Enthusing Perceived Product Quality - A Concept for the

Distribution of Sensorial Perception Information

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Product quality is more than realizing conformance to technical specifications. It is a subjective interpretation of realized product criteria compared with personal expectations. The judgment of product quality is strongly connected with the sensorial perception of a product. But a systematically elicitation, objectification and distribution of all perception information is missing. The paper at hand presents an approach to qualify the information-source "naïve customers" to "product experts" and to use the elicited sensorial information for an advanced product specification. Furthermore a concept for the localization and distribution of sensorial perception information within the supply chain is introduced.

1. Quality – company-wide and holistically designed

The technical quality has always been a key-feature of „Made in Germany" products and is associated with reliability. What has been a central purchase criterion became a basic requirement. Due to the consistent focussing on strategies of process and product improvement the competitors from low-wage countries have scattered this advantage as far as possible. Significant differentiation from the competition can only be achieved through such products, which are not only of high-quality but are also perceived that way by the customers. Therefore the concept of quality should be described in a more comprehensive way. Together with the technical quality the perceived quality comes to the forefront. Perceived quality reflects the customers' subjective judgement of the product. Those judgements vary significantly in the context of experience, expectations and requirements concerning the product [1].
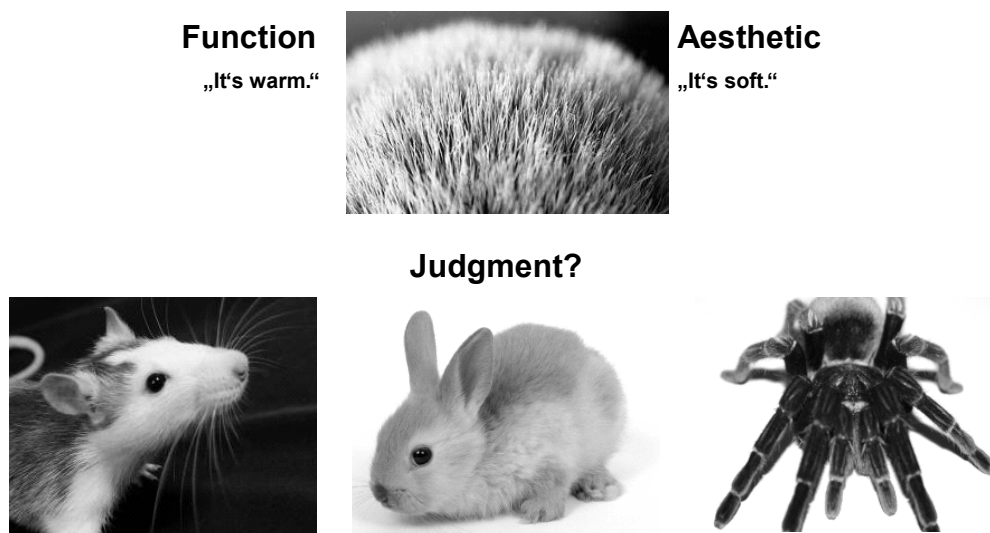

Figure1: Differentiation through perception

Requirements, originating from the expansion of the quality concept, can be met only by the reorientation of the product development process. Successful examples show that by increasing the number of identified customer requirements and their transformation into reproducible technical product characteristics, the product, which inspires the customer, can be produced and the perceived quality of the product increases. Using such a customer oriented approach allows companies to develop products in a more efficient way and to lower

the risk of market failure. As guidelines or design rules the customer requirements can also be reproduced not only by the original equipment manufacturer but by all participants of the value-added chain. Complex interactions which arise from the design of the product should be understood and controlled. Design and implementation of assembly groups and single components have a significant impact on the perceived quality of the final product. Much more complex is the conceptual formulation of perceived quality design through all development processes taking into account the increasing number of system suppliers. Currently suppliers only get technical drawings, specifications and inspection protocols for the construction of systems and components. Due to the information reduction in technical documents the products loose their originally built-in customer orientation while going through the supply chain. Misinterpretations, resulting from the lack of data, are amplified through the supply chain which leads to the fact that components, identically specified on technical level, will be perceived differently by the customer. To solve these problems classic and new - perception relevant - customer requirements shall be more carefully passed to the component supplier.

