

THE ROLE OF DESIGN IN INTERDISCIPLINARY PRODUCT DEVELOPMENT – CHALLENGES, RESEARCH APPROACHES AND FURTHER RESEARCH NEEDS

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ABSTRACT

In global competition, companies are continuously searching for a competitive advantage. A growing number of companies have identified the design of their products as a major success factor. The promises for companies associated with outstanding design are extremely attractive, ranging from better customer experience to higher sales growth. But even though the advantages of design seem to be compelling, companies are still having difficulties in leveraging the benefits of design.

In this paper, we want to identify the underlying challenges that explain this gap. We are especially interested in the role and challenges of design in interdisciplinary product development. Therefore, we perform a literature review that clarifies terminology, analyses research approaches and identifies challenges. We determine seven key challenges for design in interdisciplinary product development. Furthermore, we observe a limited scope of research approaches in the reviewed literature. Based on these findings, we propose three further research directions to strengthen the role of design in interdisciplinary product development in the future.

Keywords: Industrial design, Collaborative design, Human behaviour in design, Interdisciplinary Design

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Cite this article: Stöhr, B., Koldewey, C., Dumitrescu, R. (2023) 'The Role of Design in Interdisciplinary Product Development – Challenges, Research Approaches and Further Research Needs', in *Proceedings of the International Conference on Engineering Design (ICED23)*, Bordeaux, France, 24-28 July 2023. DOI:10.1017/pds.2023.348

1 INTRODUCTION

Companies are continuously looking for a competitive advantage in their global markets. An increasing number of companies see the design of their products as a major lever for success (Buerdek, 2015). A wave of design-centricity began in the 1990s and has steadily gained importance since then (Buerdek, 2015). The Danish company Bang & Olufsen for example has succeeded in the highly competitive market for stereo systems through outstandingly appealing products in the high-end niche market (Kotler and Rath, 2011). By the mid-1990s Apple products seemed to have become products like any other. According to Ravasi and Lojaco (2005), "sales figures were down and shares were falling". In 1997, design again became a focus for the organization and played a major role in the company's turnaround and unstoppable rise (Ravasi and Lojaco, 2005). These are just two prominent examples. The spectrum of companies that recognize design as a competitive advantage ranges from traditionally design-driven sectors such as the furniture industry to consumer electronics companies (Gemsera and Leenders, 2001). Even for industrial goods, design plays an increasingly important role (Herrmann *et al.*, 2009).

The promises for companies associated with outstanding design are extremely attractive and manifold. Design can be a major contributor for building successful products and brands (Goffin and Micheli, 2010). Design can boost customer experience and drive innovation. Companies with a focus on design see their internal creativity strengthened (Lockwood, 2011). Design can support strategic renewal even in mature industries (Ravasi and Lojaco, 2005). On top of that, design can also generate economic benefits for companies. Gemsera and Leenders (2001) investigated how the design intensity in companies from the home furniture and precision instruments sectors affects their economic performance. It was shown that in companies with both low and high design intensity, the application of design leads to competitive advantages, higher sales growth and thus to more economic success (Gemsera and Leenders, 2001).

Even though the advantages of design seem to be compelling, companies are still having difficulties in leveraging the benefits of design. In this paper, we want to identify the underlying challenges leading to this gap. Design matters for companies in many different areas. From product design to graphic and communication design. We focus in this paper on the design of products and not on aspects like communication design. Today's products can only rarely be developed by individual persons (Ulrich and Eppinger, 2016). They are developed in an interplay of different disciplines such as design, engineering and manufacturing. That is why we are especially interested in challenges that arise from interdisciplinary product development and the difficult role of design in that kind of organizational environment.

2 RESEARCH DESIGN

We performed a literature review that clarified terminology, analyzed research approaches and identified challenges for design in interdisciplinary product development. Based on this, further research directions and needs are derived.

As a basis for this paper, a literature review was performed to answer the question of what is "design". Therefore, we screened the literature to get an understanding of "design" as a term. Additionally, various terms in the context of design were analyzed. Based on this understanding and our focus of research, a valid "design" understanding for this paper was derived.

