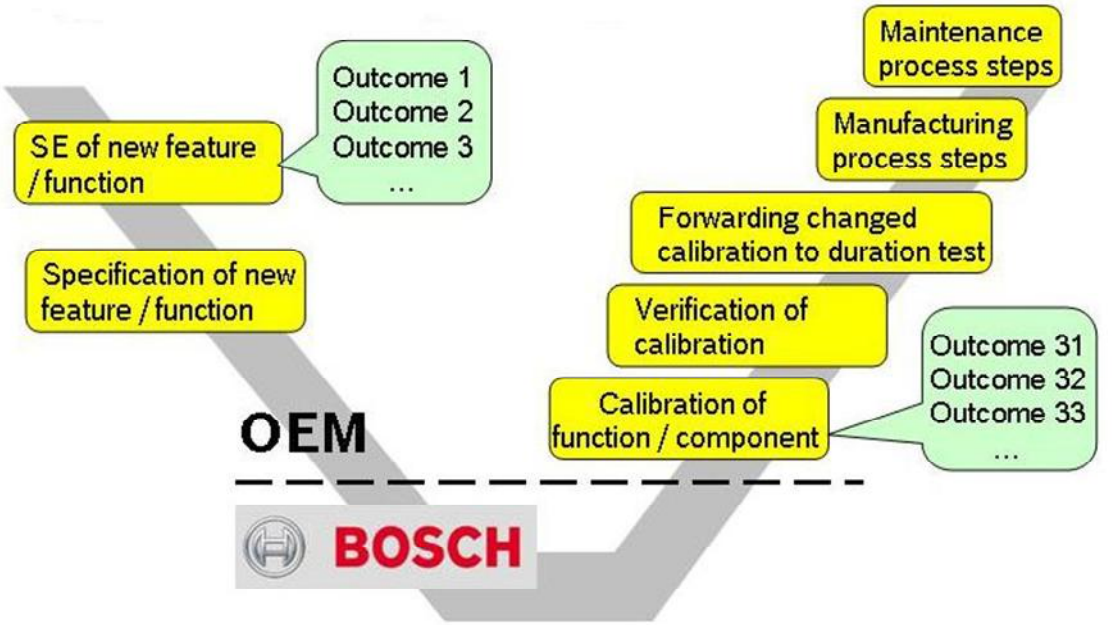
#### 3.3.3.1 Outcome Driven Innovation and Deriving Search Fields from Opportunity Map

Outcome Driven Innovation is a three stage process to identify market needs. The opportunity map is used to visualize the result of the Outcome Driven Innovation process. In a first step the jobs and the outcomes from customer perspective are defined for an

[50] Comp. Vahs D., Burmester R. (2005), p. 278 f.

emerging product or service. The crucial point here is to question the job of the customer and not the product. For example a car driver's aim is not to drive a car but to move from place A to B. Outcome means to identify how the customer defines the successful execution of a job.

In a second step the job is dissected into process steps carried out by the customer and visualized as a process step flow diagram in a job map. For each process step the outcomes for the customer are listed. Figure 21 illustrates how the outcome driven innovation approach could be applied for the engineering service which is provided for the OEMs by Robert Bosch GmBH. The process steps are projected by means of the V-development cycle which is usually applied in the automotive industry. The V-development process cycle starts with a requirement on the left side and ends with a finished product on the right side.




| | Outcome |
|---|---|
| 31 | Minimize time it takes to copy the first calibration data to the dataset |
| 32 | Minimize the likelihood of distortion by any new/changed function |
| 33 | Minimize the number of iteration loops for completing the fine tuning of the calibration data |
| 34 | Minimize the likelihood of copying the wrong data to the master dataset |
| 35 | ... |

**Figure 21: Process steps and desired outcomes for OEM's**

In a third step a survey is conducted. In the survey each outcome is questioned regarding perceived importance and satisfaction e.g.:

- How satisfied are you with the time it takes to copy the first calibration data to the dataset?
- How important is it to reduce the time it takes to copy the first calibration data to the dataset?

The questions are judged by customers with a five step scale from not satisfied/important at all to extremely satisfied/important.

The outcomes of the survey can be visualized by drawing satisfaction over importance as shown in Figure 22. It is obvious that the higher the perceived importance for an outcome the higher the customer satisfaction should be. According to this method potential for improvement is only given for outcomes rated higher than 50% importance. On the other hand we can find potential for disruptive innovation already if for the same outcome the rate of perceived satisfaction is higher than the rate of importance. Hence, the outcomes located in the white area are appropriately served in contrast to outcomes located in the upper left or lower right corner where we can find potential for disruption or improvement respectively. Outcomes which are perceived from customers as highly important and which we can fulfill are potential fields for addressing new markets. By applying regression analysis methods customers can be clustered in order to derive appropriate market segmentation[51].

Since the outcome driven innovation method is oriented on existing products, this method can be applied to optimize existing products and services. Hence, the method can be used to derive incremental or disruptive innovations but the application is limited in identifying radical innovations. The advantage of this method is that the fields for disruption or improvement can be derived from the parameters Satisfaction and Importance. This information can be obtained from end customers more easily.

[51] Comp. Ulwick A. (2009), p. 8-10

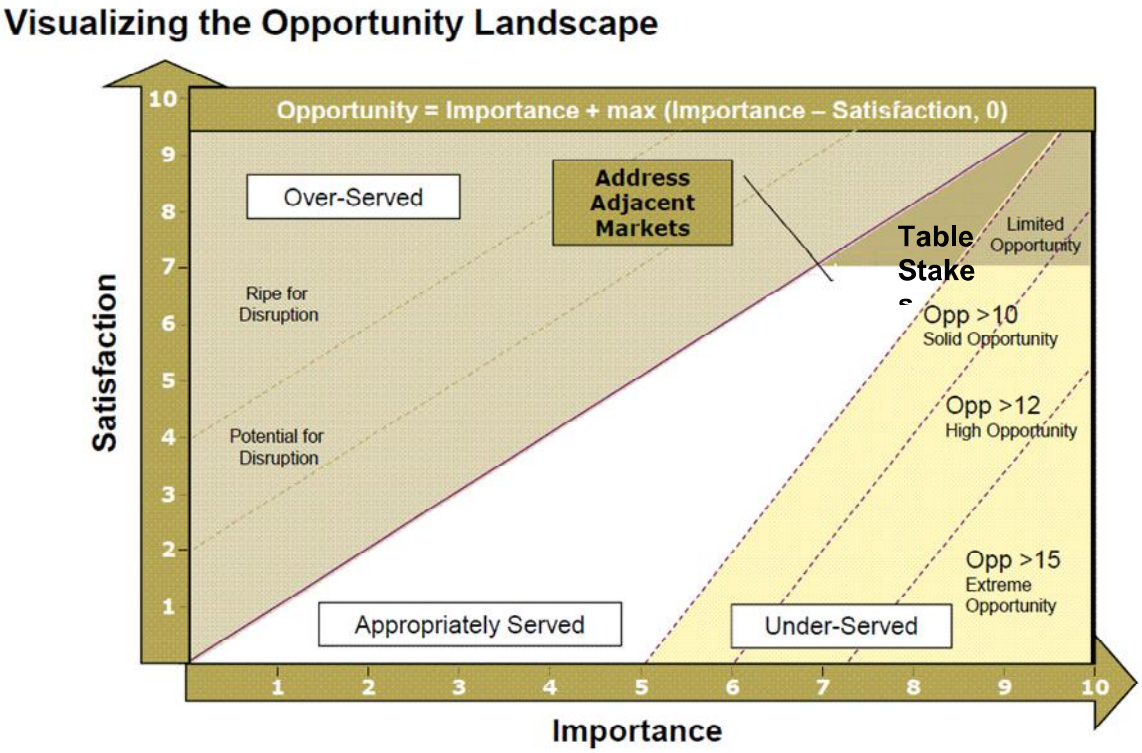



Figure 22: Opportunity map visualizing outcomes of the outcome driven innovation process[52]

### 3.3.3.2 The GAP Model

An increasing share of the revenue at DGS-EC is generated by engineering services. Hence, service activities should be covered as well if improvements in innovation activities need to be considered. The GAP model is a tool to identify gaps between desired levels and actual levels of service quality. The identified gaps constitute search fields for innovation ideas.

The basic approach of the GAP model starts with the question “What is a good service”. A service can be rated as good if the service quality expected by the customer does not deviate from the service quality perceived by the customer. Besides the customer’s service expectations due to the provider’s external communication, the expectations also result from the customer’s specific needs, word of mouth communication and past experiences. Any deviation from the customer’s perceived service quality can be designated as a gap.

According to the gap model this gap can be the origin of four additional potential failures (gaps) in the provider’s value chain for service generation. A model for all potential gaps in service quality is visualized in Figure 23. The first potential gap (Gap 1) occurs already if the management has another perception of customers’ expectations than the actual expectations of customers regarding service quality. Reasons for this mismatch (Gap1) can be the following ones:

[52] Comp. Ulwick A. (2009), p. 9

- Lacking or insufficient market research activities regarding customer expectations
- Missing or inadequate communication between staff (who is in direct contact with the customer) and managers (who have the budget and competence to react on certain issues)
- Non-efficient or slow communication flows due to too many hierarchy layers

The second gap (Gap 2) occurs if the manager's perception of service quality differs from the service quality specifications. Reasons for Gap 2 can be the following ones:

- No prioritization of customer needs and expectations
- Perception of inability of fulfilling customer expectations
- Inadequate task standardization and absence of goal settings
- No commitment of top management to service quality

Gap 3 might occur when the actual service quality delivery differs from the service quality specification. At DGS-EC the service quality specification is outlined in the Process Library[53]. Reasons for Gap 3 can be the following ones:

- Quality specifications are ambiguous and complex
- Quality specifications do not fit to the firm's culture
- Employees do not agree on the service specification and are therefore not motivated to achieve them
- Poor employee- and technology job fit
- Inappropriate supervisory control systems for service quality
- Lack of perceived control and lack of teamwork

Gap 4 occurs if the actual delivered service quality differs from the provider's external communication to the customer. External communication has an import role for service quality as it has an impact on the expected service by the customer as well as on the perceived service by the customer. Reasons for Gap 4 can be the following ones:

- Planning of the market communication activities is not coordinated with planning of the services.
- Inadequate coordination between externally-orientated marketing/sales functions and internally-oriented functions such as service engineering and controlling.
- The service firm is not able to provide the service as communicated by marketing and sales
- Marketing and sales tend to over-promise to acquire new customers

[53] The Process Library is a centralized manual containing all working instructions used at DGS.

Gaps 1 to 4 finally result in Gap 5 which is the actual difference between perceived and expected service[54].

