BALANCING THE STRATEGIC PRODUCT PORTFOLIO 
BASED ON MARKET AND COMPETENCE NEEDS

M.SC. RENE RÜBBELKE
Heinz Nixdorf Institute, University of Paderborn, Germany 
rene.ruebbelke@hni.uni-paderborn.de

M.SC. CHRISTOPH SÖLLNER
Mercedes-AMG GmbH, Germany
christoph.soellner@daimler.com

PROF. DR.-ING. JÜRGEN GAUSEMEIER
Heinz Nixdorf Institute, University of Paderborn, Germany
juergen.gausemeier@hni.uni-paderborn.de

Copyright © 2015 by the University of Paderborn and Mercedes-AMG GmbH. Permission granted to IAMOT to 
publish and use.

ABSTRACT

Companies have to cope with challenges such as globalization, increasing market dynamics, 
increasing number of competitors and growing complexity of products. Long-term success can only 
be achieved by the future oriented planning of a consistent set of product characteristics, which 
meet market requirements of tomorrow and consider upcoming environmental influences (e.g. 
legislative regulations). In fact, a company should be ahead of the race and accomplish a competitive 
position that cannot be imitated easily. To develop such products it is necessary to anticipate the 
development of markets, technologies and the business environment. Thereby, future chances and 
opportunities can be detected at an early stage, to identify a beneficial position within the 
competitive arena of tomorrow. Focusing the engineering industry and especially small and mid-size 
companies, the outlined challenge is crucial: Manufacturers offer products with increasing technical 
complexity in a dynamic global market. The consequence is an extended time to market with high 
uncertainties regarding the product specifications. Thus, there is need for a management suitable 
approach, which takes into consideration all relevant information of different fields of influence.

Within this paper we describe a suitable approach to balance the strategic product portfolio by 
means of meeting promising market demands and exploiting a company’s competencies. Therefore 
we developed an approach that leads to consistent product concepts and evaluates their realization 
priority to decrease uncertainties in the early phase of product development. To prove the approach 
we validate the following steps in cooperation with a company of the automotive industry.

In a first step, the approach focuses on the identification of factors that influence the product 
portfolio. In the considered validation case, over 30 influence factors were identified. By conducting 
a cross impact analysis, the factors are reduced to approximately 15 key-factors. For each key-factor 
up to five alternative characteristics were defined. Afterwards, a consistency analysis is performed, 
based on a pairwise evaluation of the characteristics. The results are consistent combinations 
(bundles) of characteristics, whereby exactly one characteristic of each key-factor is included in one 
bundle. Hence, the results can be interpreted as a description of consistent strategic product 
concepts. Additionally, current products of the considered company and competitors are evaluated, 
using the same characteristics as for the strategic product concepts. As one result, the competitive
arena could be visualized by the similarity of the current products and the evaluated product concepts (represented by their distance) with the help of the multi-dimensional scaling.

In a following step, a hierarchical structure of the products’ functionality and a morphological box are developed to identify solution elements and technologies, which fulfill the required functions of a product concept. Then, necessary development tasks are derived and needed competencies are described. Next, these competencies are rated within a “make, cooperate or buy portfolio” by evaluating the company’s competence position and the strategic relevance of a competence. The result is the “make or buy rate” of a product concept. In a last step, the market and technology priority of each product concept is rated and cumulated to determine their realization priority. Here, a management decision portfolio is created, to visualize the realization priority of the product concepts.

In conclusion, we achieved a practicable combination of the market-based view and the resource-based view within the strategic management. The validation case in the automotive industry shows, that the main benefit is given by the stepwise detailed and visualized information to support management decisions. The effort for generating this information is overcompensate by the decrease of uncertainties in the early product planning phase. In Addition, significant advantages regarding the consideration of a huge set of influence factors at one time could be achieved.