2. Customer's perception

Design, usability and perceived value are those terms which are named most often by customers when they are asked about reasons for their purchase decision. Functionality and accuracy are still important, but they lost their importance as differentiators. If the functionality of the product is adjusted with respect to perception, it becomes evident that a comprehensive functional performance doesn't necessarily lead to positive perception. Moreover it turns out that functionality and positive product perception are only conditionally dependent on each other.

In the automotive industry this discrepancy has already been recognized and is taken into account during the development and evaluation of new models. In car magazines vehicles are no longer tested exclusively for functional performance criteria (e.g. manufacturing, reliability), but also for emotional aspects (e.g. styling, image) (see Figure 2) [2]. After analysing these assessments and comparing them in a portfolio it becomes clear that manufacturers with a bad rating in functionality but a positive aesthetic perception can do quiet well in the overall assessment. The competitive advantage grows if good results can be achieved in both categories. The JD Power study, which involves customers as well as manufacturers, confirms this development by the fact that the attractiveness of a vehicle is evaluated through the satisfaction with the design or embodiment of the vehicle, contributing 25% to the overall assessment, in relation to the quality and reliability features with 30%, the maintenance costs with 22% and service satisfaction with 23%. This means that the subjective customer factor is interpreted as a crucial selling factor.
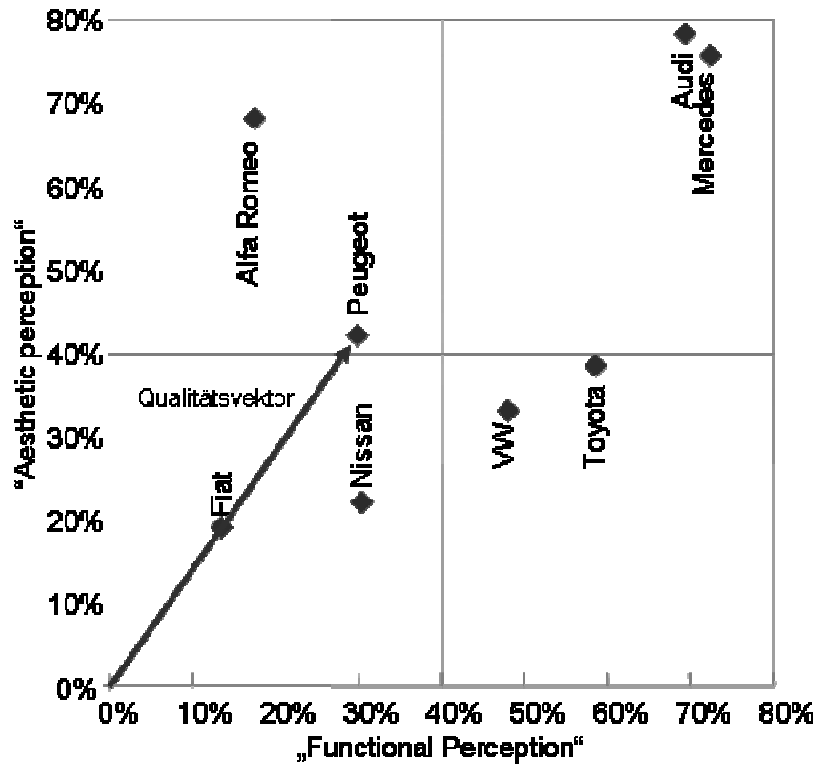
Figure 2: Perceived quality - a key factor for inspiring products

Companies that understand perceived quality as an important factor for customer satisfaction and that evaluate and continuously improve their products regarding their perception, can better differentiate themselves in the market. But first of all this requires a basic understanding of the perception of the customer during the interaction with a product.