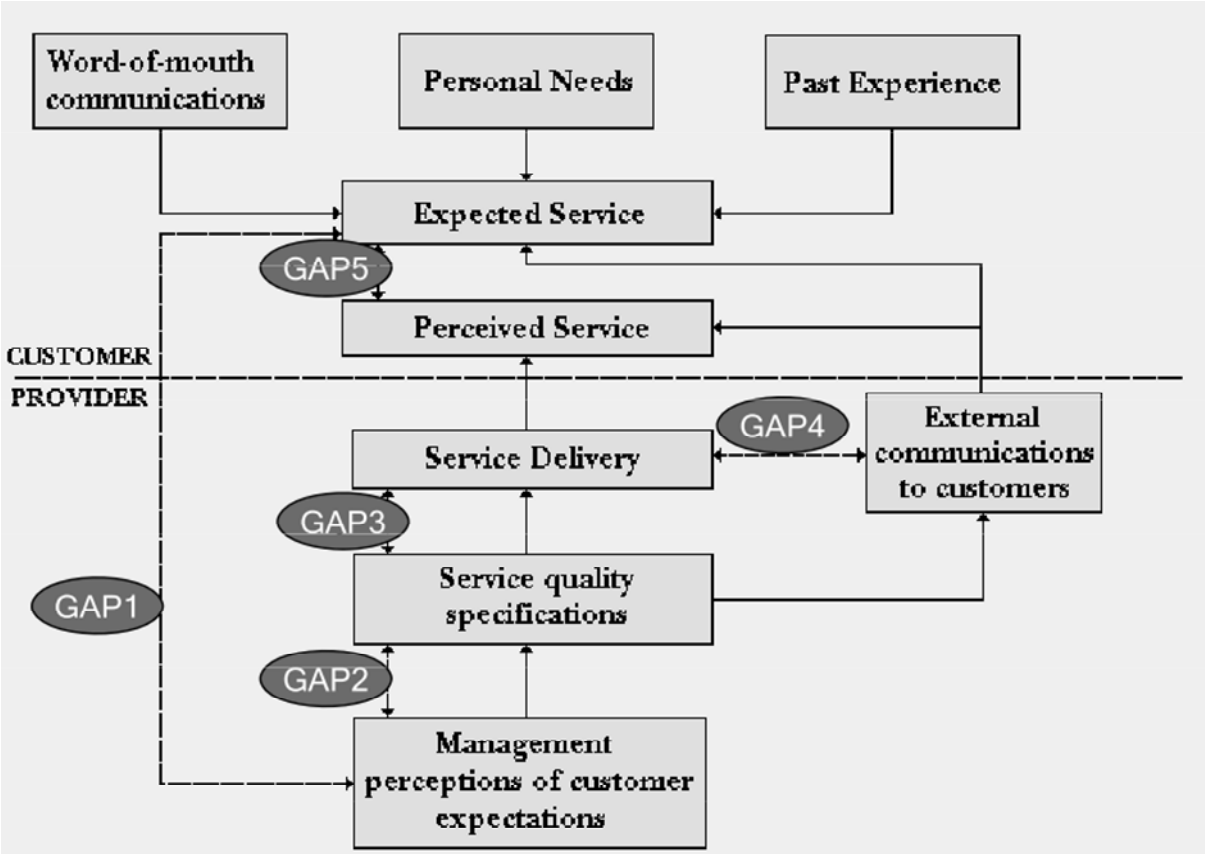



Figure 23: Model of the Service Quality Gaps[55]

### 3.3.3.3 Conjoint Analysis

The Conjoint Analysis assumes that the total value that a customer assigns to a product/service is the sum of values that the customer assigns to the attributes that make up that product or service. In order to perform a Conjoint Analysis for a new product a customer survey is necessary but it can be also used for reengineering existing products and services by analyzing the sold product attribute combinations. In contrast to the Kano Model or the Outcome Driven Innovation approach, where the customer survey is based on separated product features, the customer survey is based on a number of product variations (product attribute combinations). By applying statistical analysis methods the customer's importance for single product attributes can be calculated back. Depending on the relative importance of the single product attributes the efforts for new product developments can be better oriented.

[54] Comp. Grönroos (2007), p. 29 f.

[55] Lüthje C. (2009), p. 30

A Conjoint Analysis usually comprises the following steps: The first step is to select the attributes and attribute levels for the desired product or service. The product attributes are usually measurable parameters. For an engine control unit the product attributes and attribute levels would be as illustrated in Figure 24.

| Attribute | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| Total unit price for the customer [€] | 55 | 75 | 95 |
| Ordered engineering service as percentage of the unit price [%] | 0 | 10 | 20 |
| Performance Flash/RAM[MB]/f[MHz] | Option 1: 1.5/0.3/150 | Option 2: 2/0.56/200 | - |
| Constructed space [Inch³] | Option 1: 6x5x1,5 | Option 2: 6x6x1,5 | - |
| Power consumption [W] | 10 | 15 | - |

Figure 24: Example for product attributes and attribute levels in case of a DGS-EC engine control unit (values modified)

The second step is to combine the attribute levels in different offers. Usually each attribute level is contained in 2 to 3 offers. The higher the number of offers the better is the reliability of the generated attribute importance. Nevertheless the number of offers is limited by the cognitive capacity of the survey candidate.

| Offer | Unit Price [€] | Engineering service [%] | Performance Flash/RAM/f | Constructed Size [Inch³] | Power consumption [W] |
|---|---|---|---|---|---|
| 1 | 95 | 20 | 1.5/0.3/150 | 6x6x1,5 | 15 |
| 2 | 95 | 10 | 1.5/0.3/150 | 6x5x1,5 | 10 |
| 3 | 95 | 10 | 2/0.56/200 | 6x6x1,5 | 15 |
| N | 55 | 0 | 1.5/0.3/150 | 6x6x1,5 | 15 |

**Figure 25: Product attributes combined to offers**

In step three a survey is carried out with potential customers. The chosen price performance combinations are presented to the customer in order to obtain from every potential customer a ranking regarding the most preferred combination. The ranking of the attribute levels gives information regarding the perceived customer importance for each attribute. Attribute levels contained in the most preferred offers are weighted higher in contrast to attribute levels

contained in the least preferred offers. By adding the weights for each attribute level and by subtracting the offset of the lowest rated attribute level, the relative importance for each attribute level can be calculated. The outcome for each attribute can be visualized graphically as illustrated in Figure 26. The steeper the graph the higher is the importance and consequently the need for improving the related attribute. Based on the importance of single attribute levels the customer value for each desired attribute combination can be calculated which is an important input for pricing and market share prediction.

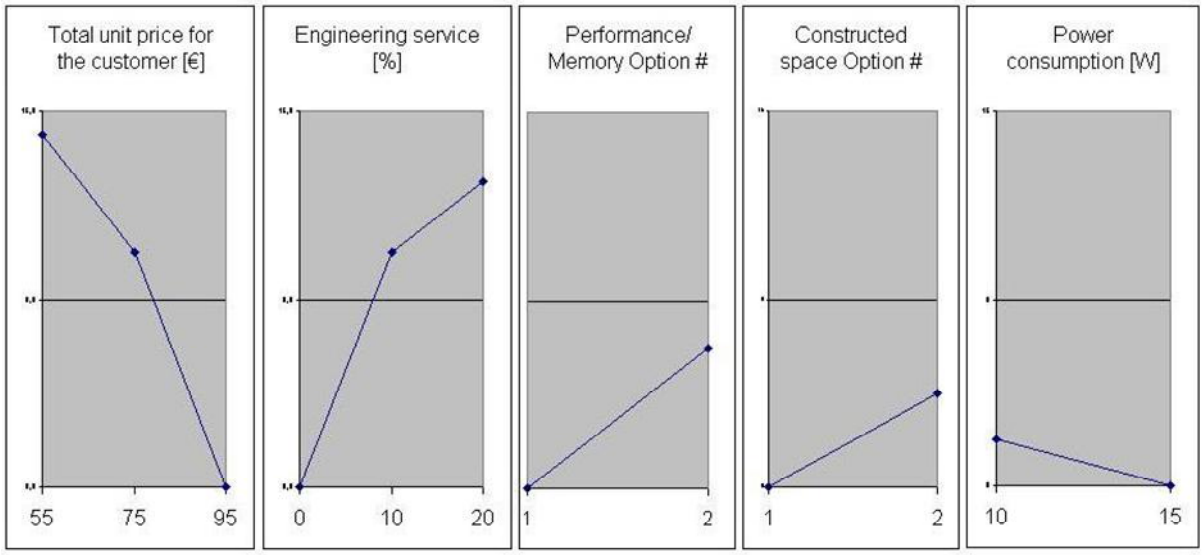



Figure 26: Relative importance between the attribute levels

A constraining factor for applying a Conjoint Analysis at DGS-EC is the required survey which comprises the following difficulties: Firstly the number of potential interview candidates is limited due to the small number of customers in the B2B segment. Further on the customer's decision process is complex and involves various persons (roles). An appropriate solution for DGS-EC could be to generate the required input based on the sales information of the existing products and customers. Such a procedure would result in a high number of attribute levels since the customers are usually served with customized solutions. For that reason the combination of attribute levels to attribute ranges is necessary (e.g. price range €55 to €65, €65 to €75 etc.). The disadvantage of this modification is that the benefit of the Conjoint Analysis is restricted to improvements of the existing products. Potential new customer groups or products outside the home base would remain undiscovered[56].

[56] Comp. Hamann/Erichson (1994), p. 47 f.

#### 3.3.3.4 Quality Function Deployment (QFD) and Target Costing

Quality function deployment is a technique that helps to translate customer needs or wants into a technique concept or design. Developed in 1972 in Japan it is actually a comprehensive tool for the stage gate process. In four steps the customer requirements ("voice of the customer") are first translated into technical specifications ("voice of the engineer") also called quality elements or design attributes. The technical solution is not created until step two. Hence, the technical specification which frames the technical solution can be regarded as - what we call - search fields. Step three links the design solutions from the second step to process operations necessary for marketing, R&D, manufacturing and delivery. In step four the process operations are linked to production requirements and resources. In the QFD those steps are symbolized as the four houses as illustrated in Figure 27 which integrates the informational needs of market, engineering, R&D and management.