**Key words:** strategic planning; competence management; resource planning; strategic product portfolio; complexity management; innovation management

**INTRODUCTION**

**Problem Statement**

In future, companies have to cope with challenges such as globalization, increasing market dynamics, increasing number of competitors and growing complexity of products (Bullingher, 1994), (Boston Consulting Group, 2006), (Spath et al., 2001). They often tend to deal with these challenges by increasing their efficiency or by reducing costs through outsourcing. However, these strategies have only shown temporary success (Christophery, 2004), (Kinkel et al., 2007). Only increasing the efficiency of an enterprise does not lead to long-term success (Hamel, 2000), (Sommerlatte et al., 2000). Long-term success can be achieved by the early planning of product characteristics, which meet market requirements and consider environmental influences (e.g. legislative regulations). In fact, a company has to accomplish a competitive position that cannot be imitated easily by offering innovative products with a unique selling proposition (USP) (Markides, 2002) (Cooper et al., 2005). To develop such products, information of detailed market needs and technological competencies are necessary. This summarizes different factors like customers’ requirements or competitive behaviour. Furthermore, USPs need a set of competencies by means of combining skills and resources (Krüger et al., 1997).

Focusing the engineering industry and especially the automotive industry, the mentioned challenges are especially true: Original Equipment Manufacturers (OEM) in the automotive industry offer products with increasing technical complexity in a dynamic global Business to Consumer (B2C) market. The consequences are long development cycles with high uncertainties during the strategic product planning phase. Facing these facts, the office of the German parliament published a report
with seven key challenges the automotive industry has to cope within the next two decades (Schade et al., 2012):

- Development of efficient cars
- Development of alternative drivetrain concepts
- Preservation of the German manufacturers as technological leaders and premium OEMs
- Additional offer of subcompact cars
- Developing BRIC markets and manage the stagnation in Europe
- Reduction of car platforms and at the same time diversification of the product portfolio
- Participation within the establishment of new mobility concepts

Most of the mentioned challenges concern the basic business of the automotive OEMs. The result is an increasing complexity regarding the decision process of product concepts and characteristics. This leads to the need for a transparent decision situation concerning the question, which priority single product characteristics have and which should be focused on from a strategic point of view.

Thus, there is a need for a management suitable approach, which takes into consideration all information from the market and technological perspective. Here, the selection of the relevant market information and the proper evaluation of competencies to achieve the targets defined by the product strategy are crucial.

**Objective of the approach**

The objective of the approach on hand is a comprehensive procedure model to describe consistent characteristics and specifications of strategic product concepts, based on valid market information and an evaluation of companies’ competencies.

Therefore, the method starts with the identification of relevant variables for the description of strategic products taking into consideration the market and technical perspective. The determination of characteristics of the variables is the basis for the consistency evaluation of promising product concepts. The determined consistent product concepts are the basis for the specification measures regarding the product development process. Afterwards, the detailed product concepts with specific measures are analyzed by means of market and technology priority taking into consideration factors like the contribution to the brand or the final utility function. In the course of this paper, we concentrate on one highlight within the evaluation of the resource-based view, which is the analysis of competence constraints: the determination of the effort by means of the competence-based view. Therefore, a competence model is set up which can be applied to identify competence gaps and to derive a management recommendation. Elements of the competence model are the hierarchical structure of the products functionality, the morphological box and a competence description framework.

**Scientific framework and current understanding**

The scientific framework of the introduced approach is the 3-cycles model (Gausemeier et al., 2014). According to this model, innovative products are the result of a complex product design process that
extends from the product or business idea to the successful product launch. This process cannot be seen as a sequence of process steps, but it involves a 3-cycle model (Figure 1).

From Business Idea...

Figure 1: 3-cycles model of product development, Source: Gausemeier et al., 2014

The first cycle represents the strategic product and technology planning. This cycle includes activities from the identification of future success potentials to promising product concepts. The second cycle addresses the product development, in which the interdisciplinary interaction of several domains such as mechanics, control technology, electronics and software engineering takes place. Parallel to the cycle of product development, the cycle of the production system development comprises the engineering of the manufacturing process.

This paper focuses on the first cycle of the introduced 3-cycle model. The first cycle covers the tasks of foresight, product discovering, business planning and conceptual design of products. Foresight aims the determination of future success potentials as well as the deduction of appropriate opportunities and fields of action. Based on the detected success potentials, the stage of product discovering concentrates on the retrieval and the selection of new product ideas as well as service ideas and their development. The objective of this stage is to derive and describe requirements for future products. Within the phase of business planning, one important aspect is the determination of the product strategy. Following the definition of GAUSEMEIER the product strategy comprises the management of the product portfolio, handling of diversified product variants, the definition of market strategies and the product program renewal during the product lifecycle (Gausemeier et al., 2014). As a result, the product strategy leads to a business plan, which shows whether an attractive return on investment can be achieved by the intended product.