Companies guarantee the quality of their products and its features, which are meant to positively influence the customer's purchase decision. However, customer perceive only a subset of these product characteristics, the so-called quality attributes, and forms his opinion according to this subset. The product characteristics that do not serve as quality attributes are blanked out by various filters (see Figure 3). Examples of such filters are the Attribute Dominance, the Halo Effect or Irradiation. For detailed information on various filter effects please refer to the according literature [3], [4], [5].
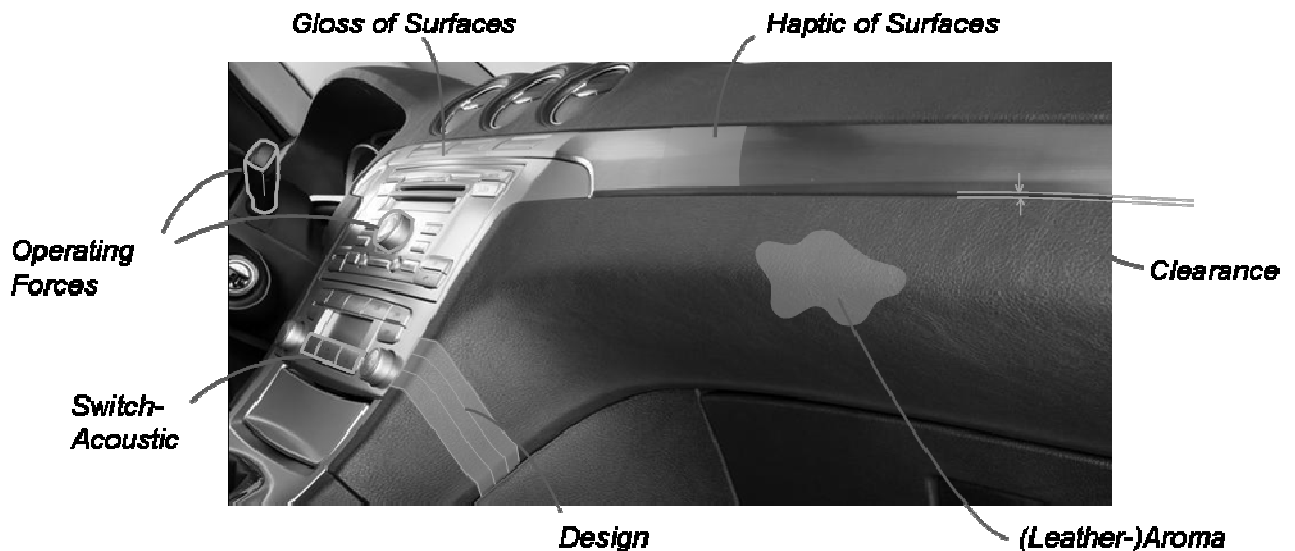
Figure 3: What do customers perceive?

Customers are usually not aware of these filters. The senses' correlation can therefore stress or weaken the information. In addition, customers are strongly influenced by their experiences. These are inherent to the customers' subconsciousness. Based on his experience with a given product group, a customer will pay special attention to those product characteristics, with which his active experience is connected, while others elude his consideration [6], [7]. All filters affect the customers in different dimensions of his quality assessment and must be considered during the development of new products.

The dimensions of quality evaluation hearken back to Michael Garvin [8]. He defines eight dimensions of quality. These are the performance of the product, its included features, reliability, conformance to requirements, durability, the product-related serviceability, the aesthetics and perceived quality. Only few companies hold a competitive position in all quality dimensions. Some quality aspects can be improved only at the cost of others. Companies must find their position in the market with regard to the conflicting priorities of these dimensions. They have to define unique selling points, which constitute the benefit compared to the competitor.

It can be concluded that customers perceive products from two perspectives: The classic objective factors such as reliability and durability on the one hand and the subjective quality criteria based on sensory perceptions of the customers on the other (see Figure 4).
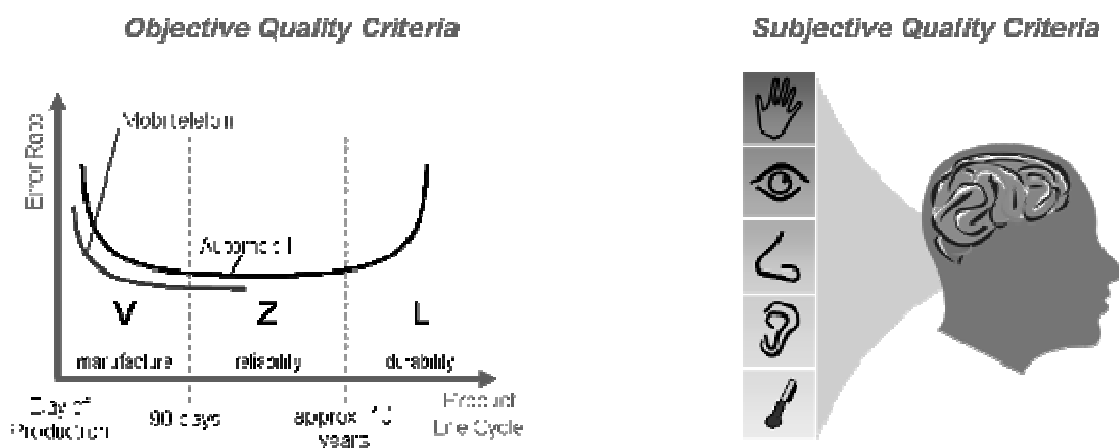