In line with our understanding of design, our second step was to search for publications that examine challenges for design in an interdisciplinary product development environment. We followed an exploratory approach to identify relevant publications and to structure the research topic. Common databases, mostly Scopus, were searched concerning paper titles. Keywords were e.g., "industrial design", "usability" or "user-experience design" and "challenges" or "barrier". Identified publications were continuously expanded through title-focused forward and backward search until a final set of approx. 370 publications was reached. In parallel, titles considered particularly relevant were extracted, abstracts and, if appropriate, full articles were read. From these publications, a final set of particularly relevant publications was selected. General criteria were the quality of the publication, the number of citations and the year of publication (more recent publications were preferred). The main criteria were the focus on interdisciplinary aspects in design and correspondingly, the focus on challenges in design. Particularly of interest were publications that provide a comprehensive picture of challenges in design as

well as those that shed a light on specific challenges. The aim was to obtain a complete, representative and multi-faceted picture of challenges for design in interdisciplinary product development. With this approach, thirteen highly relevant publications were selected as the basis for further analyses.

These publications were examined regarding their research approach to be able to better assess the evidential value and necessary further research. Therefore, we classified the publications and compared them along specific characteristics. We were interested in basic information like publication date, area of design (usability, industrial design, user-experience, etc.), country and domain. In addition, we captured more specific information. For this purpose, we analyzed the design of the studies itself. Therefore, the literature was classified along involved departments/roles (design, engineering, management, marketing, manufacturing). Furthermore, we were especially interested in how data was collected. Our further classification criteria were sample size, location (lab, field), method (interview, survey, observation) and measurement approach (cross-sectional, longitudinal).

The final step of our literature review was to examine the relevant publications regarding challenges for design in interdisciplinary product development. We followed the approach of [Braun and Clarke \(2006\)](#), generated initial codes, searched and reviewed themes, and defined and named themes. The result of this process are the main challenges for design in interdisciplinary product development derived from literature.

3 RESEARCH RESULTS

The research results are presented in three sections. The first section investigates the meaning of the term "Design". Related terms and definitions are described and a valid design understanding for this paper is presented. The subsequent sub-chapter provides an overview of the relevant literature concerning applied research approaches. Finally, the main challenges for design in interdisciplinary product development are presented.

3.1 What is "Design"

Defining and discussing the term "Design" would easily fill a separate publication. In this section, we focus on the term as well as related ones with a focus on product development processes and generate a basic understanding for this paper. The term "Design" has become a word of everyday use with manifold interpretations ([Reese, 2005](#)). It is applied in completely different areas such as software design and architectural design. Consequently, it is often used as an "umbrella term" ([Bratteteig et al., 2016](#)). Design is both the object as well as the process of creating the object ([Valencia et al., 2013](#)). The object is the output of a design process during which an idea is transformed into either a tangible product or an intangible service ([Stamm, 2010](#)). There are a variety of terms that are used in the context of design. **Industrial Design** is related to the industrial revolution and has established itself in academia even if it seems to be outdated in the age of digital transformation ([Heufler et al., 2019](#)). Industrial Design has been defined in many ways ([Gemsera and Leenders, 2001](#)). According to [Heufler et al. \(2019\)](#), industrial design is a "holistic problem-solving process to improve the functional, interactive and aesthetic qualities of products. The objective is to align consumer goods on one hand to the user needs and on the other hand to comply with the rules of the market, corporate identity and economic production in the interests of the company" ([Heufler et al., 2019](#)). Another term which is often used in the context of design is **Usability**. The ISO standard defines usability as the "extent to which a system, product or service can be used by specific users in a specific context of use to achieve specific goals effectively, efficiently and satisfactorily" (DIN EN ISO 9241-11, 2018). From a methodological perspective, User-Centered Design and Usability Engineering are the two most common approaches for achieving a usable product design ([Kuijk, 2010](#)). But a product can be usable, but still boring to use ([Kuijk, 2010](#)). This is where **User-Experience Design** comes into play. User experience, abbreviated as "UX", is a "consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g., complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g., organizational/social setting, meaningfulness of the activity, voluntariness of use, etc.)" ([Hassenzahl and Tractinsky, 2006](#)). **Interaction Design** is concerned with the way how humans interact with a product ([Buerdek, 2015](#)). It describes the dialogue between the user and the product as a system that can respond with feedback to a user's input ([Buerdek, 2015](#)). Closely related to Interaction Design is **(User) Interface Design** which is about the visual representation of content as well as the operating elements, for example on a display ([Buerdek, 2015](#)).

Interwoven with the discussed terms is **Ergonomics**. Ergonomics has the goal of optimizing the comprehensibility, manageability and comfort of consumer and industrial goods. The design principles are anthropometric as well as visual and haptic design (Goetz, 2019).

Summarizing, the term "design" is difficult to grasp. Moreover, there are several closely related and overlapping terms. We are interested in the challenges from an interdisciplinary product development perspective. That is why we take a simplifying functional organizational perspective and consider designers as those roles in the interdisciplinary product development process that are engaged in industrial design, user experience design, usability design and closely related topics. We consider the design of a product as the result of an interdisciplinary development process. Hence, the design is defined by aspects of industrial design, user experience design, usability design and closely related approaches. Following, we use the term design synonymously with the mentioned related terms.