The approach on hand can be integrated in the phases business planning and conceptual design of products. Within these phases, widespread approaches are the resource-based view and the
market-based view. The resource-based view focuses on the application of existing resources (and competencies) to reach sustainable competition advantages. This point of view is also named inside out perspective. The weakness of this approach is that it does not ensure a compatibility of the developed products to market needs (Gausemeier et al., 2014). Therefore, for the description of promising product concepts, the market needs have to be considered as well. This opinion is also shared by Schuh et al. as they recommend an inside out orientation within the strategy development process of technology orientated companies. However, they also point out, that additionally the market requirements need to be considered (Schuh et al., 2011).

Next to the described framework of Gausemeier existing approaches focus on single steps of the method on hand. For example, within the evaluation of product concepts, the market based view is analyzed by the KANO model (Berger et al., 1993) or the confirmation / disconfirmation paradigm (Homburg et al., 2003). Furthermore, the technology perspective is analyzed taking into consideration the maturity and other factors of technology assessment to analyze the priority from the inside out perspective (Schuh et al., 2011).

In summary, state of the art of science and technology shows that there is a lack of a method which takes all the mentioned aspects into consideration. For the purpose of this paper the step upfront to analyze the product characteristics and specifications as well as the competence evaluation are described in detail.

**CREATION OF CONSISTENT STRATEGIC PRODUCT CONCEPTS**

**Derivation of variables**

The first step of the method is the description of variables and characteristics of the potential products. As product concepts are mainly evaluated in the context of the environment of a company and the leading strategic dimensions (Becker, 2000), an environmental analysis has to be conducted.

The methodical basis for the environment analysis is built by the approach of Gausemeier. For each field of the environmental, the factors of influence or product configuration are analysed (Gausemeier et al., 2014). Sources are trend reports like of the report of the German parliament regarding future challenges of the automotive industry (Schade et al., 2012). The result is shown in Figure 2.
According to Figure 2, each field of influence is filled with a factor, describing a market, technology or business environment. Considering all is important to focus the market pull as well as the technology push perspective.

In the next step, the factors of influence are described as variables. These variables build the basis for the further evaluation of consistent product concepts. In many application cases, the number of variables is extensive. Within the validation example on hand, the number increased up to over 30 variables. To ensure the applicability of the method, the key variables are identified in the following step with the aim of the reduction of the variables to the necessary minimum number.

**Selection of key variables**

To determine the most relevant variables, an influence matrix and a relevance matrix are used to receive a clearly arranged grid as a basis for the selection of the key variables. Both, the influence analysis and the relevance analysis are conducted by a pairwise comparison of all variables. The influence matrix evaluates the influence of one variable to the others by using a scale of influence from 0 (no influence) to 3 (high influence). The result is an active sum (How strong does the variable influence other variables?) and a passive sum (How strong is the variable influenced by other variables?). In addition, the paired comparison of the relevance matrix gives evidence of the relevance of the evaluated variables (Gausemeier et al., 2014).

The results are shown in the selection grid of Figure 3 with bubbles containing three kinds of information. Derived from the influence analysis, the ordinate shows the active sum, the abscissa the passive sum and the values of the relevance analysis are illustrated as diameter of the bubbles.
On the basis of the identified key variables (yellow bubbles in Figure 3) possible characteristics are subsequently described within the next step.

**Description of characteristics**

Referring to the scenario method of GAUSEMEIER (Gausemeier et al., 2014) the characteristics have to be described by considering all possible future trends. For each variable, between 3 and 5 different characteristics are described. The limitation of characteristics is important for the applicability within the evaluation of consistent characteristics within a further step.

For example, the variable “Driving dynamics” has the characteristics “Maximum Racetrack Performance”, “State of the Art Racetrack Performance” and “Driving Dynamics Basic in Segment” (Figure 4).

The trend “Energy prices fall” is from the current point of view hard to imagine, but it is one possible trend of the future. So, this trend description is taken into consideration for the description of consistent product concepts. For the identification of possible characteristics, for example the Delphi method can be used to integrate the perspective of experts (Haeder et al., 1994). Another source can be the conduction of a customer survey or market analysis (Lindemann, 2009). For the validation example on hand, in addition to the mentioned methods, reports of car magazines were analysed.
Evaluation of consistent characteristics

The evaluation of consistent characteristics has the aim to create consistent product concepts. Here, the scenario method of GAUSEMEIER et al. was adopted on the evaluation of the product strategy. In the course of the evaluation of product characteristics, the consistency matrix is filled and each characteristic is compared pairwise regarding the consistency value between 1 (totally inconsistent) and 5 (strong mutual positive influence). An example of this evaluation scheme is illustrated in Figure 5 (Gausemeier et al., 2014).