Figure 4: Two perspectives of quality

In this context, the perceived quality can be described as the result of a cognitive and emotionally controlled process of comparison of a product and customer requirements. This process is based on conscious and unconscious sensory perceptions, which depend on subjective experiences as well as expectations of specific customer segments. Regarding the human sensory perception there are four senses relevant to the evaluation of technical products [3], [9]:

Vision: Through the eyes visual impulses such as colour, brightness or shape are absorbed. In terms of product assessment, vision is considered as the initial sense [10].

Audio: The ear gathers most of acoustic sensations. These are characterized through the reception of a sound event. In extreme sound events (such as thunder), these sensations are also perceived by other senses (e.g. touch).

Touch: People perceive appearance or temperature by a combination of tactile perception receptors. Human skin is the principal organ, which is supported by different receptors in muscles, joints and tendons, to construct the information for the deep sensibility.

Smell: The nose receives stimuli, which customers often link to the individual experiences and emotions from other "smell"-experiences.

In the following example of a vehicle interior the impact of the sensory perception on the quality evaluation of the customer is shown (see Figure 5).

For the positive evaluation of a surface, the expectations created by the visual appearance should match the tactile impressions. A silver-coloured bezel, for example, leads to a certain expectation regarding the temperature feeling. If this expectation is not met, this can lead to a negative assessment by the customer. Since the customer has no indicators for the durability of the product at the point of purchase, he focuses, among others, on the aesthetic impression of the product. In this connection uniformity or consistency (e.g. of gap dimensions) are important.

The automotive industry constantly makes efforts to adjust the emission rates of adhesives, solvents and leather in the vehicle interior. Regarding leather, strongly laminated leather is sensed by the customers as "too artificial". Not processed leather, however, is not durable enough. Thus, one should optimize the tanning and finishing processes with regard to the correlation of odour and durability.

The acoustic of products play a crucial role in the customer perception. Thus, whistling (such as from an air conditioner) is associated with the air support and considered as a positive functional noise. Howling (for the same product), however, is connected with turbine noise and is seen as noise disturbance or a failure.
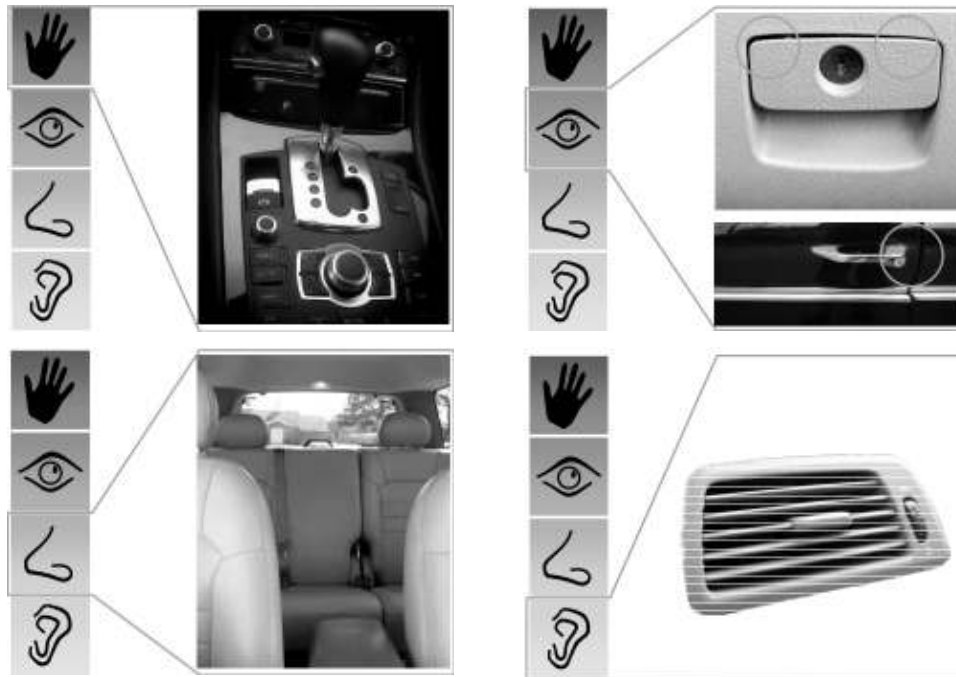
Figure 5: sensory perception in the vehicle interior

Based on the these basic principles of subjective perception and the associated challenges for manufacturing companies, the project idea for "enthuse Perceived Product Quality" was developed. In the following chapter, the European research project will be presented in detail.

