ABSTRACT

Product innovativeness is regarded as a critical construct in new product development research (e.g., Avlonitis et al., 2001; Danneels and Kleinschmidt, 2001). Several researchers have focused on the issue of conceptualizing and measuring innovativeness (e.g., Green et al., 1995). However, product innovativeness is very rarely assessed from a design perspective. This fact is surprising, especially when considering that in many markets new products are very similar in technological features, but compete on the product design (Veryzer, 1995). Drawing from different literature streams, such as design and consumer research, we build an argument for why product innovativeness both from a design and technology perspective may impact sales performance of new products.

In order to investigate these effects, we conducted a study based on a sample of 157 new car models launched in the German market between 1978 and 2006. For measuring both innovativeness dimensions, different data collection methods are combined, such as expert interviews, expert ratings, and document analyses. Responding to recent calls for more objective performance metrics (Sourescu et al., 2003), actual sales data are used as a performance measure.

The results of our study demonstrate that product innovativeness is a relevant driver of new product performance. Firms in the automotive industry who launch more innovative new products are able to generate higher sales with these products compared to their less innovative competitors. In particular, the results lend support to our suggestion that design newness is a relevant dimension of product innovativeness. The finding that design newness has a significant effect on car sales, underlines the importance to consider a design perspective when assessing product innovativeness and its performance effects.
INTRODUCTION

Product newness is regarded as a critical construct in new product development (NPD) research (e.g., Avlonitis et al., 2001; Calantone et al., 2006). Several researchers have focused on the issue of conceptualizing and measuring innovativeness (e.g., Danneels and Kleinschmidt, 2001; Gatignon et al., 2002). Although conceptualizations differ vastly, most authors suggest product innovativeness to be a multi-dimensional concept, which includes at least a technology dimension, and sometimes a market dimension or an organizational dimension (e.g., Danneels and Kleinschmidt, 2001; Garcia and Calantone, 2002; Green et al., 1995). However, product innovativeness has never been assessed from a design perspective. This fact is surprising, especially when considering that in many markets new products are very similar in technological features, but compete on the product’s design, i.e. its visual appearance (Hertenstein et al., 2005; Person et al., 2007; Veryzer, 1995).

For example, while similar in functional features, the Apple iMac G3 revolutionized the PC market based on its new design. Wrapped in friendly, translucent colours and ovoid forms, the iMac stopped being a product designed for office use only, but became an appliance for the home (Verganti, 2006). Even more revolutionary in its effect on its market was the launch of the ‘Alessi Dental Floss Holder Otto’. Dental floss used to be stored away in bathroom cabinets in its disposable standard packing. Complemented with the cute pastel-colored rubber guy it got out of the cabinets and went on display. There is wide agreement that product design is an opportunity for differential advantage in the marketplace (e.g., Hammer, 1995; Hertenstein et al., 2005; Veryzer, 1995). A number of companies, such as Alessi, Apple or Kartell, successfully focus on product design as a competitive tool (Verganti, 2006). As these examples emphasize the relevance of design among a new product’s features, it appears consequential to consider changes in this feature when determining a product’s innovativeness. However, the management literature has neglected both conceptualizing this aspect and investigating the performance impact of the design’s newness.

It is a central objective of this article to build an argument for why a design perspective is essential when assessing product innovativeness. In order to do so, we draw from different literature streams, such as design and consumer research.

The next objective is to investigate whether such a perspective has an impact on the performance of new products and to provide evidence for this relationship. Therefore, a quantitative empirical study is conducted. First, we develop a conceptualization of design newness, which, to our best knowledge, has not been proposed to the NPD literature yet.

In addition, we compare the performance impact of design newness with the one of technical newness. While design newness assesses the product’s external appearance, technical newness take a closer look at a product’s inside by focusing on its core technology and technical components. There are several product categories that mainly compete on the technical dimension. For example, today, office printers emphasize benefits, such as productiveness, low wattage, or speed and quality of the print. However, in their appearance, most of them follow the functional approach from the 1980ies. These printers are still covered in grayish plastic, have a large numbers of visible keys and pushbuttons among displays and several drawers, and also their bulky shape seems primarily determined by its technical function.

Hence, not only because technical newness is a dominant element of innovativeness in the relevant NPD literature, but also because it is relevant at the product level and can sometimes play an antagonistic role to design newness as a distinctive product feature, we use it to contrast the effects.