The consistency matrix is evaluated with the help of the Scenario Software® (Gausemeier et al., 2014). The software calculates the similarity of possible product concepts and bundles them up to a manageable number. The results of this step are consistent product concepts, visualised with the help of multi-dimensional-scaling (MDS). Figure 6 shows an example for the validation example on hand.

Figure 4: Exemplary variables and characteristics of the considered validation example

<table>
<thead>
<tr>
<th>Variables</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving Dynamics</td>
<td></td>
</tr>
<tr>
<td>1A Maximum Racetrack Performance</td>
<td></td>
</tr>
<tr>
<td>1B State of the Art Racetrack Performance</td>
<td></td>
</tr>
<tr>
<td>1C Basic-level in Segment</td>
<td></td>
</tr>
<tr>
<td>Electrical Drive</td>
<td></td>
</tr>
<tr>
<td>2A Use to fulfill legal Requirements</td>
<td></td>
</tr>
<tr>
<td>2B Use to improve Driving Dynamics</td>
<td></td>
</tr>
<tr>
<td>2C Use as Main Drive</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Consistency matrix

<table>
<thead>
<tr>
<th>Consistency Matrix</th>
<th>Characteristics</th>
<th>Maximum Racetrack Performance</th>
<th>State of the Art Racetrack Performance</th>
<th>Basic-level in Segment</th>
<th>Use to fulfill legal Requirements</th>
<th>Use to improve Driving Dynamics</th>
<th>Use as Main Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question:</td>
<td>How consistent is characteristic A (row) with characteristic B (column)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>(consistency value):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 = totally inconsistent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 = partially inconsistent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 = neutral / independent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 = mutual positively influence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 = strong mutual positively influence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables</th>
<th>Characteristics</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving</td>
<td>Maximum Racetrack Performance</td>
<td>1A</td>
</tr>
<tr>
<td>Dynamics</td>
<td>State of the Art Racetrack</td>
<td>1B</td>
</tr>
<tr>
<td></td>
<td>Performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic-level in Segment</td>
<td>1C</td>
</tr>
<tr>
<td>Electrical</td>
<td>Use to fulfill legal Requirements</td>
<td>2A</td>
</tr>
<tr>
<td>Drive</td>
<td>Use to improve Driving Dynamics</td>
<td>2B</td>
</tr>
<tr>
<td></td>
<td>Use as Main Drive</td>
<td>2C</td>
</tr>
</tbody>
</table>

Figure 6: Example for the validation example on hand
As illustrated in Figure 6, each bundle of similar product concepts can be described by a concise sentence. This sentence can be seen as the essence of the different characteristics of the variables as each variable is represented by one concise characteristic. Figure 6 shows only apparitional product concepts, for the validation example in the automotive industry approximately 10 consistent product concepts were identified. On the basis of the resulting consistent product concepts, the product specifications can be setup stepwise.

**Figure 6: MDS with consistent product concepts**

**Evaluation of current products**

Important basic information for the further concretion of the product strategy is the analysis of the status quo. Thus, the distance of the current products to the strategic product concepts is analyzed.

To conduct the evaluation of the current products regarding the characteristics of the consistent product concepts, the current products have to be described on the same level of abstraction. Figure 7 shows this procedure in dependence to BÄTZEL (Bätzel, 2004). The evaluation of the current products regarding the characteristics of the strategic concepts is conducted by using values between “0%” – the current product does not fulfill the strategic characteristic and “100%” – the current product achieves the strategic characteristic already by 100%.
### Variables

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Driving Dynamics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Racetrack Performance</td>
<td>1A</td>
<td>100</td>
<td>75</td>
<td>0</td>
<td>100</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>State of the Art Racetrack Performance</td>
<td>1B</td>
<td>0</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Basic-level in Segment</td>
<td>1C</td>
<td>0</td>
<td>0</td>
<td>75</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Electrical Drive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use to fulfill legal Requirements</td>
<td>2A</td>
<td>100</td>
<td>75</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Use to improve Driving Dynamics</td>
<td>2B</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Use as Main Drive</td>
<td>2C</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Consumption &amp; Emission</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Benchmark Level</td>
<td>3A</td>
<td>0</td>
<td>25</td>
<td>75</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>State of the Art</td>
<td>3B</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>0</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Of minor Role</td>
<td>3C</td>
<td>75</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>0</td>
</tr>
</tbody>
</table>