3.2 Research approach

This sub-section provides an overview of how the thirteen relevant publications conducted their research. First, we give a brief overview of basic information such as publication date, area of design (usability, industrial design, user-experience, etc.), country and domain before going into details about studied roles and data collection.

3.2.1 Basic information

The relevant publications for this paper and their basic information are shown in Table 1. All publications were published in the period between 2006 and 2021, with most being published from 2010 onwards. Most of the publications are in the area of usability, user-experience and industrial design. The geographical focus of the collected data is mostly on Europe. Some authors consider multiple countries, while others focus on a specific country. The publications cover a broad range of domains, from software to consumer electronics.

Table 1: Basic information of analyzed literature

Author	Publication Date	Area of Design	Country	Domain
Inal <i>et al.</i>	2020	UX	Various	Unknown
Ardito <i>et al.</i>	2014	Usability, UX	Italy	Software
Micheli <i>et al.</i>	2012	Industrial Design	UK, Italy	Various (e.g. lighting)
Chilana <i>et al.</i>	2010	Usability	Unknown	Various (e.g. aviation)
Kashfi <i>et al.</i>	2017	UX	Sweden, US	Various (e.g. IT)
Pei	2009	Industrial Design	Singapore	Consumer electronics
Kuijk	2010	Usability, UX	Netherlands	Consumer electronics
Zhang <i>et al.</i>	2011	Industrial Design	China	Various (e.g. automotive)
Silveira <i>et al.</i>	2021	UX	Brazil	Software
Boivie <i>et al.</i>	2006	Usability	Sweden	Unknown
Laursen	2017	Industrial Design	Denmark	Various (e.g. light fixture)
Micheli <i>et al.</i>	2018	Design	UK	Various (e.g. furniture)
Wale-Kolade and Nielsen	2015	Usability	Scandinavia	Software

3.2.2 Studied departments and roles

Today's products require an interdisciplinary development approach. Design, engineering, manufacturing and marketing department are key to successful product development (Ulrich and Eppinger, 2016). Enhanced by a management function, they form an interdisciplinary product development team. This is also consistent with the roles considered in the literature, see Table 2. Explicitly considered departments are marked with "X", implicitly mentioned departments are marked with "(X)".

Table 2: Studied departments and roles in analyzed literature

Author	Design	Engineering	Management	Manufacturing	Marketing
Inal <i>et al.</i>	X		(X)		
Ardito <i>et al.</i>	X		X		X
Micheli <i>et al.</i>	X		X		X
Chilana <i>et al.</i>	X	X			
Kashfi <i>et al.</i>	X	X	X		
Pei	X	X	X		
Kuijk	X	X	X	X	X
Zhang <i>et al.</i>	X				X
Silveira <i>et al.</i>	X	X	X		
Boivie <i>et al.</i>	X	(X)	X		
Laursen	X	X	X		X
Micheli <i>et al.</i>	X	X	X		X
Wale-Kolade and Nielsen	(X)	X	X		

In line with our focus on the analysis of challenges in design, design departments and their associated roles are part of all considered publications. Pei (2009) and Laursen (2017) study specifically collaboration between engineers and designers. Micheli *et al.* (2012) study specifics in collaboration of designers and managers. The study of Kuijk (2010) in the area of usability and user experience is the most comprehensive one. His analysis covers design, engineering, management, manufacturing, as well as marketing departments. In sum, the publications focus mostly on design, engineering and management departments and related roles.

3.2.3 Data collection

A clear picture is revealed concerning data collection. As shown in Table 3, data collection always took place in a field environment. Almost all publications were interview-based, only three were survey-driven. Observations were used the least. A combination of different methods can only be found in Pei (2009) and Ardito *et al.* (2014). Observation techniques are only applied by Pei (2009). In his study, an industrial designer, an engineer and a project manager were observed for two weeks.