3. ePPQ Cornet Project

The ePPQ project, which is funded by AIF in the framework of the Era-Net Cornet project in Germany, has been executed and followed up by the Department of Metrology and Quality Management of the Laboratory for Machine Tools and Production Engineering of the RWHT Aachen University (WZL RWTH), the Instituto de Biomecánica de Valencia (IBV) and the Federation for Quality Research & Science (FQS) together with a consortium of industry partners.

3.1 Project Presentation

On the one hand, manufacturers of luxury cars it becomes increasingly difficult to position their products on the market and to create clear differentiating features. Prior quality characteristics such as reliability and durability are an absolute prerequisite now. The predicate "Premium" can no longer be achieved through technology. The quality perceived by the customer - the Perceived Quality – becomes crucial for success. It covers not only the emotional charge of a product through the design and image but the overall multi-sensory perceptual experience.

On the other hand, in global supply chains an automobile manufacturer is no longer capable of applying such characteristics as quality of manufacturing, surface appearance in the interior, noise level and operating concepts on an excellent level all by himself. Both, design and production are carried out in cooperation with suppliers from different tiers, some of which supply completely assembled segments such as car dashboards or vehicle fronts. In addition, the position of the automobile manufacturer has changed from self-sustaining development cycles to a responsive identification and fulfilment of new market opportunities.

In order to enable the suppliers in this environment to create products, which appeal to the customer, it requires new ways of communication, especially a way of distributing Perceived Quality data over the entire supply chain (see Figure 6).

The German-Spanish project ePPQ develops new possibilities for the acquisition and dissemination of product data that is important for perception and evaluation of the product by the customer.
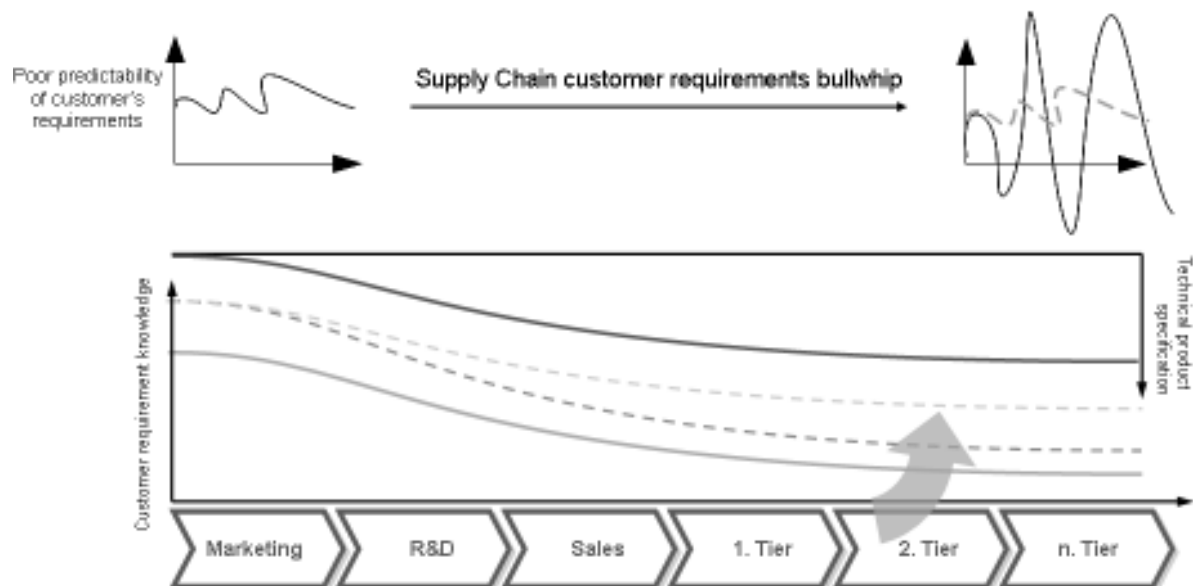

Figure 6: Information loss within the Supply Chain

Special attention is given to the customer perception in this project. Various studies have been carried out in Germany and Spain in order to reveal how relevant perception clusters and related product quality characteristics are for the overall assessment of a product. The data has been validated and adapted (matched, levelled) using real automotive components. By analyzing the data regarding the development and production scale of the various stages of the supply chain, technical specifications for the product, with which the Perceived Quality of the final product can be affected even in early stages of the development, have been obtained. By establishing an appropriate data structure, the project's results can be implemented directly into the industry.