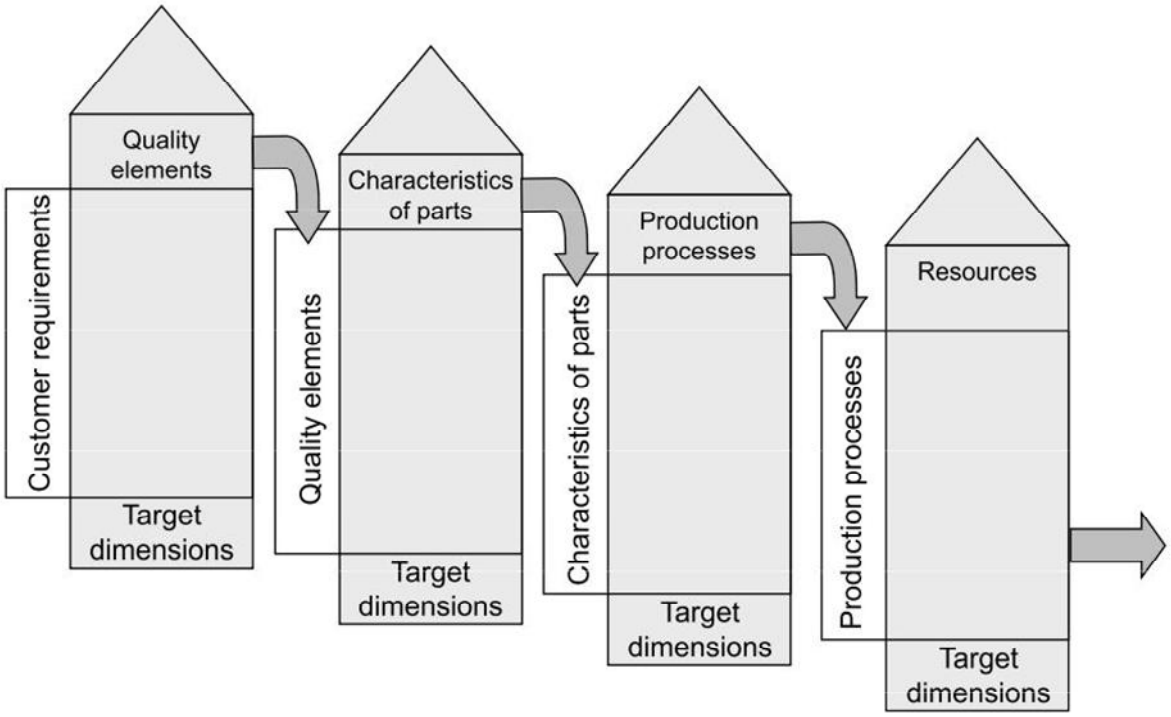



Figure 27: Quality function deployment – The model of the four houses[57]

The first house which is called house of quality will be explained more detailed as illustrated in Figure 28. The starting point is the customer requirements block which must be derived from a customer needs or wants study. As an example the following methods can be mentioned for collecting the customer needs:

- Customer surveys
- Focus groups

[57] Comp. Schmidt (1996), p. 55

- Customer site visits
- Lead user method
- Customer complaints
- Factor analysis

Besides identification of customer needs, relative importance needs to be determined. The relative importance can be derived from a conjoint analysis for example. Finally the survey candidate must rate the perceived product performance compared to competitors' products performance. These results are gathered in the house of quality's right hand side block (see Figure 28)

Subsequently a structuring of the customer needs is helpful in order to make it more manageable (usually 100-400 needs can be expected). In addition a differentiation between basic, performance and excitement (customer needs and wants) is necessary since those attributes are usually rated differently by the customers. Basic needs, for example, will always be rated high compared to excitement attributes, but the latter will be necessary for product differentiation.

The block technical specifications or quality attributes represents a set of technical parameters necessary to cover all customer needs. In general the technical parameters must fulfill the following standards:

- Measurability: Technical parameters must be measurable for being used as control parameters during the innovation process.
- Able to be influenced: Technical parameters need to be open to changes during the innovation process. Only the technical quality elements can be changed by R&D, whereas customer requirements cannot be changed.
- Solution neutrality: Technical requirements should not imply a technical solution. Defining technical requirements instead of solutions, allows for finding the best or new / unknown solutions. Hence, technical requirements act as frames for the innovation ideas (search fields).

The interdependencies between the quality elements are represented by the roof of the house of quality. Pairs of various technical parameters should be examined if their combination produces either supporting or trade-off characteristics.

The central block is called the relationship matrix and shall contain the relationship between customer needs and technical specifications. The quality team should make the decisions as to which quality elements influence which customer requirements.

The bottom block "Operationalization of quality elements" finally shall gauge competitive products on the same physical units specified by the technical requirements. Based on the relationship of strength to the customer needs of a specific technical parameter and by considering the comparison of competitors the target values of the technical parameters are specified. Those target values provide the decision criteria for the innovation gates.

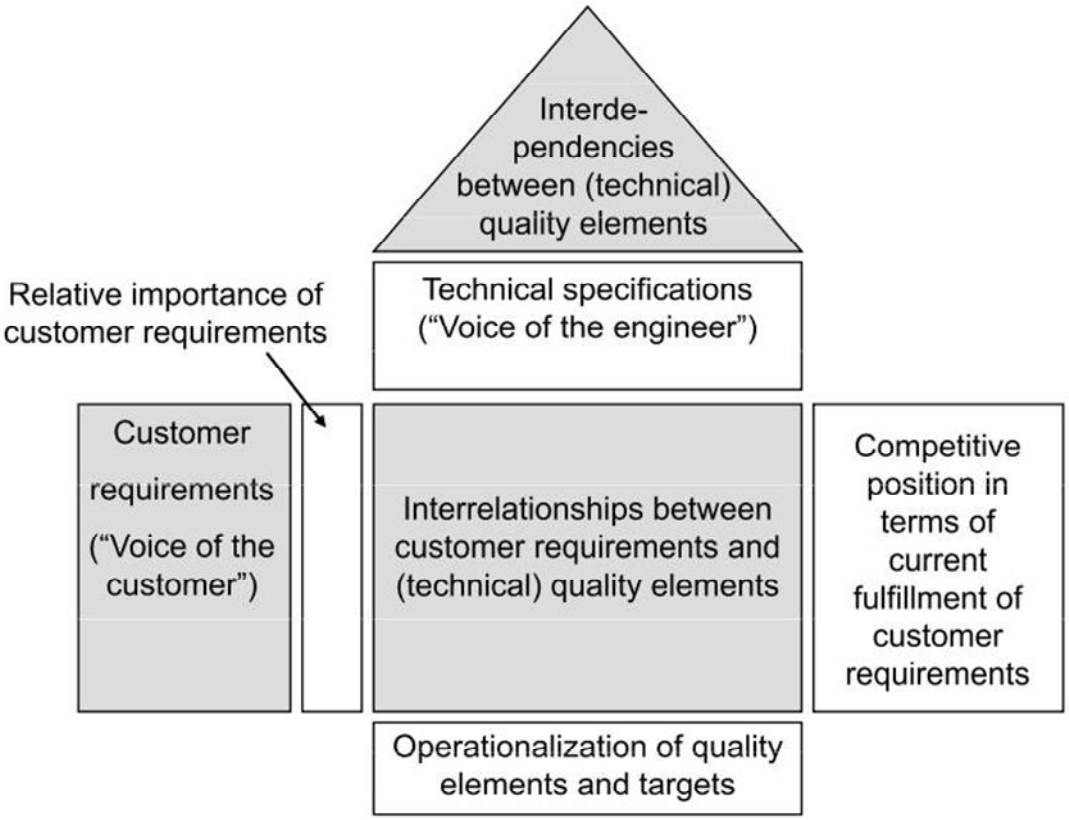



**Figure 28: House of quality - Elements and structure**[58]

An approach how to apply a quality function deployment for DGS-EC is illustrated in Figure 29. In the example, seven customer requirements are mentioned. Three of them will likely be considered as basic and four as performance attributes. The importance was rated on a scale from 0 to 5 (5 = highly important). The technical specifications can vary from very detailed and hence easy to measure like power consumption to rather conceptual like competent staff. The interdependencies can be either neutral or supportive like feasibility for software exchange and cycle time for customer request or trade off like power consumption and performance. The customer perception of competitive products was rated in three stages, from competitors perform better (-) to neutral (0) to Bosch is leading the competition (+). Subsequently the customer perceptions of competitive products have been expressed in

[58] Comp. Cooper R. (2001), p. 200

technical specifications as listed in the block target dimensions. In the relationship matrix the assessment was done on a scale from blank (=0) to high relation (=5). Finally this systematic evaluation will provide the target values for the design attributes (technical specifications). High efforts on target dimensions should be spent if strong relationships between customer requirements and design attributes (technical specifications) exist and if competitive products are superior in that specification. The example shows that a focus on competent staff followed by performance/ memory is crucial. The design attribute (technical specification) "feasibility for software exchange" is strongly represented in the performance customer requirement section. Hence, this could be a key parameter in order to differentiate from competitive products[59].