In order to investigate these effects, we conducted a study based on a sample of 157 new car models launched in the German market between 1978 and 2006. For measuring both innovativeness dimensions, different data collection methods are combined, such as expert
interviews, expert ratings and document analyses. Responding to recent calls for more objective performance metrics (Sourescu et al., 2003), actual sales data are used as a performance measure. This approach further goes along with the advantage of avoiding common source bias (Ernst, 2002; Lee and Grewal, 2004).

The remainder of this article is organized as follows. First, the literature is reviewed to build a convincing argument for why design newness is a relevant dimension when assessing a product’s innovativeness. Then, the conceptual model is developed for explaining the relevance of both a product’s design newness and technology newness for sales performance. After outlining the research design, the results are reported. The article concludes with a discussion of the study’s findings, its limitations, implications for management, and avenues for future research.

CONCEPTUAL FRAMEWORK AND HYPOTHESES

**Design, Product Design and Product Appearance**

Design is a research topic that several academic disciplines have studied, such as design theory, art history, economics, or psychology. Due to this fact, a vast array of definitions exists across all disciplines (Olson et al., 1998).

Even in the NPD related literature, there are several concepts that can be broadly distinguished by their understanding of design as a process or an outcome. From a process perspective, design describes the process of translating technical solutions into products with tangible properties and features, in order to enhance the value, utility, appearance, and manufacturability of a product (Veryzer, 1995). For example, Hise et al. (1989) see design as including several process activities, such as making rough drawings, creating crude working models and testing prototype models. Authors devoted to this perspective often use the term industrial design (e.g., Gemser and Leenders, 2001).

Authors following an outcome perspective tend to use the label product design (e.g., Bloch, 1995; Sewall, 1978; Veryzer, 1995). Product design usually pertains to the external surface(s) which house or protect the inner workings (e.g., mechanical or electrical components) of a product (Veryzer, 1995). Some researchers use different labels when describing product design, such as product form (Bloch, 1995), product shape (Berkovitz, 1987; Raghurib and Greenleaf, 2006), exterior appearance (Nussbaum, 1994) or product appearance (Creusen and Schoormans, 2005). However, all these authors share the understanding that product design refers to the exterior features of a product that are observable by consumers. According to this understanding, the product design of a personal compute, hence, would encompass merely the exterior features, like the exterior shell, the monitor, or the keyboard. The invisible elements, such as the hard disk, the processor, or the working memory, would not be considered. In this article, we follow the predominant understanding of product design that is related to the exterior appearance of a product. According to Schoormans and Robben (1997), the appearance of a product is the most prominent means to induce novelty, and changes in the exterior appearance will therefore influence whether the product is seen as novel. Hence, with regard to our goal of investigating design newness, focussing on the product appearance is advisable.

**Design Newness**

The design literature uses several concepts to capture design newness, such as originality (e.g., Runco and Charies, 1993), novelty (e.g., Hekkert et al., 2003), uniqueness (e.g., Bloch, 1995) or a-typicality (e.g., Loken and Ward, 1990). All concepts describe the deviation in a product design from a current design state. Most explanations suggest that design newness is primarily a function of the design fit within a product category. From this perspective, the design newness of a product depends on the degree to which it has attributes
in common with other members of its category (Whitfield and Slatter, 1979). The newer a product design is, i.e. the more atypical it is of a category, the less attributes it shares with other members of the category (Loken and Ward, 1990).

This category view implies that the design newness of a product can be determined by comparing its appearance with those of competing products. When applying this view to rating the design newness of the Dyson DC01 vacuum cleaner, one would have to compare its appearance to all other vacuum cleaners that were on the market when it was launched in 1993. Due to its transparent plastic design with a high-tech appeal, its design was revolutionary new and clearly differentiated its appearance from all competing products.

However, apart from using the products of competitors as reference points, Monö (1997) proposes two other reference dimensions that can be considered when determining design newness: (1) the present product portfolio of the firm and (2) the product generations, i.e. predecessors of the product. Both of these dimensions are firm-internal in their reference to current and former products. Thus, the design newness of the Dyson DC15 would result from the comparison with its predecessor DC14 or with all other Dyson vacuum cleaners, such as the Dyson Radix 6 handheld, the Dyson DC11 telescope or the Dyson DC06 robot.