*Figure 7: Evaluation of current products*

The step shown in Figure 7 is also carried out for the current products of the competitors. The result of the evaluation is integrated in the MDS shown in Figure 6 and so all results could be combined and visualized as shown in Figure 8.

Within the resulting MDS (Figure 8), the status quo by means of possible strategic product concepts and evaluated current products of the considered company and the competitors are illustrated. The distance of the elements within the shown MDS can be seen as indication for similarity. This information can be used within the further setup of the product strategy where the product concepts are evaluated in a market and technology portfolio.
Product specification by indicators

The product concepts illustrated in Figure 8 are described on the basis of variables and characteristics. This description has to be detailed in a further step to evaluate the product concepts as strategic products with precise parameters. These parameters are determined for each variable of the product concepts. Exemplary indicators of the variable “Driving Dynamics” are:

- 0 – 100 km/h
- 100 – 0 km/h
- 0 – 400 m
- Slalom 36 m
- Racetrack Time 1
- Racetrack Time 2

Using this indicators, the products can be described by a specification list with quantitative and qualitative values. Here it is important to determine whether an exact, minimum or maximum value. The chosen value is dependent from many factors like the internal product positioning target, the competitive set or the customers’ perception. The determination of the values is not described in depth in this paper. For the further description of the approach, the resulting specification list is important (Figure 9).
The specification list builds on the one hand the basis for the controlling of the product specifications within the product lifecycle as well as for all further evaluation and prioritization. In this paper, the focus is on one aspect regarding the effort for development: the evaluation of competencies needed to realize a certain product concept.

COMPETENCE BASED EVALUATION

A prerequisite to describe the steps of the competence evaluation is a definition of “competence”: According to DANNEELS, a (technological) competence gives a company the ability to design and manufacture physical products (Danneels, 2002). In addition, KRÜGER and HOMP describe a competence as a (unique) combination of skills and resources (Krüger et al., 1997). Following those definitions, it is necessary for an innovative company, to know the competencies, needed to realize future products. Thus, we developed an approach that allows the deduction of competencies in a very early phase of the product development process. As example for validation, the concept “Sporty Cars meeting customers’ preferences regarding driving performance with affordable TCO values in worldwide markets.” is chosen.

Establishment of the hierarchical structure of the products functionality

The basis for the competence description is the hierarchical structure of the products functionality. Therefore it is useful, to describe the product concept in not more than six hierarchical levels. As the given validation example is a company with existing business in the automotive industry, the hierarchical structure of an existing product can be used. In that case, it is necessary to evaluate, if there are new functions added to the investigated product concept. For the example on hand, the hierarchical structure of the products functionality is shown in Figure 10, highlighting the new function “generate driving force electrically."
The hierarchical structure of the products functionality, shown in Figure 10, is one input information for the morphological box, which is filled within the next step.

**Derivation of a morphological box with solution paths**

The lowest level of the hierarchical structure of the products functionality is transposed into the first column of a morphological box. Then, the rows are filled with matching solution elements (orange) and technologies (blue) as shown in Figure 11. Solution elements are components which fulfill the requirements of a function and are probably already used in existing products. Using a solution element, the approach constitutes that the company has all necessary competencies available. In contrary, technologies are possibilities that also fulfill the requirements of a function, but they are not available internally. Technologies are still in the research phase or only available at suppliers. If there is no solution element or technology known for a specific function, the methods for technology foresight are suggested to find possible solution elements (Reger, 2001).

Using the initial information which is filled in the morphological box, the existing products and product concepts can be described by a so-called solution path within the morphological box (dotted connection lines in Figure 11) (Pahl et al., 2005).