[59] Comp. Cooper R. (2001), p.199-201

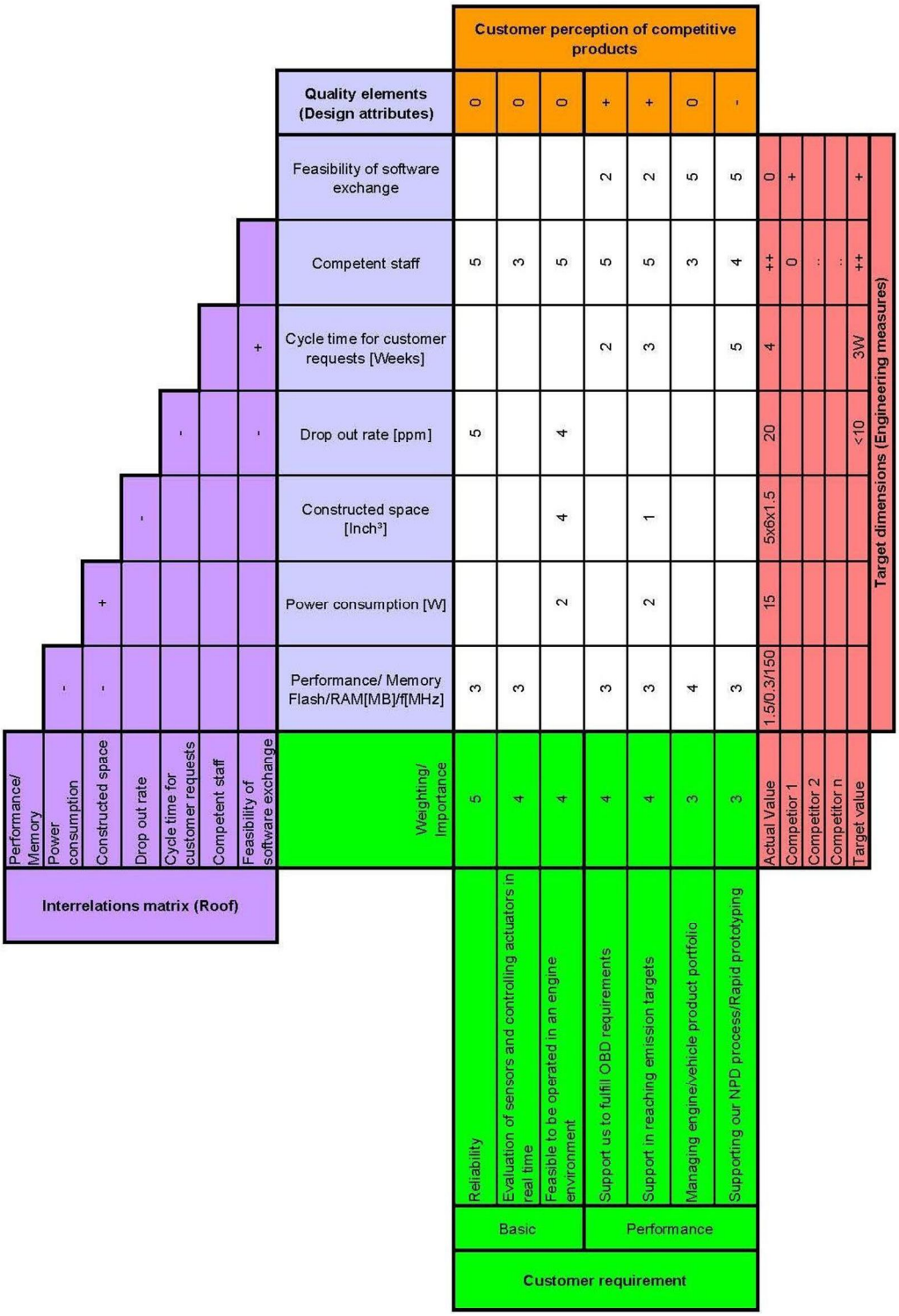



**Figure 29: The House of Quality in Quality Function Deployment**

A similar tool which is used for technological planning at Bosch is the so called “Technologie Quadrant”. As illustrated in Figure 30 this method is initially focusing on requirements (KPI) as well, nevertheless compared to the QFD the “Technologie Quadrant” method relates requirements to technical specifications instead. In the “Technologie Quadrant” method the

design attributes (technical specifications) are directly transformed into process steps. For each process step a roadmap and the responsible departments can be specified. In addition, the product succession planning and some financial projections like sales forecast are carried out. A "best of both worlds" improvement can be made if the house of quality (first house of QFD) is combined with the "Technologie Quadrant".

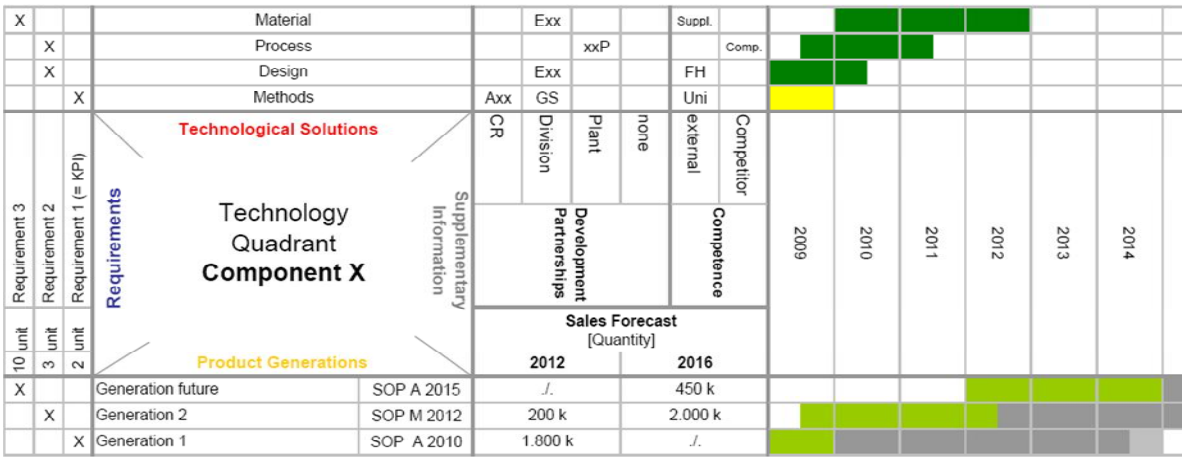



**Figure 30: Technology planning method Technologie Quadrant**[60]

The pros and cons of the QFD can be summarized as follows:

Pros:

- Products better meet customer needs (less subsequent improvement after serial production)
- Transparency of conflicts and negative interdependencies of technical specifications
- Better communication between R&D, production and marketing[61]
- Easy and understandable documentation
- Concentration of resources on the most important customer requirements

Cons:

- Greater efforts at the beginning of the development process
- Highly complex method
- Matrixes and tables become quickly unmanageable. Hence, some authors claim that QFDs greatest success occurs when the model is used conceptually, rather than in its detailed form as it is usually described[62]
- No consideration of pieces and costs

[60] Ziuber DS/ERC, Bosch Diesel Systems (2009)

[61] Comp. Griffin D., Hauser J. R. (1992), p. 199

[62] Cooper R. (2001), p. 199

Weaknesses of the QFD, such as the lack of account for prices and costs, can be avoided by complementing it with target costing. The aim of target costing is maximizing the customer benefit by efficient use of the limited resources. The starting point is the market price which is predetermined by the market. The achievable market price is related to the customer's willingness to pay. The number of customers who are willing to pay a certain amount of money for a product is usually declining with increasing price. From this relationship we can derive the expected number of products sold at a certain market price, also called the target unit price. By applying the reverse costing approach we can calculate the target costs which are given by Formula 1:

**Target costs = Target unit price – Contribution margin** Formula 1

It is obligatory to ask the question "How much are we allowed to spend for the product" before we start with the development of the product or prototype!

The next step is to split the target costs for the entire service or product into target costs for specific service elements or components of a service or product. Therefore the functions or attributes of the service or product must be determined. In addition, the relative importance from a customer perspective of each of the functions or attributes must be evaluated. Hence, asking the customer is necessary by using a conjoint analysis for example. Based on that information a weighting matrix can be generated as stated for an example of an engine control unit in Figure 31. In the example the single components of an engine control unit are listed in the left column, the functions or attributes are listed in the upper row. For each attribute based on its importance a functional weighting can be calculated (∑ Weighting factors = 1). Subsequently the project team has to assess to which extent the single product components contribute to the various product functions or attributes (∑ Contribution factors per function = 1). Finally the target costs of the single product components as a percentage of the target costs of the total product can be calculated by using Formula 2.

| | Performance Memory | Power consumption | Constructed space | Drop out | Target costs |
|---|---|---|---|---|---|
| Function weighting / Component | 0.3 | 0.1 | 0.2 | 0.4 | |
| **Printed board** | 0.1 | 0 | 0.2 | 0.1 | 11% |
| **Case** | 0 | 0 | 0.1 | 0.1 | 6% |
| **Connector** | 0 | 0 | 0.3 | 0.4 | 22% |
| **CPU/Memory** | 0.8 | 0.4 | 0.1 | 0.1 | 34% |
| **Gate array/Power supply** | 0.1 | 0.2 | 0.1 | 0.1 | 11% |
| **Power stages** | 0 | 0.4 | 0.2 | 0.2 | 16% |

Figure 31: Target costing for an engine control unit (numbers modified)

$$ZK_i = \sum_{j=1}^{m} K_{ij} h_j * 100$$ Formula 2

$ZK_i$ = Target cost index for component i

$h_j$ = Relative weight of function j of all functions

$K_{ij}$ = Weight of the component I in terms of the contribution to achieving the function j

The target costs can be compared to the actual cost by applying the method as illustrated in Figure 32. Each component is represented by one dot in the actual cost over target cost diagram. In an ideal case each point is located in the green area along the 45° line. The higher the cost fraction of the component the more accurately the actual cost should converge to the target costs. As depicted in Figure 32 the green area narrows to the upper right area. For components located above the green area cost reductions will be necessary which can be used for performance improvements of products below the green area[63].

[63] Comp. Benz, Weigand (2004), p. 66

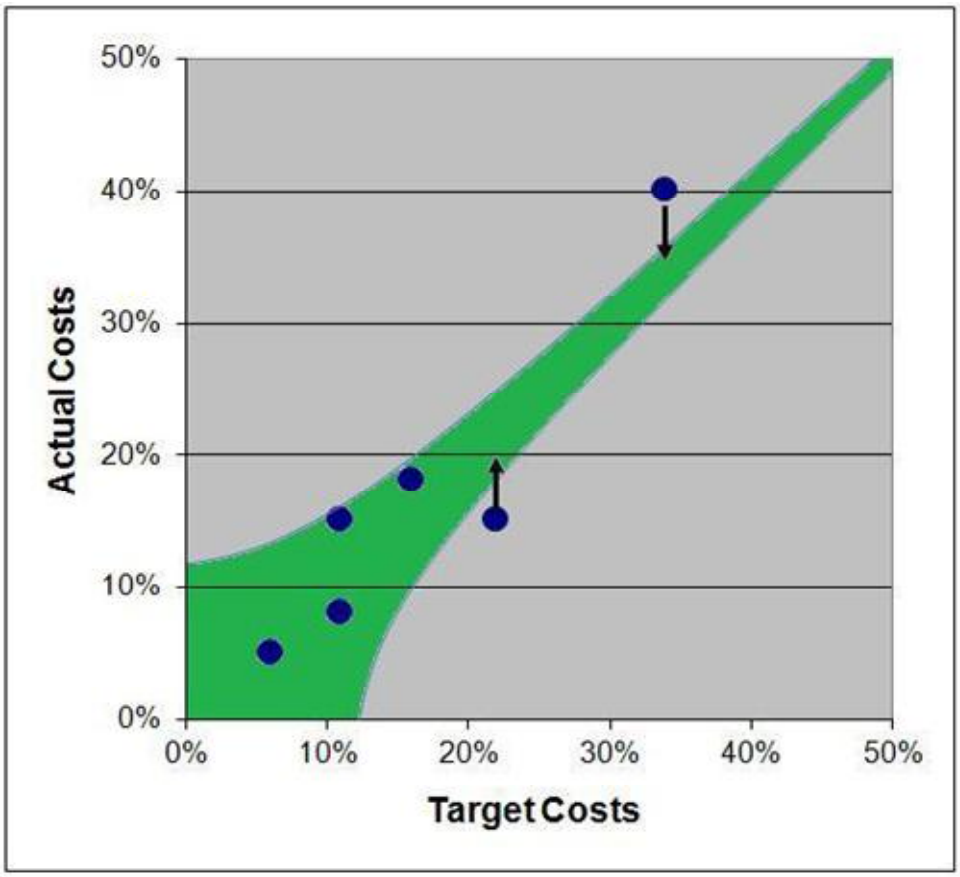



Figure 32: Target cost diagram

### 3.3.3.5 The Kano Model

The Kano model is a method for analyzing customer satisfaction. It classifies product attributes according to customer perception and their effect on customer satisfaction. Aims of the Kano Model are:

- Specific calculation of the impact of customer requirements on customer satisfaction
- Developing customized solutions to different market segments
- Defining priorities for concept and prototype development
- Analyzing competitive products with respect to their potential to create customer satisfaction

According to the Kano model product attributes can be classified into the classes' basic (=customer needs), performance and excitement attributes (=customer wants). Basic attributes are self-evident, not articulated must-haves of a product. Over-fulfillment of basic attributes does not significantly increase customer satisfaction whereas under-fulfillment decreases customer satisfaction rapidly. Performance attributes are product specific, measurable and hence explicitly disclosed. Customer satisfaction is linearly correlated to fulfillment of performance attributes. Excitement attributes are not articulated and not

expected. It will not decrease customer satisfaction in case of under-fulfillment but it usually contributes to customer satisfaction in case of fulfillment.