While interesting from a firm-wide design strategy perspective (Person et al., 2007), assessing design newness along internal reference dimensions is unlikely to have the same effect on performance factors, such as consumer adoption decisions. This view is supported by the results of the empirical study of Person et al. (2008) that builds on Monö’s (1997) concept. When asked about critical factors in a new product’s appearance, design managers rate a product’s design newness compared to competitors as most important. In the consumer research literature, the proportional effect of different design newness dimensions has not been empirically explored. In most studies, however, design newness is assessed from a category view and the effects shown, speak for this concept’s relevance (e.g., Schoormans and Robben, 1997), as will be detailed in the next section. Hence, when rating a product’s design newness, we follow the predominant understanding and compare it with competing products’ designs.

Performance Impact of Design Newness

The NPD literature has largely neglected investigating the performance effect of a new product’s design newness. In the consumer research literature and design literature, however, there is evidence for the potential of impact design newness on consumers. Basically there are two different lines of argument: 1) design newness can act as a trigger for and/or facilitator of the adoption process (e.g., Schoormans and Robben, 1997), and 2) design newness can address consumer needs and/or values by itself (e.g., Yalch and Brunel, 1996).

A review of the literature that follows the first line of argument shows that evidence can be grouped according to the effect of design newness on the different stages of an individual’s adoption decision. Several studies demonstrate that the more a product’s design deviates from existing products the more attention it receives (e.g., Garber, 1995; Schoormans and Robben, 1997). Other authors suggest that a high initial incongruity of a novel design with previous ideas about that product category leads to a higher interest in that product and a higher willingness to take action to resolve this incongruity (e.g., Krippendorff, 2005). This willingness to act may lead to an active search for further information on that product, exchange of opinions with other users, or product trials.

However, apart from these positive effects on the adoption process, very novel and unique designs were also found to have opposite effects. In their experimental study of consumer response to novel ground coffee packaging, Schoormans and Robben (1997) found that the most radical shape got high attention but scored low on acceptance, as the packaging
was perceived as being outside the range of acceptable packaging shapes for that product category.

There is also literature on how design newness can directly affect consumer needs or values (Yalch and Brunel, 1996). From that perspective, design newness itself is a mean to satisfy an end, such as affiliation, achievement, variety-seeking, or self-expression (Engel et al., 1993). According to Yalch and Brunel (1996), products with unique and innovative designs can, for example, help consumers satisfying their need to be accepted by a certain group and differentiate themselves from other consumers. They can also assist variety-seeking consumers in their striving to maintain a preferred level of arousal and stimulation. Consumers with a need to develop freedom in self-expression can use products with a distinctive, innovative design to express their sophisticated taste.

Hence, from prior research mostly arguments for a positive performance effect of design newness can be derived. However, as design newness has not been thoroughly investigated in the management literature, there is a lack of empirical evidence for its power of driving performance factors, such as sales. Yet, we can again borrow from a real-life example: the Alessi 9093 Tea Kettle. Since its launch in 1985, Alessi has sold more than 1.5 million units of this rather expensive kettle. With its cone-shaped body, the circular handle and the little plastic bird on its spout, its design was more unique and novel compared to the other kettles on the market. Hence, we hypothesize:

\[ H_1: \text{Increased design newness has a positive impact on product sales.} \]

**Technical Newness**

Technical newness can be understood as the aspect of the degree of innovativeness that is most inherent to a new product, as it stays on the level of the product investigated by describing the change in its features (Pauwels, 2004) rather than its consequences on the producing firm, the market or the environment (Dannels and Kleinschmidt, 2001; Garcia and Calantone, 2002). Most generally, a high degree of technical newness can be realized when new technological principles, architectures, components or materials, are used in a product (Gemünden et al., 2005). New products with a high degree of technical newness, thus, often embody a technology that follows a new technological paradigm (Garcia and Calantone, 2002), and/or realize considerable technological performance enhancements (Green et al., 1995). As a result, market structures can change and old technologies can get superseded (Salomo, 2003).

Typically, researchers determine the degree of technical newness on the level of the overall product. However, most of today’s products are conglomerates of modules and components, so that for each component a distinct level of newness could be assessed. The literature dealing with product modularity, however, has not been well integrated in the NPD literature (Grunwald and Kieser, 2007). So far, only Henderson and Clark (1990) have adapted the idea that products consist of multiple components in their concept of architectural innovativeness. Following this concept, technical newness can be understood as an aggregation of the degree of change happening in each product component. In this article, we integrate the idea of Henderson und Clark (1990) in the established perspective on technical newness as this is considered to better represent today’s mostly multi-component products.