3.2 Project procedure

Below the details for the project's process, which was divided into different steps, are listed (see also Figure 7):

1. Focus on components: In this first step guidelines have to be set, which are essential for the establishment of an objective system that can be used for the identification of relevant product characteristics. This approach ensures the comprehensive and sustainable identification, prioritization and selection of components that delight the customers. The aim is to generate a method enabling the companies to identify the characteristics of different product components that should be optimized in order to obtain a competitive product. This is the information that has to be passed through the entire supply chain.

2. Questionnaire: In this step a market analysis regarding the perception of product quality from retail point of view has to be conducted. This is done in order to attain a better understanding of the car market. In addition, a bibliographic research based on secondary data is performed. The goal is to gain knowledge from the end user regarding the perceived quality and thereby to take into account the influence of the previously selected components.

3. Effect on the customer: In this step a method has to be developed to elicit information from the customer concerning his quality perception within a next-to-real-life environment. Therefore customers have to interact directly with products or product components in contextual studies.

4. Communication of quality terms within the supply chain: In this part of the project the guidelines for translation of customer requirements into product specifications have to be defined. Because of the knowledge gained from the previous steps, a translation method for key product components can be developed. The objective of this project step is partly an adaptation of existing technical specifications with the focus of integrating subjective sensation.

5. Communication software within the supply chain: In this step the previously obtained results have to be conversed into a software tool. This tool integrates all gathered data regarding perceived quality and distributes it to the according members of the supply chain. The tool can be installed as an add-on to traditional data management systems, existing within the supply chain, and supports especially bi-directional communication between the partners.

6. Evaluation and continual improvement: The results of the various sub-steps are validated together with the participating SMEs of the project consortium and are continuously improved. During the validation the research results have been reviewed for their acceptability.

The main objective of this approach is to build a bridge between the technical product requirements and customer requirements during the product development, and furthermore to distribute all customer requirements throughout the supply chain. The leading question is: How can customer requirements be collected (comprehended) and holistically described, so that they can be passed further to the supply chain? This must be done considering current changes in the traditional communication methods within the supply chain.
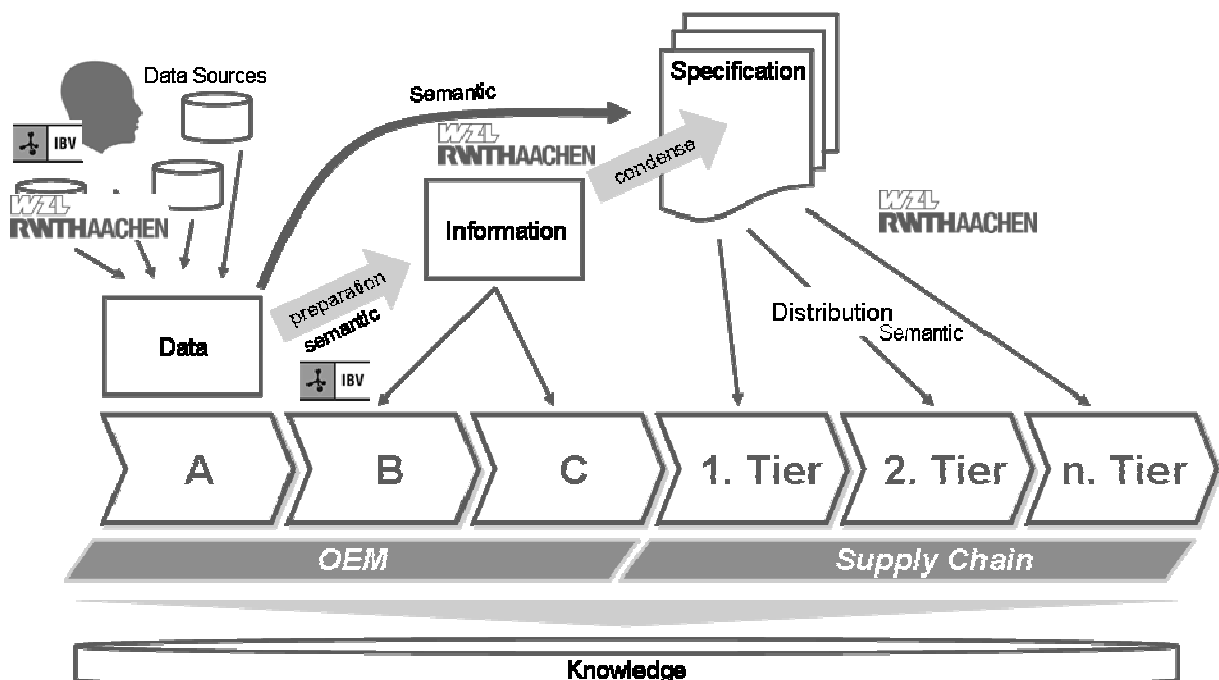