The Kano Model comprises a four step process. In the first step the product and service attributes are identified. In the second step a questionnaire is prepared in which for each attribute a functional and dysfunctional question is formulated, e.g. If attribute X is available or If attribute X is not available, what would you think? Step three is an interview with potential customers where each question can be rated in five steps from "It would satisfy me" to "I would be dissatisfied". Step four contains the data analysis and interpretation. Firstly each functional/dysfunctional answer couple has to be classified by using Figure 33.

| | | Dysfunctional | | | | |
|---|---|---|---|---|---|---|
| | | Like | must be | Neutral | live with | Dislike |
| Functional | Like | Q | E | E | E | P |
| | must be | R | I | I | I | B |
| | Neutral | R | I | I | I | B |
| | live with | R | I | I | I | B |
| | Dislike | R | R | R | R | Q |

E…Excitement
B…Basic
P…Performance
I …Indifferent
R…Reverse: Customers do not want that product attribute
Q…Questionable result: Question is apparently vague and poorly formulated

**Figure 33: Classification of the answers**[64]

For each attribute the distribution of answers in class E to I can be transformed into the customer satisfaction coefficients. Formula 3 provides the coefficient for satisfaction and formula 4 provides the coefficient for dissatisfaction. Attributes which are rated by a majority of customers with R should not be contained in the product. If attributes are rated by a majority of customers with Q, the questions are probably formulated ambiguously.

$$Satisfaction = \frac{E + P}{E + P + B + I}$$ **Formula 3**

$$Dissatisfaction = \frac{B + P}{E + P + B + I}$$ **Formula 4**

[64] Comp. Bailom et al. (1996), Baier (2001), p. 41

The customer satisfaction coefficients can be visualized in a two dimensional diagram. Depending on the location of the attribute, the attribute type can be assigned[65]. In addition the Kano model can be applied in order to derive appropriate product variations.

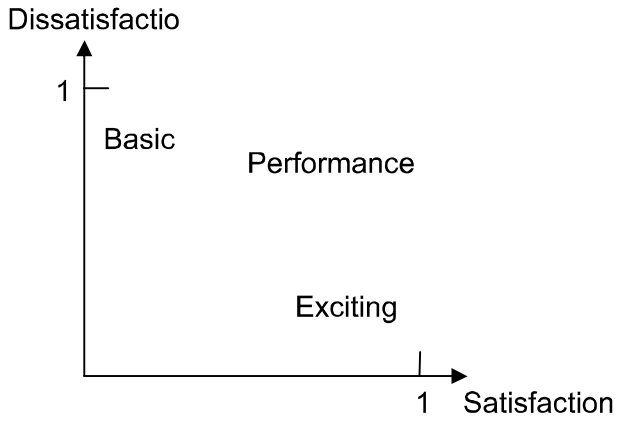



Figure 34: Deriving the type of attribute from the customer satisfaction matrix

It is helpful to apply the Kano model process in front of a QFD process since a mix of different attribute types can distort the outcomes of the QFD.

### 3.3.4 Finding new Market Applications for Existing Technical Solutions – the ISAA Method

The ISAA method is a technique where the search fields are derived from the field of technology. It is a four step approach for commercialization of technology push innovations. ISAA stands for Identify Search Analyze Assemble. The idea is to find alternative market applications for existing technologies or patents and hence to leverage the ROI of the already spent R&D costs e.g. by licensing an existing patent for other fields of industry. According to Bosch C/HDP definition the search of alternative applications for existing technologies is called “Type B” search field.

The ISAA method comprises the following four steps:

Step 1: Identification of the need based benefits. The goals are to understand the technology, to identify the USP (unique selling proposition) and to find the benefits of the technology. Therefore the following questions need to be answered:

- Which problem does the technology solve?
- What are the technology’s opportunities and limitations?

[65] Comp. Berger et al. (1993), p. 38

- What is the USP from the customer perspective?
- Which special needs are met within the current field of application?

Step 2: Search for problem holders. The aim is to search for users with similar problems and to search for alternative fields of applications. It is useful to answer the following questions:

- Which users have problems comparable to those of users in the current field of application?
- In which industries are the identified needs based benefits relevant, too?

For the search process itself several methods can be employed such as broadcast search, screening and pyramid search. Broadcast search is a technique where each member of a community or network is asked by posting the solution e.g. via internet. A commonly used platform for exchange of problems and ideas is provided by INNOCENTIVE (www.innocentive.com). By the search technique pyramiding referrals are used to identify the target person (problem holder) in a stepwise manner. Questions typically look like "Do you know the problem of…?", "Do you know someone who suffers from a similar problem?" That technique is also feasible to identify other types of communities which might have a similar problem which must be solved. Finally, screening is a technique where a sample of people is used to identify problem holders. An example for a screening method is a classical survey conducted e.g. by market research firms.

Step 3: Analyze potential application arenas. This step comprises a quick check of potential application arenas and an in-depth analysis of the most promising application arenas. The check of potential application arenas includes a check for strategic fit. In contrast to Cooper's Arena assessment (see 3.3.2.1) Kainz and Prügl emphasize the benefit relevance in addition. The assessment for strategic fit is divided into an assessment for the "Time Horizon" which is rated on a scale from 0 (= Timeline for planned market entry is impossible) to 2 (= Timeline for planned market entry can be meet) and "Resource Fit" which is as well rated on a scale from 0 (= Market can be penetrated only by increasing the resources significantly) to 2 (= Market can be penetrated with existing resources). The benefit relevance for the new field of application depends on the factors "Benefit hits" and "Relevance". "Benefit hits" is the ratio of the relevant need based benefits to all need based benefits identified in step 1. A need based benefit is relevant for the new field of application if the following criteria can be rated high (e.g. on a scale from 0-2):

- The problem I have described is highly relevant
- The relevance of the problem described will increase in the future
- Currently, there's no appropriate solution for this problem
- Many people would benefit tremendously from a solution for this problem

Both, “Strategic fit” and “Benefit Relevance” can be visualized in a two dimensional diagram where the most promising fields of application can be found in the upper right area.

For the in depth analysis of the most promising arenas Kainz and Prügl use the dimensions competiveness, need for modification, market growth (color of bubble) and market potential (size of bubble) as illustrated in Figure 35.

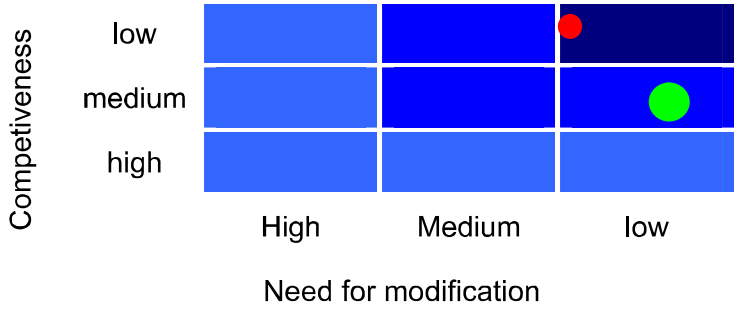



**Figure 35: Market potential matrix for in depth analysis of the alternative applications for an existing technology**

Step 4: Assemble actionable commercialization strategy. This step contains the creation of the business model (not described in detail here)[66].

[66] Comp. Kainz ,Prügl R. (2008), p. 28

# 4 Assessment of the Described Methods regarding an Application at DGS

The assessment of the methods' applicability was done by experts and innovation representatives of DGS. As a first step a pre-evaluation of the methods has been carried out by the author and his supervisor in order to select only the most promising methods for the presentation. Consequently an innovation workshop with innovation experts and representatives was conducted where the author of the study presented and consequently collected the feedback for each and every method.

## 4.1 Pre-Evaluation of the Described Methods regarding an Application at DGS-EC

A summary of strengths, weaknesses and opportunities of the described methods is given in Table 2. In addition it was considered whether the described methods are part of corporate instructions or recommendations. Depending on this pre-evaluation the most promising methods have been selected for presentation.

From the collection of foresight methods only one method was selected since corporate foresight is not in the scope of a single PU and central departments can provide the necessary information. Nevertheless some foresight skills are necessary to adapt the available foresight information to the specific PU. As the most suitable method of this category the scenario analysis has been chosen since this method is well accepted within the organization and the necessary know how for appropriate conduction is available.

From the strategic planning category both investigated methods have been presented since strategic planning is the most important process step for strategic innovation planning within a PU. For both methods central corporate recommendations for implementation exist as well.

From the "voice of the customer" category the Kano model and the conjoint analysis have not been selected for the survey. The Kano model can be regarded as a comprehensive model for the QFD but its information can not be directly converted into product development. The conjoint analysis can be abandoned since the necessary customer survey is difficult to carry out. QFD, "Technologie Quadrant" and target costing have been presented in combination since the "Technologie Quadrant" is already applied at DS and the combination with the first house of the QFD could be an evolutionary improvement of an already existing method.