**Performance Impact of Technical Newness**

Several researchers have dealt with the performance effect of technical newness. However, empirical evidence does not provide an unambiguous picture of the performance effect of technical newness (e.g., Zhou et al., 2005; Calantone et al., 2006). In a quantitative meta-analysis, Kock (2007) finds that technological newness has almost no performance impact (mean correlation \( r = .046 \)). Henard and Szymanski (2001) also report that the
correlation between product innovativeness and performance varies significantly between all studies included in their meta-analysis (from $r=-.62$ to $r=.81$).

Most researchers argue that from a conceptual perspective, technical newness impacts a wide array of benefits associated with new products. One can reasonably expect a product with new technical performance features to be on average better able to meet latent needs of potential customers (Veryzer, 1998). High relative advantage has often been reported as product attribute with the strongest effect on product adoption (Rogers, 2003). A novel technology can also serve as an effective argument for product positioning and differentiation from competitors (Lynn et al., 1996). Such positioning can allow for the realization of temporary monopoly rents (Kleinschmidt and Cooper, 1991).

However, these positive effects are counteracted by increased risk and complexity following high levels of technical newness (Leifer et al., 2000). Risk and complexity emerge due to high market, technology, resource, and organizational uncertainties (Lynn et al., 1996), as for radical technological innovations, the problem structure and scope are vague, and many problem components are unpredictable. From a technological viewpoint, that can mean increased development time, lacking expertise, unstable routines, deficient products, and higher failure rates (Griffin, 1997; Lynn et al., 1996). In order to manage and reduce these increased levels of risk and complexity, oftentimes, significant resources need to be allocated (Lynn et al., 1996).

The result of the meta-analysis by Kock (2007) show that internal project performance is rarely positively impacted by increased technical newness, which may be a consequence from the increased resource demand. A similar picture reveals as soon as technical performance is concerned, which again may be reasoned by the arguments mentioned above. However, when looking at market performance, the picture changes, as more evidence exists for a positive effect of technical newness on market performance (e.g. Bayus, 2003; Cooper and Kleinschmidt, 1991; Talke, 2007). In this article, we will focus on the effect of both newness dimensions on product sales, which is a classical measure of market performance. Hence, we follow those studies that argue and find support for positive effects and hypothesize:

$H_2$: Increased technical newness has a positive impact on product sales.

**METHOD**

**Sample**

Our analyses are based on a sample of 157 new car models belonging to different segments (e.g. luxury cars, mid-size cars) launched in the German market between 1978 and 2006. We chose the automotive industry as a field of investigation because of the strategic role of both technical and design aspects in product innovation in this industry (Pauwels et al., 2004). Cars are an excellent representation of more complex products, which consist of different modules and, thus, require an adequate decomposing assessment of product newness. Further, as cars constitute a high involvement product, large amounts of publicly available data, mapping also historical new product introductions in detail, are available for building a rich data set, while allowing to minimizing retrospective bias. Additionally, the industry is subject to governmental awareness both from the perspective of taxation and safety regulation. Each new product needs to be registered in a central database allowing unique accessibility of actual sales data over time.

We chose the German market due to its strong competitiveness and large size. As it is the largest European automotive market, it is composed of all relevant segments in sufficient size and many models also from international carmakers are present in each segment, hence, allowing a complete picture of the automotive market.
In building the sample for our analysis we focus on five main automotive segments ranging from micro vehicles to luxury class models. This definition of segments follows the official classification from the German vehicle registration office, which is mainly based on size and engine power criteria. The models in these selected segments account for more than 70% of the overall automotive sales in 2006. In order to secure sufficient variance in our sample, we included models from both German and international carmakers, and models with strong and limited market share in our sample. Additionally, we asked a panel of five automotive industry experts with significant technology and/or market expertise to identify car brands, which follow different product/market strategies, from which to choose models for our sample. Hence, we secured that we both include models from brands, which try to achieve competitive advantage through technology and design (e.g., BMW) or through a cost leadership strategy (e.g., Skoda).