Figure 7: Steps of the ePPQ project

3.3 Achievements

Within the project different fundamental studies were carried out, which will be briefly explained in the following passages.

In the first study perception clusters for vehicle interiors have been identified. For that purpose a vehicle of the compact car class had been investigated. 139 probands took part in the study; as a result nine demographic rating groups were formed. The study was performed in individual interviews (approx. 20 min), which were semi-structured with open questions. For further investigation, video and audio recordings of the interviews were also taken. Object of investigation was the front cabin starting at the B-pillar. For the analysis the obtained data was digitized and intersections in the statements of the participants were determined. This was followed by the identification of the perception cluster by means of statistical analysis, the evaluation of the perception clusters and the identification of interfaces.

Based on the results of the first study, the second study aimed at identifying the quality attributes of one perception cluster. For this purpose the steering wheel was selected. In a first workshop with 12 participants, six steering wheels were analyzed. For the individual description of the steering wheels, the subjects needed approximately sixty minutes. The study was led by two facilitators and contained parts of open discussions between the participants. Those had steering wheels available for their assessment, which were presented separately from the vehicle interior. The brand names were visible. The assessment was carried out concerning visual and tactile characteristics. In a subsequent control study six steering wheels were investigated by the 64 "naive" participants. They should first give 10 general quality attributes of steering wheels and subsequently assess each of the steering wheels with regard to the given (developed) quality scales.

As a result of these studies among other things the systematic definition of perception clusters can be noted. Within the first study, seven perception clusters for the vehicle interior of compact cars have been determined. Furthermore, the systematic definition of quality attributes has been developed. For the steering wheels 25 quality attributes were identified, for example, the distance between the hand position and the function buttons, the required force to actuate the horn and the perceived temperature of the material. Based on this, a questionnaire for detailed analysis of general conditions considering the expectations of customers and retailers has been developed. The according survey was conducted with approx. 400 probands. As a result the perception clusters Steering Wheel, Dashboard, Centre Stack, Shift Gear and Hand brake got the highest importance ratings. For these clusters different analyzable characteristics have been identified. In addition, the specific characteristics for the steering wheel form, as one of the quality attributes, have been analyzed with the purpose of obtaining the best options for designing a steering wheel with the best perceived quality. In this project different studies are still in progress, as well as the implementation of the translation of requirements into technical specifications by the help of a software template.

4. Discussion

The presented project and its basic principles show how customers perceive a product and how important the different product characteristics are. Not yet considered are the stimuli that are triggered by these. For this further investigation clinical studies with magnetic resonance tomography have to be conducted. One well-known example that tries to explain the complexity of how the customers evaluate products is known as the Coca-Cola-Pepsi test. During the consummation of Pepsi Cola and Coca Cola brain activity is measured by magnetic resonance tomography. If he drinks "blind", Pepsi Cola is preferred by the proband. This triggers a stronger brain activity in the areas responsible for pleasure and reward. Moreover, the majority of the test participants think that Pepsi Cola has a better taste. On the other hand, if the brand is known to the participants, Coca Cola wins the evaluation. The

stronger brain activity in the area of self-confidence is meanwhile observed. The fact that Coca Cola is definitely preferred in the test, leads to the conclusion that positive memories and a sense of self-confidence have a greater impact on the customer's judgment then the flavour.

This brief excursus shows that the consideration of the subjective perception is indeed a decisive factor in the purchase of products, however, the multidimensional factors such as brand image or social status should not be neglected. Especially while focussing on the process of customers' judgment.

5. Acknowledgements

6. Literature

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