Finally the introduction of the ISAA method as representative for the technology push category was not pursued any longer since its outcome would target a completely different

customer group and would therefore require a radical change of the business model (e.g. licensing of patents to outside businesses).

| Type | Method | Focus | Central instr. | Strengths | Weaknesses | Opportunities | Executed By |
|---|---|---|---|---|---|---|---|
| Foresight Methods | Scenario Analysis | Time frame 5-10 yrs, can be applied for:<br>• Products, product categories<br>• Technologies, technological fields<br>• Business units<br>• Companies<br>• Entire industries and markets | x | • Systematic approach<br>• Systematic consideration of environmental conditions | • Appropriate application of the method is important<br>• Experienced moderator is necessary<br>• Outcome is a forecast which might include uncertainties | • Provides information necessary for decision making at DGS<br>• Provides direction for product planning<br>• Systematic approach in order to derive a strategy which covers the most likely scenarios (robust strategy) | Bosch (C/AI), BU, PU |
| | Delphi Analysis | Time frame 5-10 yrs, can be applied for<br>• Products, product categories<br>• Technologies, technological fields<br>• Business units<br>• Companies<br>• Entire industries and markets | | • Method is less difficult than scenario analysis<br>• Anonymous survey which avoids bandwagon effects and the overweighting of dominant persons' opinions | • Finding experts is challenging<br>• Outcome results from subjective assessments<br>• Outcome is a forecast which might include uncertainties | • Provides information necessary for decision making at DGS<br>• Can be applied within product planning for decisions regarding the direction | Bosch (C/AI), BU, PU |
| | Extropolation-Retropolation | Time frame 5-15J, can be applied for<br>• Products, product categories<br>• Technologies, technological fields<br>• Business units<br>• Companies<br>• Entire industries and markets | | • Combination of scenario method and trend analysis<br>• Can provide more accurate forecasts | • High effort<br>• Acceptance within Bosch<br>• No in-house experiences with the method<br>• Outcome is a forecast which might include uncertainties | • Comparable to scenario analysis<br>• Potential to reduce uncertainties in scenario analysis | Bosch (C/AI), BU, PU |

| Type | Method | Focus | Central instr. | Strengths | Weaknesses | Opportunities | Executed By |
|---|---|---|---|---|---|---|---|
| Strategic Planning | Product Market Growth Matrix | • Tool for deriving a growth strategy (Who, What, How)<br>• Addresses market-based view (outside-in perspective) | x | • Approach for systematic search for new markets and product opportunities | • Method probably too coarse-grained to be applied for product planning within a PU | • Reveals new and market opportunities | Bosch, BU, PU? |
| | SWOT/Norm Strategies | • Can be applied for company analysis<br>• Addresses the resource-based view or inside-out perspective | x | • Applicable for many different problems<br>• Advantages for strategic planning become visible in combination with norm strategy method<br>• Method can easily be carried out | • For strategic planning, input from additional methods e.g. the Ansoff method (opportunities) and the scenario analysis (e.g. threats) is necessary | • SWOT leverages the benefits of the methods described above | Bosch, BU, PU |
| Technology push | ISAA Method | • Technology push innovations<br>• New application for existing technology | | • Systematic search for new applications of existing technologies | • New applications outside DGS-EC business<br>• Technology push innovations are difficult to launch in general<br>• Relatively new method, not yet applied within Bosch | • Leveraging the product development efforts | BU |

| Type | Method | Focus | Central instr. | Strengths | Weaknesses | Opportunities | Executed By |
|---|---|---|---|---|---|---|---|
| Voice of the customer | Outcome Driven Innovation | • Applicable for products and services | | • Opportunity map provides input for improvements as well as for disruptive innovations<br>• Shows cost saving potentials<br>• Points out on which product features or service characteristic variants are required | • Customer survey necessary<br>• Design of questionnaire is tricky | • Customer value chain can be analyzed systematically for innovation potentials | BU, PU |
| | Quality Function Deployment | • Translation voice of the Customer into voice of the engineer<br>• Method can be applied for products and services | x | • Systematic approach<br>• Considers customer require-ments, competitors and inter-relations of technical attributes<br>• Explicit differentiation between customer needs and technical attributes | • Matrices and tables become quickly unmanageable especially if QFD is carried out too detailed<br>• Dependence on input from sales and customer engineering regarding customer require-ments | • Combination with applied "Technologie Quadrant" possible<br>• Improvement of customer satisfaction | BU, PU |
| | Target Costing | • Comprehensive tool for QFD<br>• Provides the cost structure of components | | • Simple method if input data are available | • Customers' rating regarding importance of single product functions is a necessary input (e.g. conjoint analysis is required in addition) | • Costs for components related to customer benefit (=willingness to pay) → development of competitive products | BU, PU |

| Type | Method | Focus | Central instr. | Strengths | Weaknesses | Opportunities | Executed By |
|---|---|---|---|---|---|---|---|
| Voice of the customer | GAP Method | • Creation or improvement of services (e.g. engineering services) | | • Provides better understanding of how service quality originates<br>• Systematic procedure to analyze potential reasons for dissatisfied service customers | • Identified gaps do not reveal reasons for low customer satisfaction, the model does not provide direct recommendations and implications for the firms<br>• Specific reasons for gaps have still to be analyzed<br>• Increasing customer expect-ations (and hence Gap5) regarding service quality due to the previously conducted customer satisfaction survey<br>• No direct recommendations for cost savings | • Improvement of engineering service quality | BU, PU |
| | Conjoint Analysis | • Method which splits the overall customer benefit (=willingness to pay) of a product into single functions of product/service | | • Provides information about importance of single product functions | • For new products a customer survey is necessary<br>• Method is based on "Would you buy" questions, nevertheless customer's purchasing decisions are not made by one person<br>• Applicable for few product functions only | • By analyzing existing project acquisitions, customer's rating regarding importance of single product functions can be derived | BU, PU |

**Table 2: Evaluation of the selected innovation management methodes regarding suitability for the application at DGS**

## 4.2 Primary Research Method and Administration

### 4.2.1 Research method

After the author determined the theoretical background of the issue by screening secondary data (see chapter 3), a primary research was conducted which should provide an evaluation regarding the applicability of the methods for strategic innovation management and product/service planning.

Regarding the nature of the defined research questions (see 1.2) the organization of an innovation workshop with innovation representatives was necessary. The selected participants are dedicated innovation representatives of the departments marketing (MKT), function and software development (NE2), engineering processes (EPQ) and customer engineering (CE). In a three hour workshop the following six selected methods have been presented to the above mentioned persons:

- Scenario Analysis
- Ansoff Product / Market Growth Matrix
- SWOT analysis in combination with Norm Strategies
- Quality Function Deployment in combination with “Technologie Quadrant” and Target Costing
- Gap Method
- Outcome Driven Innovation and Opportunity Map

The subsequent discussion amongst the experts gave already valuable inputs regarding the applicability of the respective method.

Additionally a survey was conducted for collecting the feedback.

### 4.2.2 Administration of the survey

The research sample consisted of the innovation representatives (as described above) who participated either personally or via net meeting at the innovation workshop. The questionnaire as described below was handed out at the beginning of the meeting. Afterwards the methods were presented by the author of the study and after each presented method a subsequent discussion took place. The participants had the possibility to fill in the questionnaire for the respective method while the presentation was taking place.

After the workshop all filled in questionnaires were collected and could be analysed together with the inputs of the discussion.

### 4.2.3 Design and development of the questionnaire

The questionnaire contains the same questions for each of the methods presented (as described above). Due to the nature of the research questions a mixture of open and closed questions was designed. The open questions deliberately seek longer answers and the aim is to gather qualitative inputs:

1) For which problem the described method could be applied at DGS?

2) Which barriers do you see for the introduction of that method at DGS?

With the following closed questions a quantitative evaluation of every method is possible:

3) On a scale from 0 to 5, how do you rate the necessary effort for the application of that method at DGS?

4) On a scale from 0 to 5, how do you rate the benefit of the introduction of that method at DGS?

5) On a scale from 0 to 5, how suitable do you assess the described method for the development of an innovation strategy for DGS?

6) Would you apply the method? (Yes/No)

The questions were formulated in a way that they provide answers to the following points:

- Applicability of every method
- Comparison of efforts versus benefits per method
- Commitment of involved employees
- Specific fields of application
- Specific barriers for the application

The formulation of the questions was conducted jointly by the dedicated engineer for the innovation process at DGS-EC and the author of the master thesis.

# 5 Empirical Evaluation regarding Suitability of the Described Methods for DGS

The following summary shows the consolidated feedback regarding the presented methods for strategic innovation management and product/service planning.

**Scenario Analysis**

In general the scenario analysis was evaluated as a suitable tool to assess the development of an engine control unit industry environment. The evaluation has shown that the scenario analysis can be used to answer the following two questions:

- Is the strategy which DGS-EC applies appropriate for all scenarios which might occur (robust strategy)?
- Into which directions shall the development of the next product generation be directed?

The scenario analysis is seen as a tool which can reveal future opportunities and risks for the business as well as for the identification of indicators which disclose possible future scenarios. It was also mentioned that the future scenarios provided by the central corporate departments are too coarse-grained for being used by the engine control unit department. Hence, at least a separate scenario analysis which refines the outcomes of the corporate departments is required for DGS-EC in order to get a useful picture of the future.

As a barrier for a successful introduction the high efforts inherent in the execution of this method have been identified. Additionally the participation of a skilled moderator and experienced participants from various fields are considered as fundamental for achieving valuable outcomes. It was also questioned if the management accepts decisions according to the outcomes of the scenario analysis and if future scenarios are monitored according to the indicators derived by the method.

**Ansoff Product Market Growth Matrix**

Compared to the scenario analysis the benefits of the Ansoff matrix for DGS-EC have been assessed as significantly lower. Possible fields of application have been seen in a systematic search for gaps in the product-market landscape but also for the identification of the strengths and weaknesses in the current business areas.

Two of the six survey candidates were not convinced that the method can reveal opportunities which couldn't be found intuitively as well. The tool was perceived as a typical marketing tool which does not come up with specific outputs.

**SWOT analysis in combination with Norm Strategies**

The SWOT analysis especially in combination with the norm strategy method has been considered as a very effective tool for developing an innovation strategy as well as for being applied for different kind of questions in the daily business. Identified fields of application are the following ones:

- Strengthening the department's competitive position
- Developing core competences
- Applicable as general problem solving approach

**Quality Function Deployment in combination with "Technologie Quadrant" and Target Costing**

This method was perceived as too complex and time-consuming compared to the achieved benefits. The development of new product types and the translation of substantial product briefings have been regarded as possible fields of application as long as the detail level isn't too high. For smaller changes the engineer's intuition and know-how is considered as a more efficient tool for translating customer needs into products. An additional barrier might be the high amount of required customer input (e.g. importance of requirements). This could also be a barrier for the target costing method. Nevertheless the demand for target costing methods at DGS-EC has been explicitly stressed during the meeting by the survey candidates.

**Gap Method**

In general this method was considered as useful for improving or developing service activities nevertheless the missing identification as service provider might be a drawback. An additional barrier might be the fact that the method is not listed in any corporate instruction handbook.