As we are interested in the effects of design and technological newness on sales performance, our sampling procedure needs to secure that major technological innovations and changing design paradigms relevant in the automotive industry are included. Due to the specific technology and design clock speed of this industry, combined with the sample size requirements for robust statistical analyses, we chose to include new car model introductions between 1978 and 2006 in our sample. By analyzing a time span of 29 years, we are able to capture such major innovations like ABS (introduces 1978), aluminum chassis (1994), and daylight or rain sensors (1999). Overall, our sample consists of 157 new car models introduced to the German market between 1978 and 2006. The following table 1 shows the distribution of new product introductions across brands and segments included in our sample.

Table 1: Number of new car model introductions per brand and segment in the sample

<table>
<thead>
<tr>
<th>Brand</th>
<th>Micro</th>
<th>Mini</th>
<th>Lower medium-sized</th>
<th>Medium-sized</th>
<th>Upper medium-sized</th>
<th>Luxury</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audi</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>BMW</td>
<td></td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Fiat</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Ford</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Mercedes</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Opel (Saturn/Pontiac)</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Peugeot</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Renault</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Seat</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Skoda</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Toyota</td>
<td>6</td>
<td>10</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>Volvo</td>
<td>2</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>VW</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Overall</td>
<td>7</td>
<td>34</td>
<td>39</td>
<td>40</td>
<td>27</td>
<td>10</td>
<td>157</td>
</tr>
</tbody>
</table>
**Measures**

In order to test our performance hypotheses, our model relates the two independent variables ‘design newness’ and ‘technical newness’ to model-related yearly sales data. We also include ‘competitive intensity’ and ‘relative price’ as control variables, as these measures are considered relevant for car sales (Pauwels et al., 2004).

**Market performance:** For assessing market performance we focus on sales of new cars. As every sold new car needs to be registered with the German central registration office (Kraftfahrt-Bundesamt), model specific sales figures are publicly available. Although sales are reported on a monthly basis, we choose to use yearly sales in order to minimize the effect of potential sales figure management practices applied by some carmakers. Only for the first model year we use mean monthly sales to account for varying new model introduction timing. In order to assess the relative performance of a model, we calculate a relative sales performance measure by dividing individual yearly sales with mean yearly sales of all competitor models in each segment.

**Design newness:** Following our conceptual understanding of design, ‘design newness’ is measured as the change in exterior appearance of new car models compared to the current design state within the respective model segment. A new car model’s visual appearance is primarily based on its exterior shape and style. Design newness can then be established by the amount of change in a car’s proportions, dimensions, contour, and its structure (Kohler, 2003). A change in proportions relates to the relative size of sub-areas or -volumes, e.g., the relative size of transparent door-window areas related to the overall door area. Dimensional change manifests in change of absolute size of modules or the overall product. Contour related design newness refers to a change in a car’s silhouette, typically from a side-view. The introduction of a v-shape design in the 1970ies is a prominent example for a significant contour change in car design (Kieselbach, 1998). Finally, design newness may relate to a change in structure, i.e. an alternation of the inner order of an object. The front view or ‘face of a car’ is for example structured by a specific composition of front grill, lights, and front bumpers.

In order to assess design newness we prepared a standardized set of pictures for all car models in our sample. Each model was represented through a front, rear and side-view picture. To avoid unintended interfering effects, each picture was scaled to a similar size. Within one segment we aimed at using car images with the same color, and background noise was additionally reduced to a minimum through removing other objects apart from the relevant car from the pictures. The model images were arranged on large wallpapers according to their date of introduction, with each model line occupying one row and with models from one segment below each other.

We followed a multi-rater approach for assessing design newness based on the above-explained visual representations of our sample models. A pre-test with four MBA students was used to test the assessment process. This pre-test served in particular for detailing the intensity of up-front information and training necessary for preparing potential raters. A sample of 50 raters was then used to actually assess design newness. In order to secure some affiliation with the product to be rated, only individuals with own driving experience were selected. The group of raters split half in male and female raters with a mean age of 32 (spanning from 19 to 69 years). Before performing the design newness assessment, each rater was introduced to the concept of car design and the newness measurement approach of this study. Each rater performed a test rating together with a supervisor, which aimed at creating a unified assessment approach across raters. Within this training exercise raters were also presented with examples of very radical and incremental design changes in order to establish common reference points for the newness rating. Then each rater was asked to rate overall design newness on a Likert-type scale from 1 (=incremental change) to 7 (=radically
different) of each sample model relative to the state of design in the respective car segment at the time of market launch. Due to the training and standardized assessment procedure followed by each individual rater, inter-rater reliability was remarkably high. This allows using a mean score of design newness across all raters. While we secure that raters follow a standardized procedure in assessing relative design newness, we cannot completely rule out a retrospective bias in this assessment. As cars that may have been launched with a radical new design in the 1990ies have become a regular appearance in today's traffic, these design changes may be rated less innovative compared to more recent new product launches. And indeed, mostly independent of age or experience of raters, cars launched many years ago are rated less innovative from the design perspective than current models. To control for this systematic increase in design newness, we adjust the relative design newness of individual models by subtracting the slope from regressing design newness on years, weighted with the time span between the year of the first launch in our sample (1978) and the individual launch year.