---

**Figure 10: Extract of a hierarchical structure of the products functionality**

---

<table>
<thead>
<tr>
<th>Provide energy</th>
<th>Drive vehicle</th>
<th>Influence longitudinal dynamics</th>
<th>Provide mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generate driving force</td>
<td>Break vehicle</td>
<td>Influence transverse dynamics</td>
<td>Enable movement</td>
</tr>
<tr>
<td>Generate driving force (mech.)</td>
<td>Change driving direction</td>
<td>Absorb dynamic force</td>
<td>Bear vehicle</td>
</tr>
<tr>
<td>Transmit driving force</td>
<td>Transmit steering force</td>
<td>Absorb transverse forces</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

---

Influence longitudinal dynamics:
- Drive vehicle
- Provide energy
- Generate driving force
- Generate driving force (mech.)
- Transmit driving force

Influence transverse dynamics:
- Break vehicle
- Generate breaking force
- Transmit breaking force

Absorb dynamic force:
- Stabilize vehicle
- Damp vehicle
- Absorb transverse forces

Enable movement:
- Provide mobility

Bear vehicle:
- Provide mobility
- Provide energy
- Drive vehicle
- Influence longitudinal dynamics
- Influence transverse dynamics
- Absorb dynamic force
- Change driving direction
- Absorb transverse forces
- Bear vehicle
- Stabilize vehicle
- Damp vehicle
- Absorb dynamic force
Generally, for each function, one element has to be selected. To guarantee a consistent path through the elements of the morphological box, a plausibility check by means of the proper combination of the elements has to be conducted. Therefore it is necessary to match the requirements of a product concept (see Figure 9) with the performance of a solution element or technology.

By using the method, existing products as well as product concepts can be described. In Figure 11, the blue dotted path shows exemplarily an existing product. All solution elements are known, so that there is no need for a detailed competence analysis. The orange dotted path shows an extract of the considered new product concept. As illustrated in Figure 11, several existing solution elements can be used. But, especially for the new function “generate driving force electrically” no solution element is available internally. For this and all other elements, which are not available internally, the effort for developing the necessary competencies has to be evaluated. In the validation example the technology “Plug In Hybrid” is selected. For this technology the competence evaluation is conducted within the next step.

**Determination of competencies**

To determine competencies needed to realize a certain technology, the necessary steps within the product development process are analysed. Practical application shows, that the description of a company specific reference process by general development-tasks is reasonable regarding the ratio of benefit and effort (Rübbelke et al., 2013). Often, these processes are well defined in technology-orientated companies. If not, we recommend the *reference process for developing intelligent*...
technical systems as a source for development tasks. This process suggests overall 77 development tasks according to the following domains (Gausemeier et al., 2014):

- Mechanical Engineering – e.g. “Determine dynamic forces”
- Control Engineering – e.g. “Develop control concept”
- Software Engineering – e.g. “Determine appropriate models/algorithms”
- Electrical/Electronic Engineering – e.g. “Modelling of information processing hardware”

The given reference process, is used by companies to select those development domains and tasks that fit to their product portfolio. If necessary, new tasks could be added. Overall, a number of 20 tasks should not be exceeded to keep the efficiency.

Figure 12 shows the competence description framework with an example of the validation case. First, the function that should be fulfilled and the aspired technology are named. Then the development skill is determined by selecting a domain and a development task. By adding the needed recourse to execute this task, the competence is fully described.

![Figure 12: Competence description framework](image)

The competence description framework (Figure 12) needs to be applied on every new element within the solution path in the morphological box (Figure 11). The application in the validation example shows, that this task should be executed by an expert team of the R&D department. Here, we recommend a small, interdisciplinary team consisting of innovation-management and pre-development.

With the competence description framework (Figure 12), the evaluation of the needed effort to build up a competence internally has to be conducted. Therefore, the intended executing department should estimate the effort by two dimensions:

- Staff capacity requirements (can be converted into a monetary size)
- Investments for further resources (e.g. software applications or test-equipment)

The head of each development department gets the request, to fill-out the related competence evaluation list. After finishing the evaluation, the lists are collected and the evaluated competencies are combined to the described solution paths for the aspired product concept. Finally the realization effort of the product concepts is evaluated and the product concepts are prioritized from a competence (resource) perspective.
Make, cooperate or buy Decision

In consideration of time and money, not all competencies could be developed internally. A decision concerning external sourcing (buy), cooperation with suppliers or engineering service providers or the entirely internal development is necessary. This decision is supported by the make, cooperate or buy portfolio (Figure 13).