**Outcome Driven Innovation and Opportunity Map**

This method was considered as quite suitable for the identification of service innovation potentials. During the discussion the suggestion come up, that this method might be appropriate for company internal service providers. The missing identification as service provider, the necessary customer survey, the necessary efforts and the missing acceptance within the company have been regarded as barriers for a successful implementation.

The following figures show graphically how the different methods have been rated with regard to involved benefit vs. effort and the degree of applicability.

In Figure 36 for every method the results for the expected benefits in comparison to the efforts are shown in a two dimensional diagram. In the upper left quadrant the methods where the realization causes the highest benefits and necessitates the lowest efforts are

shown. Thus in the sample the implementation of the SWOT and norm strategy method are evaluated as most promising within a DGS-EC innovation process. The scenario analysis is also rated as highly beneficial; nevertheless the implementation requires high efforts.

In contrast the QFD and "Technology Quadrant" methods are rated as inferior with regard to benefit and effort. The appropriate methods for service improvements, such as the gap analysis and the outcome driven innovation applied for services, are considered as less constructive but at least they require fewer efforts. One explanation therefore can be the missing identification as service provider and, hence, the missing demand for such methods.

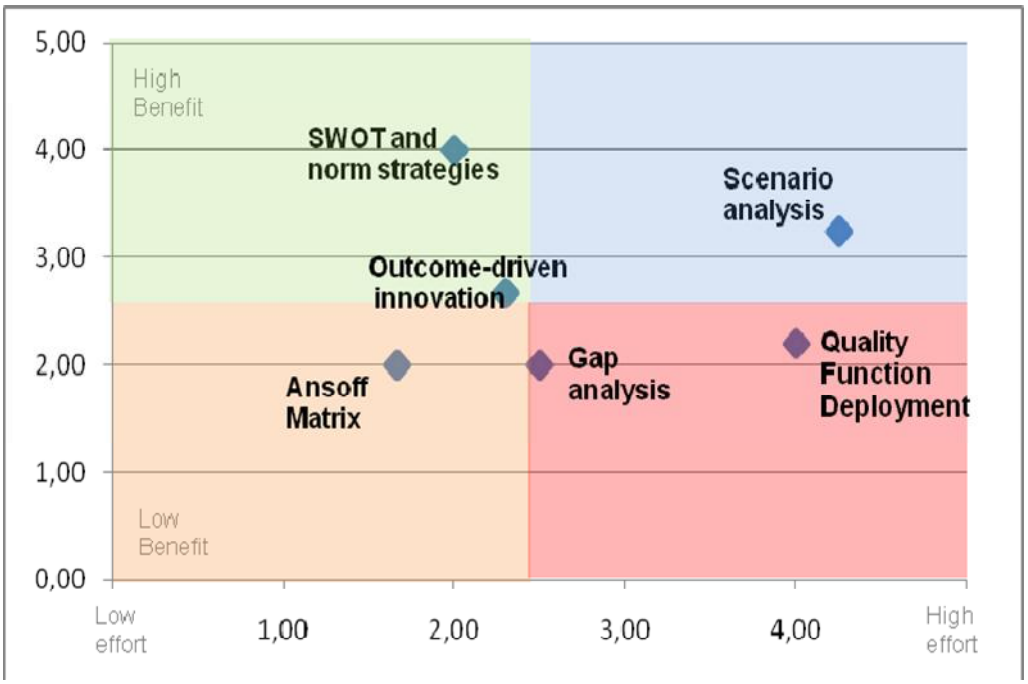



**Figure 36: Benefit and effort of the selected methods for the development of a DGS-EC innovation strategy**

The evaluation of the methods' applicability for DGS-EC is shown in Figure 37. The chart shows that the rating of applicability correlates with the benefit ratings. Significantly low ratings are assigned to the methods "Ansoff matrix" and "Quality function deployment and Technology Quadrant". Again the SWOT / norm strategy as well as the scenario analysis method are considered as highly applicable for introduction into the DGS-EC innovation process.

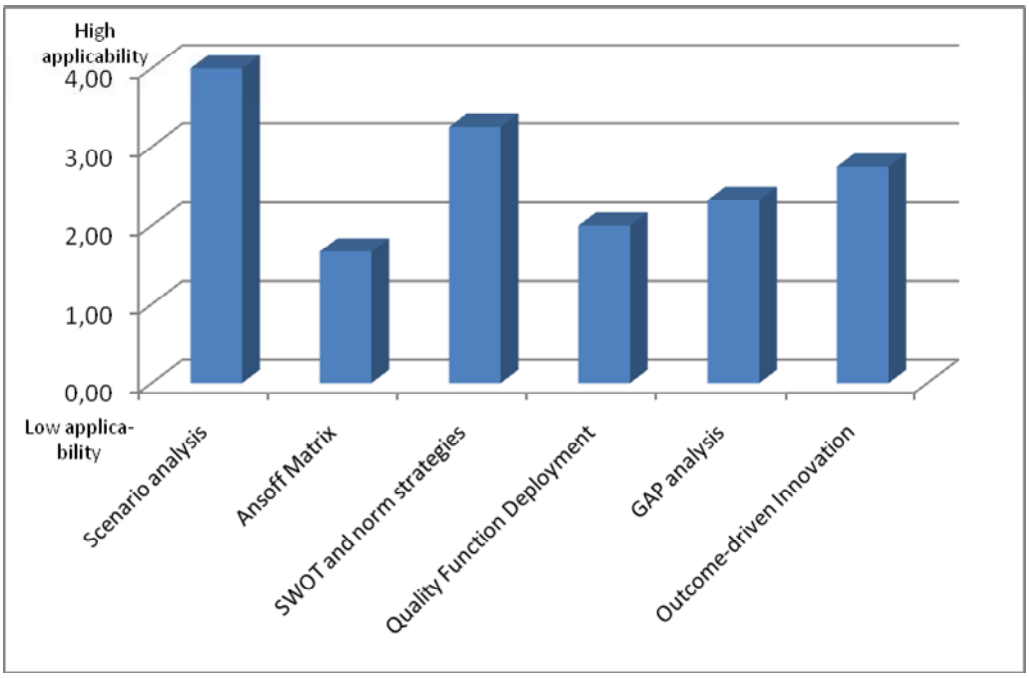



**Figure 37: Applicability of the different methods for DGS-EC (max = 5)**

The question, regarding the personal commitment to implement a method, gives a similar picture. Except for the Ansoff matrix, high commitment is dedicated towards the methods which can be applied for strategic innovation management, namely the SWOT and norm strategy method and the scenario analysis.

The quality function deployment and the "Technologie" Quadrant, as listed in the literature, applied for product and service planning are rated significantly lower by the engineers.

Finally it needs to be mentioned that the applicability strongly depends on the concrete situation and the respective problem. The innovation representatives' willingness and commitment towards the application of the single methods is depicted in Figure 38.

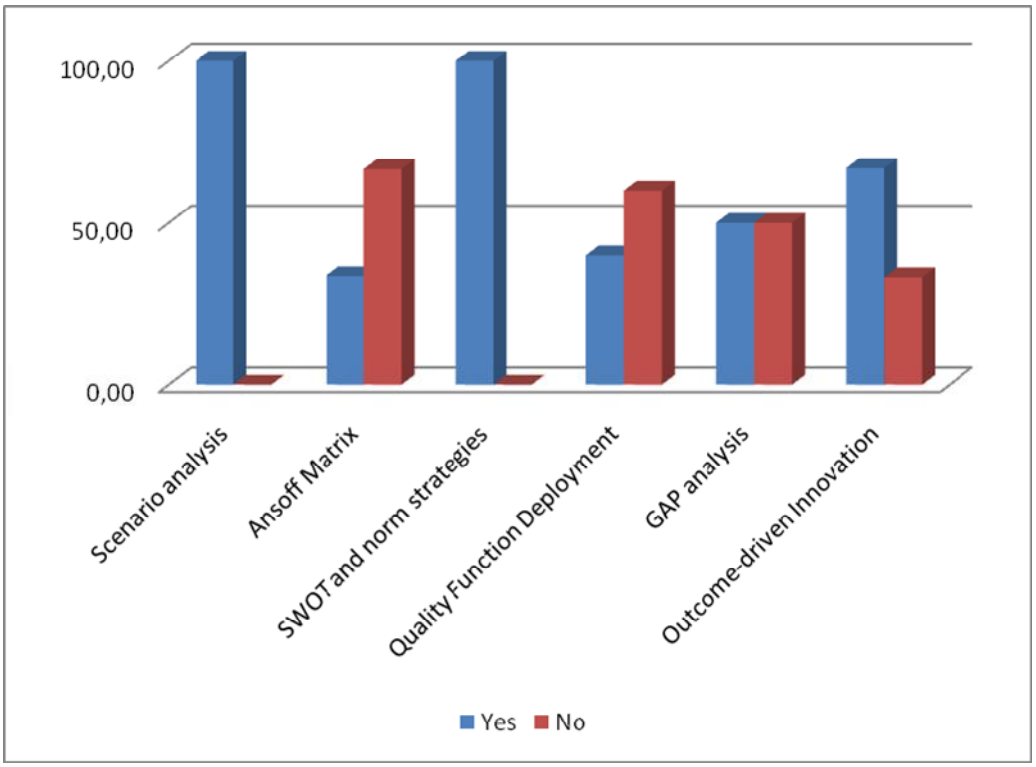



**Figure 38: Innovation representatives' willingness and commitment to apply the method**

# 6 Conclusion

In the course of this master thesis various methods have been analyzed which cover the corporate innovation strategy fields of corporate foresight and corporate planning, and which can be used for product planning. On the one hand this analysis aims to consider methods which are useful for a top down product development process. On the other hand methods are evaluated which are helpful in providing search fields and which tie bottom-up innovation activities supportive to top down managed product development activities.

From the analyzed corporate forecast methods the scenario analysis was selected as the first step of strategic innovation management. The study revealed that even in an organisation where corporate foresight activities are conducted primarily by the central departments, comprehensive foresight activities in the PUs are necessary in order to provide relevant future scenarios for e. g. an engine control unit development. The derived future scenarios are necessary in order to align the planning of the PU next generation's core product (engine control units) and, in the course of a robust strategy, to align the technological management to be prepared for future technological challenges. The study has shown that the presented method is quite appropriate to support that process but the survey candidates at DGS-EC have also expressed their concerns regarding the effort which comes along with the introduction of such a method.

The SWOT analysis in combination with norm strategies and the Ansoff product / market growth matrix are the selected methods for the corporate planning stage. The Ansoff product/market growth matrix as representative for the outside-in view was considered as less useful for a PU like DGS-EC by the innovation representatives. The main deficit is the unspecific and too coarse grained output for a PU.