**Technical newness:** We define technical newness of a new car model as the accumulated degree of technical change in substantial product components relative to the technical state of the art in the automotive industry. In order to establish this technical newness of a car we followed a step-wise procedure. First, major technical innovations in the automotive industry between 1978 and 2006 were identified through an intensive literature analysis of relevant industry journals. This extensive list of technical innovations was presented in personal interviews to 40 industry experts. To qualify as an expert we required an engineering degree and a multi-year experience in automotive technology development either in OEM or first tier suppliers. The experts were asked to verify and complete the list of technological innovations, to provide a date of first appearance of these innovations in new car models, and to rate the degree of technical newness of each of the innovations at its first appearance. Following previous measurement approaches for technical newness (Danneels and Kleinschmidt, 2001; Salomo, 2003) we asked for assessment on four items (‘new technical principle’, ‘achieved performance leap with new technology’, making old technologies obsolete’, and ‘degree of induced technological change in overall car’), each rating newness on a Likert-type scale from 1 (=incremental change) to 7 (=radical change). Again, inter-rater reliability was sufficiently strong, allowing the use of a mean score of technological newness for each of the technical component innovations. A third step involved establishing, which technological component innovations were integrated into each of the models of our sample. To this end, we used information from the expert interviews to determine technological minimum requirements for each innovation. We then identified at least two test reports for each new model in our sample from the major German automotive journal (‘Auto-Motor-Sport’), which contains detailed information about technological components of newly introduced cars. This information was supplemented by test reports from other automotive journals, Internet queries and direct contacts to OEM. Overall, more than 1,000 different documents were used to determine the existence of technological component innovations in each model at the time of market introduction. The technological newness of a car is then calculated as the sum over all existing components, each weighted with its individual technological newness score. Parallel to the design newness measure and in order to account for the technological state of the art in each car segment, an additional transformation is required to reach at the final ‘relative technological newness’ measure. To this end, the individual technological newness is divided by the mean technological newness of all other competitor car models in each segment.

**Control variables.** When assessing performance effects of newness we need to control for relative price and competitive intensity. For price information on each model we relied on the German industry journal ‘Autokatalog’, which reports prices on all models available in
the German market on a yearly basis. Individual model prices are inflation adjusted and divided by the mean model price of the respective segment to achieve a measure of relative price on a yearly basis. Competitive intensity is assessed on a yearly basis through calculating the mean time span since competitors have introduced new models to the respective segment. To ease interpretation, this measure is multiplied by -1.

**ANALYSIS AND RESULTS**

Descriptive statistics for the cases in our sample are displayed in the appendix. To test our performance hypotheses, we perform a multiple regression analysis. Accounting for the typical product lifecycle in the automotive industry with major sales occurring in the first four years after the launch, our analysis of performance effects from design and technical newness focuses the first four model years. Results of this regression analysis are presented in table 2.

**Table 2: Regression results – Sales Effects of Design and Technical Newness**

<table>
<thead>
<tr>
<th></th>
<th>Model year 1</th>
<th>Model year 2</th>
<th>Model year 3</th>
<th>Model year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design newness</td>
<td>.233**</td>
<td>.179*</td>
<td>.163*</td>
<td>.158</td>
</tr>
<tr>
<td>Technical newness</td>
<td>.166‡</td>
<td>.434**</td>
<td>.357***</td>
<td>.267***</td>
</tr>
<tr>
<td>Competitive intensity</td>
<td>-.299***</td>
<td>.006</td>
<td>.091</td>
<td>.008</td>
</tr>
<tr>
<td>Relative price</td>
<td>-.034</td>
<td>.031</td>
<td>.027</td>
<td>.157</td>
</tr>
<tr>
<td>R²</td>
<td>.159</td>
<td>.269</td>
<td>.190</td>
<td>.178</td>
</tr>
<tr>
<td>R²_adj</td>
<td>.129</td>
<td>.242</td>
<td>.161</td>
<td>.146</td>
</tr>
<tr>
<td>F</td>
<td>5.669***</td>
<td>10.201***</td>
<td>6.728***</td>
<td>5.565***</td>
</tr>
</tbody>
</table>