![Make, Cooperate or Buy Portfolio](image)

The make, cooperate or buy portfolio has the aim to calculate the “make or buy rate”. This rate indicates the potential of differentiation for a certain product concept. The abscissa of the portfolio represents the strategic relevance, evaluated by the criteria synergy effects, competitive advantages and availability at suppliers. The ordinate represents the competence position of the considered company by the criteria resource strength, skill strength and degree of use in current products. Competencies with low strategic relevance and a low specific competence position of the company should be sourced at suppliers (buy). High rated competencies should be build up internally (make).

The middle part of the portfolio is divided into two areas. The upper left corner indicates a high strategic relevance, but a weak position of the company. Competencies in this area should be developed in long-term partnerships or “bought” by merge and acquisition activities. Competencies in the lower right corner are of low strategic relevance, but easy to access for the company. These competencies should be developed in project-based, short-term partnerships. Product concepts with a high “make rate” have high potential for differentiation; a high “buy rate” indicates a low potential for differentiation because used competencies and technologies are available for every stakeholder of a branch.
Management decision portfolio

The different information generated in the introduced method has to be integrated in a suitable management decision portfolio. Therefore, we visualize the product concepts of Figure 8 by the help of a realization priority portfolio (Figure 14). This kind of visualization portfolio is common understanding within management boards because it summarizes a lot of information and delivers specific recommendation for action. The portfolio consists of the following information regarding the future product concepts: the ordinate indicates the market priority by means of sustainability considering the criteria “competitive situation” and “brand contribution”. The values of the axe are derived from the results of the chapter “Evaluation of current products” (Figure 8) and further market analysis which was not described within this paper. The technology priority of the product concepts is shown on the abscissa. It is evaluated by the criteria “resource strength”, which is derived from the competence evaluation and the additional evaluation of the “strategic fit”. The “make or buy rate” is represented by the diameter of the each bubble. The resulting diagonal line describes the realization priority of the product concepts.

![Figure 14: Realization priority portfolio](image)

In the illustrated portfolio of Figure 14, product concepts III and IV have the highest priority. Because of the better reachability, concept IV should be prioritized. All product concepts in the area “high realization priority” are highly recommended for series development, because these products are very important for the future business and at the same time reachable for the considered company. Product concepts in the “average realization priority” area have to be investigated, whether they have synergy effects with products concepts of the “high realization priority” area. If there are
synergy effects they might be realizable with low effort. If there are no synergies, they might be rejected. Products concepts in the area “low realization priority” should not be realized. Needed resources should be used for product concepts with more future potential.

Remark: As this is an ongoing project, we needed to change the used values in terms of confidentiality. Also, we did not implement a supporting software tool yet. This will be done after the validation of the method is successfully completed by expanding the Innovation Database of the Heinz Nixdorf Institute (Brink et al. 2008).

CONCLUSION

A well-defined strategic product portfolio requires the consideration of external and internal aspects. With the approach on hand, a combination of market-based and resource-based view could be achieved already within the definition of strategic variables of future product concepts. So, a significant reduction of uncertainties in the early phase of the product development process is realized. This procedure is consequently pursued as the evaluation of the product concepts applies on the one hand methods within the market-based view (e.g. competitive information on product specifications) and emphasises also the resource-based view by analysing competencies, needed to realize market needs. Displaying the results in a management decision portfolio that illustrates the realisation priority guarantees the practical usability and supports the acceptance of the approach. Hence, the defined requirements within the problem statement and motivation can be completely fulfilled.

In a next step of enhancement, there could be further aspects integrated in the method and the resulting management decision report. Those aspects are the customers’ perception of product indicators as well as the similarity evaluation of product concepts. With this information the invested development resources can be prioritized and the product portfolio optimized regarding the target return rate. Next to a balanced product portfolio in the distribution markets, this information is important for the decision process in connection to the competence view. In addition to the measurement of these factors, it is important to integrate them in an efficient and transparent premise controlling. This makes sure that the specifications of the product indicators set within the strategic phase are valid throughout the whole product lifecycle. Furthermore, there is a need to operationalize the results of the competence evaluation by means of translating them in concrete actions for the Human Resource department. This step is mandatory especially regarding the applicability in small and midsize enterprises. To ensure a continuous use of the method in the companies, the described comprehensive method has to be supported by a database which can be used decentralized in different departments. To have a valid data structure for the database, further validation needs to prove the applicability of the method in other branches like the service industry.

REFERENCES