In contrast to the Ansoff Matrix the SWOT/Norm strategy method has received much more recognition. Especially the norm strategy method as representative for an inside-out view was viewed highly. Nevertheless it must be clarified to which extent the opportunities, which might be derived from a scenario analysis, are sufficient as input for the SWOT/norm strategy method.

The benefits of the methods which might be useful for product and service development like the quality function deployment, the outcome driven innovation process and the gap analysis have been assessed as mediocre only. The introduction of the methods (aimed to improve the market orientation of the department) showed the following problems: Firstly, not all departments of the PU acted initially as a service provider, hence, methods for improving the

service quality are perceived as not relevant for those departments. Secondly, most of the methods imply a customer survey which is difficult to carry out in that business. The market information available for DGS-EC comes instead from the sales and the customer engineering departments. In addition methods like the QFD and "Technology Quadrant" have been regarded as too complex and less efficient compared to human intuition.

The weak acceptance for methods like the Ansoff Product/Market matrix and the voice of the customer methods might also be an indicator for the strategy which the company is following. It is evident that the organization is very familiar with methods which cover the inside-out perspective (e.g. SWOT/norm strategy method). On the other hand methods which can be assigned to the outside-in approach (e.g..Ansoff method) as well as voice of the customer methods (e.g. QFD method) are according to the conducted survey poorly accepted within the organization. Thus the market orientation is not that strong, leading to the conclusion that Bosch does not follow a differentiated strategy. Referring to the strategy topology of Miles and Snow the organization applies rather a technology push strategy. This implies again that this strategy does not favour marketing methods, as initially an idea is developed and the corresponding market is targeted as a second step.

The study has also shown to which extent bottom up innovation activities can be managed e. g. by the definition of search fields. Search fields which might result from corporate planning methods (e.g. SWOT/norm and Ansoff method) were better accepted for aligning the bottom up innovation activities to the corporate strategy. The attempt to apply the definition of search fields for the development of specific product characteristics was considered as less efficient. However, bottom up innovation activities are crucial for a firm's innovation process and the question to clarify is how to provide the necessary breeding ground for a bottom-up innovation friendly environment.

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## Appendix

| Stärken / Strengths | Schwächen / Weaknesses |
|---|---|
| Erfindungsmeldungen trotz zahlenmäßigem Einbruch | Fehlende Markt-, Produkt-, Technologie- und Innovationsstrategie |
| Kundengetrieben Innovationsthemen (Kunde hat "unternehmerische" Entscheidung schon getroffen) | Querdurchlässigkeit NEx- Bereiche |
| High focus of technology intensive innovations. | Rollen im Innovationsmanagement unklar |
| im CE-Bereich sind wir sehr gut über Kundeninteressen bez. SG-Features, die Richtung I/O, Konfiguration und Ressourcen gehen, informiert | Kapa, Budget, Aufmerksamkeit/Promotor fehlen |
| zufrieden stellt uns, wenn wir den Kunden kompetente Ansprechpartner zur Diskussion weiterer Vorgehensweisen zur Verfügung stellen können | Fehlende/unvollständige Konzeptphase MEDC18 |
| Bosch fördert allgemein Innovationen /z.B. EM-Incentives | Erwartung: Nutzen aufzeigen bevor Idee weiter verfolgt werden kann schwierig zu erfüllen |
| Bündelung Push-Pull mit CR | Fehlende fachliche Tiefe neue Ideen / mit Blick für Wirkkette/System / im CE-Bereich |
| Technologieprozess mit CR läuft gut | Very few cost saving innovations |
| | im CE-Bereich ist man funktional (physikalisch) nicht nah genug an den Kundeninteressen dran -> Diskussion von funktionalen/physikalischen |
| Organisation für IM vorhanden | "Nöten" im Detail ist sinnvoll mit NEx |
| | kein Budget für Innovationen |
| | Durchgängiger Prozess von CR bis SOD fehlt |
| | im SC Inno und gg. unseren Kunden keine / kaum Verbindlichkeiten bezgl. Innovationen |
| | Inno-Liste zu feingranular |
| | wenig inhaltliche Querabstimmung, auch mit CR |
| | Was verstehen wir unter Innovation? Fehlende Begriffsdefinition |
| | Geschäftsfeldplanung und Inno-Strategie: Wo geht es hin? Was gibt es da? Es kommt wenig an |
| | Kommunikation und Rollout von Strategie / Inno-Themen |
| | Inno-Prozess wird nicht gelebt (unklar, wann er angewendet werden soll) |
| | keine positiven Bsp. für Prozessanwendung (mit Gates, etc.) |
| | untaugliches Wissensmanagement |
| | Definition von Gates bei CR und DGS-EC unterschiedlich |
| | Über Ideenportal kommt nichts rein |
| | Inno-Themen müssen über Kunden getrieben werden (bei Gefahr, das wegen hohem Neuheitsgrad nichts daraus wird) |
| | Zu teuer für einfache Themen |
| | MEDC18-Inhalte unklar |

| Chancen / Opportunities | Gefahren / Threats |
|---|---|
| Breite fachliche Kompetenzen, Vernetzung mit anderen GB | Wirtschaftliche Situation |
| Innovationsworkshops nach Definition von Ideensuchfeldern machbar | Ideen werden nicht zu Ende gedacht …nicht weiter untersucht |
| Externe besser nutzen (Diplomanden, etc.) | Wir kommen mit den Themen zu spät |
| Informationsaustausch vertikal und horizontal | Stabiles Innovationsmanagement unabhängig von Umorganisationen |
| Focus on innovation that reduce "Time to market" of our ECUs ( Faster applications, Faster SW development) | Innovationsgeschwindigkeit bei wichtigen Themene paßt nicht zur Kundenvorstellung. -> Wir müssen ggü. unseren Kunden klare Aussagen treffen, wann und in welchem Umfang wir uns mit welchem Thema beschäftigen. (Beispiel MEDC18) |
| durch die NEx-Bereiche haben wir eine gute Know-How-Konzentration | Geschäftsmodell ändert sich aufgrund Autosar |
| über die CE-übergreifende Kundenplattform-Runde können wir sehr schnell Abfragen über alle Kunden durchführen bzw. Kundenmeinungen/-interessen einholen. Wichtig dabei: Anfragen müssen konkret sein. | keinen nachhaltigen Rollout von Inno-Themen (nicht nur Studie, sondern umsetzen) |
| Technologie-Träger / Demonstratoren, auch zur Diskussion mit dem Kunden | Kunde macht immer mehr selbst |
| Wenn Bosch wüsste, was Bosch weiß | Plattform-Budgets /Abrechnung über Kd.EA beschneidet Weiterentwicklung |
| SG-VVGK kann über Riesenstückzahlen Innovationen finanzieren | |
| "Innovation" definieren | |
| Zusammenfassung Innovationen und Kommunikation nach außen | |
| Zwischen den NEx mehr zusammenarbeiten | |
| neue Themen mit dem Kunden als kompetenten Ansprechpartner zu diskutieren | |
| höhere Kunden- / Dienstleistungsorientierung | |
| flexibler werden, Standards (z.B: Tools) mehr nutzen | |
| zentraler Inno-Topf zur Finanzierung | |

**Appendix 1: SWOT analysis about Innovation Management at DGS-EC (2010)**


**Appendix 2: Expectations to the DGS-EC innovation process (2010)**

| | Stärken/Strengths (S) | Schwächen/Weaknesses (W) |
|---|---|---|
| | 1. Produktqualität wurde seit 1989 um ca. 25 % erhöht<br>2. BMW verfügt in der Fertigung über hohe Flexibilitätspotenziale<br>3. BMW verfügt mit der Forschungs- und Ingenieurzentrum GmbH über einen kompetenten »Think-tank«<br>4. BMW ist in den vergangenen Jahren stärker gewachsen als die Gesamtbranche<br>5. BMW hat seine Kompetenzen auf den Automobilbereich fokussiert | 1. Überdurchschnittliches Lohnniveau im Vergleich zu ausländischen Herstellern<br>2. BMW ist an relativ wenigen strategischen Allianzen beteiligt<br>3. Konkurrent Mercedes-Benz setzt in den USA und Japan wesentlich mehr Komfortlimousinen ab<br>4. BMW verfügt zu Beginn der neunziger Jahre lediglich über eine Marke |
| **Gelegenheiten/ Opportunities (O)** | ***SO-Strategie(n)*** | ***WO-Strategie(n)*** |
| 1. Dichter werdender Stadtverkehr erfordert neue, kompakte Fahrzeugkonzepte<br>2. Immer mehr junge Menschen können sich einen (3er) BMW leisten<br>3. Wiedervereinigung ermöglicht den Aufbau von Werken in Ostdeutschland | *Markteinführung des BMW 316 i compact (S2+S3/O1+O2)*<br>*Aufbau und Erweiterung des BMW-Werkes in Eisenach/Thüringen (S5/O3)*<br>*Entwicklung eines Kleinwagens für den Stadtverkehr (S1+S2+S3/O1)* | *Aufbau und Erweiterung des BMW-Werkes in Eisenach/Thüringen (W1/O3)* |
| **Bedrohungen/ Threats (T)** | ***ST-Strategie(n)*** | ***WT-Strategie(n)*** |
| 1. Niedrige Notierung des US-Dollars<br>2. Japanische Konkurrenz erweitert Angebot im Bereich der Komfortlimousinen<br>3. Steigende Benzinkosten<br>4. Erhöhte Sensibilität der Gesellschaft ggü. Ökologieproblemen<br>5. Starke Auslastungsschwankungen in der Automobilbranche<br>6. Begrenztes Wachstum des Welt-Automobilmarktes | *Aufnahme der Roadster-Fertigung in den USA (S5/T1+T5)*<br>*Angebot einer hohen Ausstattungsvielfalt in der Kompaktklasse (S2+S3/T6)*<br>*Übernahme der Rover Group PLC und damit:*<br>*- Konzernwachstum*<br>*- Gewinnung einer 2. Marke*<br>*- Diversifikation*<br>*(S4+S5/T2+T5+T6)* | *Aufnahme der Roadster-Fertigung in den USA (W1+W3/T1+T5)*<br>*Übernahme der Rover Group PLC und damit:*<br>*- Konzernwachstum*<br>*- Gewinnung einer 2. Marke*<br>*- Diversifikation*<br>*(W4/T2+T5+T6)*<br>*Entwicklung eines Kleinwagens für den Stadtverkehr (W2+W4/T3+T4)* |

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## Appendix 3: TOWS-Analyse der BMW AG (vgl. Macharzina, K. 1995 S. 278 f.)