*a dependent variable: model sales per year relative to mean sales of segment per year

n_{model year 1} = 130, n_{2} = 116, n_{3} = 120, n_{4} = 106, n fall short of total sample n due to missing sales data for some model years caused by inconsistent data bases at the German central car registration office. Car models with missing sales data did differ significant from complete cases in mean variable values.

‡p ≤ 0.10, *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001

Overall our results indicate strong predictive power of design and technical newness for new car sales performance. Dependent on the model year, our independent variables explain between 13% and 24% of the overall variance in relative sales performance. All models show strongly significant F-values, thus allowing interpretation. Sales performance in model year 1 is primarily explained by competitive intensity and design newness. The highly significant and positive beta value of design newness lends support to hypothesis 1, suggesting positive sales effects from increasing design newness. Technical newness is also positively related to relative sales performance. However, the effect is only significant at the 10%-level. While relative price does not impact sales performance significantly in any of the model years, cars introduced in a situation of limited competitive intensity, show significantly stronger relative sales performance in the year of their launch. This negative performance effect of strong competitive intensity is only apparent in the first model year. In all following years, competitive intensity does not exhibit a significant sales effect.

The regression results for model year 2 to 4 show a slightly different picture. While design newness remains significant and with a positive impact on sales performance until model year 3, albeit with a less strong effect compared to model year 1, technical newness becomes a major predictor of sales performance. The highly significant and very strong beta values for technical newness in the regressions for model year 2 to 4 lend strong support to our hypothesis 2 for these later stages of the product life cycle.
DISCUSSION

The results of our study demonstrate that product innovativeness is a relevant driver of new product performance. Firms in the automotive industry who launch more innovative new products are able to generate higher sales with these products compared to their less innovative competitors.

In particular, the results lend support to our suggestion that design newness is a relevant dimension of product innovativeness. The finding that design newness has a significant effect on car sales, underlines the importance to consider a design perspective when assessing product innovativeness and its performance effects. The finding also indicates that even in technology-intense industries, like the automotive industry, the distinct appearance of a new product is an immensely important adoption criterion. Technical newness also proves to be a powerful means to increase new product performance. This finding lends further support to those articles that emphasize the advantageous effects of a high degree of technical newness (Kleinschmidt and Cooper, 1991; Lynn et al., 1996; Veryzer, 1998).

When taking a closer look at the performance impact of both newness dimensions over the product lifecycle, an interesting picture emerges. For design newness, the effects are particularly strong in the first year after the model launch, but decrease continuously towards insignificance in the last model year. This may indicate that design newness can generate a high initial awareness and interest among consumers, which acts as a trigger for the adoption decisions. However, the awareness related to a new product’s exterior appearance seems to wear out over the lifecycle, so that the effect on sales diminishes. It also seems plausible to presume that especially in the first years after the launch, a model with a novel design can serve as a means to differentiate a consumer from others and to demonstrate achievement, both consumer values that drive adoption (Yalch and Brunel, 1996).

For technical newness, we find that only in the second year after the model launch this newness dimension starts driving sales significantly. Considering the usual shape of the diffusion curve (Rogers, 2003), the finding may imply that novel technical features need some time to get diffused within a market. Especially those consumers that are less enthusiastic about new technology are likely to require more than the information provided by the OEM or car dealer. In order to lower their perceived risks, they will most likely search for additional information about the usefulness of new features, e.g., from test reports, test drives, or opinions from people they know that were early adopters. Such reasons are in line with findings from consumer research (e.g., Bagozzi and Lee, 1999), which show that the majority of consumers need time to get used to really new products, understand new features, and overcome technology-related risks before deciding to buy such products.

The effect of a car model’s relative price proves to be insignificant over the entire lifecycle. This result may not come as a surprise when considering that we used the model’s price relative to the segment’s mean price. Within several segments, particularly the smaller ones as well as the luxury segment, price competition is not overly excessive, and hence, the range of variation is limited. However, integrating absolute price data in our analysis is not advisable, as the sales of a BMW 7, will not depend on the price of a Renault Twingo or a Ford Fiesta but on the price of an Audi A8 or a Mercedes S-Class.

Competitive intensity shows a significant negative effect on the sales of a new model in its first year after launch. Since this measure expresses the mean time span since competitors have introduced their new models to the respective segment, this finding seems reasonable. One could argue that consumers are particularly receptive to models which are launched after not much new happened within a segment for a while. In the years that follow this effect may wear off, as the competitors of that segment follow suit with their new models.
Limitation and avenues for future research

This study has some limitations that provide worthwhile avenues for further research. First, we analyzed only the automotive industry, in which design and technology play a major role in the adoption decision, and thus, in product sales. The performance effects of design newness and technical newness we found are likely to primarily occur in products, where both visual appearance and functionality are relevant. Although these aspects are important decision criteria for many consumer goods, there may be exceptions, such as cheap articles with a one-time usage only. Hence, a validation of our results in other industries is an important area for further research.

Second, we focus on a single country. The German car market is the biggest European car market, however, it will not be free from a certain country of origin effect (Chao, 1998; Bilkey and Nes, 1982). A stronger preference for German brands will result in a higher market share of brands like BMW, Mercedes, or VW compared to other country’s car markets. This again, may lead to a proportionally higher influence of these German brands’ design newness and technical newness on the strength of the relationship between both newness dimensions and sales. As we also integrated other car brands in our sample, such as Ford, Toyota, Opel, Fiat, Renault, or Volvo, this effect will most likely be limited. However, additional work could compare our study results with those of other countries.

There may also be a country specific perception of design (Dawson et al., 2005; Keillor and Hult, 1999) that can have an influence on the assessment of design newness. However, as we do not assess the aesthetic preference or the symbolic meaning of a design but its newness as a differential indicator, the assessment of such a measure should be less dependent on the national context. In addition, we intensively trained the raters before their assessment of design newness. Therefore, it is unlikely that the country has an impact of the assessment of design newness, however, future research may produce evidence on that question.

In our study, we use actual product sales as a performance metric, which gives an objective, comparable overview of how each car model was diffused in the market over its lifecycle. Using return on sales as a performance metric would provide additional information on model-related profitability, and thus, enrich the performance measure with financial, i.e. cost, aspects. However, unlike sales data, model-related return measures are not externally available, as firms do not disclose it. Apart from this accessibility problem, financial ratios are more likely to be diluted by strategic accounting politics than sales figures.

The sales figures we extracted from the KBA database mirror the overall number of cars sold in Germany each year. This type of data does not include information on the customers who bought these cars. Hence, from the data at hand, we cannot investigate the reasons for a purchase decision of a certain customer. However, future research may consider such a perspective, as both technical newness and design newness could have the goal of addressing new customer segments, and attaining this goal not necessarily has to result in attracting more customers, but different ones. In this case, we will not be able to detect a significant effect on sales as the overall number of models sold remains on a similar level. However, as these effects remain undetected, this may imply that future research may find even stronger performance effects of design newness on models sold when relating sales figures to individual customers.

Implications for Managerial Practice

Our results indicate that firms that launch more innovative new products generate higher sales compared to their less innovative competitors. For management practice, this
finding suggests to clearly define objectives for product innovativeness, which can guide new product development and to deliberately strive for higher degrees of newness.

Our results also show that products that offer enhanced performance through novel technical components stand a better chance to meet latent needs of customers. Thus, introducing products, which are more technologically advanced than competitor products, helps achieving superior sales performance. For NPD managers, this positive performance effect of technical newness is important, as it substantiates the relevance of innovating activity and technology development in particular. As our results are based on a detailed and facts related assessment of technical newness and performance is measured with objective sales data, the finding can serve as a reliable reference when reporting to top management. Hence, our results may help to justify investments in technology-based innovation, which compete with alternative investment options, traditionally recognized as closer related to performance.

At the same time, our study also highlights that product innovativeness is not sufficiently described by technical newness alone. Even in a technology-intense market, as the automotive industry, our results show that product design has become a critical element of a product’s competitive advantage. Hence, when thinking about product innovativeness, management should also take the product’s appearance into account. We recommend to NPD managers to strive for an innovative product design, by differentiating a product’s appearance from competitor products in order to positively influence individual adoption decision and, finally, overall sales.
REFERENCES