Table 3: Data collection in analyzed literature

Author	Size	Location		Method			Measurement	
		Lab	Field	Interview	Survey	Observation	Cross-Sectional	Longitudinal
Inal <i>et al.</i>	422		X		X		X	
Ardito <i>et al.</i>	4/36		X	X	X		X	
Micheli <i>et al.</i>	19		X	X			X	
Chilana <i>et al.</i>	21		X	X			X	
Kashfi <i>et al.</i>	17		X	X			X	
Pei	31/3		X	X		X	X	
Kuijk <i>et al.</i>	69		X	X			X	
Zhang <i>et al.</i>	113		X	X			X	
Silveira <i>et al.</i>	88		X		X		X	
Boivie <i>et al.</i>	13		X	X			X	
Laursen	20		X	X			X	
Micheli <i>et al.</i>	53		X	X			X	
Wale-Kolade and Nielsen	6		X	X			X	

Only Kuijk (2010) conducted multiple interviews in his study to retrospectively identify causal reasons for usability issues in design. Since the interviewees were different over time, we marked his study as a cross-sectional study. None of the publications performed a longitudinal study.

3.3 Challenges in design

In the previous sub-chapter, we established an understanding of the research approaches in the relevant literature. In this section, we answer the question on specific challenges of design in interdisciplinary product development. Our literature analysis led to seven main challenges as shown in Figure 1. These are common understanding of (good) design in interdisciplinary development teams (**Conceptualization**), prioritizing design (**Prioritization**), a different understanding of the development process (**Process**), integrating design into development (**Integration**), differences in the use of language by members of the interdisciplinary development team (**Language**), restrictions in designers' freedom of design (**Design Freedom**) and a lack of knowledge about design (**Knowledge**). The seven challenges derived from the literature are presented in more detail in the following.

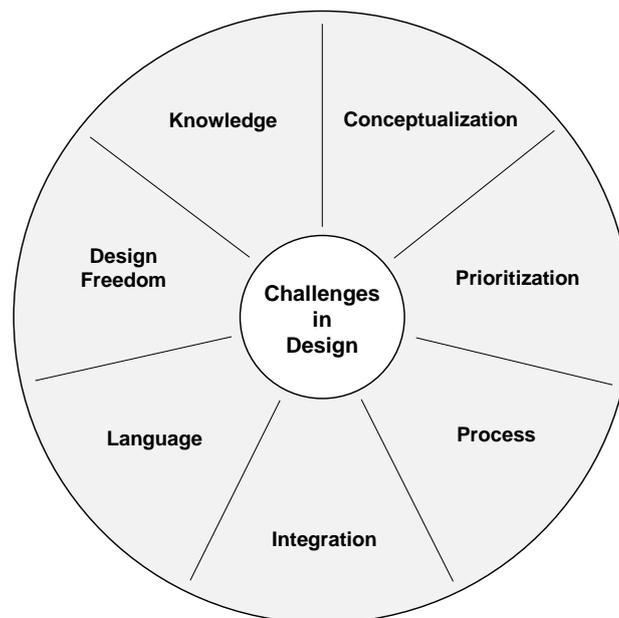


Figure 1: Literature-based challenges in design

Conceptualization: Already the previous literature analysis showed a variety of different terminologies and additionally different interpretations of terms in the context of design. For example, usability is still "fuzzy" and not commonly understood, although it is defined by an ISO standard (Ardito *et al.*, 2014). Whether this ultimately influences product design is not clearly mentioned in the literature. Kuijk (2010) concludes in his study that there are indeed challenges concerning a common understanding of design, but only a few interviewees considered this also as a reason for a lack of product usability. In addition to unclear terminology, there is subsequently also no common understanding of what "good" design means and respectively the goal of "good" design is. Micheli *et al.* (2012) studied that phenomenon specifically for designers and managers. There is a high level of commonality between designers and managers on what "good" or "poor" design is. But designers take the view that a "well-designed product is original, it makes a provocative design statement and it evokes emotions in consumers and users". Their goal is to create an "iconic" product. Managers do have a different perspective and are more focused on exclusivity, price and brand (Micheli *et al.*, 2012).

Prioritization: There are different views on the importance of design, whereas the importance of design is often not recognized (Kashfi *et al.*, 2017). There is a lack of awareness on management level (Boivie *et al.*, 2006). Design is one aspect among others contending for priority in interdisciplinary product development (Boivie *et al.*, 2006). For designers, design plays an essential role, but for managers, it is only one aspect of many (Micheli *et al.*, 2012). Focus, especially amongst engineers, is traditionally more on objectively measurable aspects (Kashfi *et al.*, 2017). Developers have a "developer mindset" that takes technical aspects such as code quality into account but ignores design (Ardito *et al.*, 2014). Additionally, design is still a fuzzy concept which makes prioritization difficult in the context of interdisciplinary product development (Kuijk, 2010). Particular tension arises in trying to quantify the impact of design. This leads to the paradox that the more the contribution of

design in the early stages is analyzed, the more conservative design becomes (Micheli *et al.*, 2018). In the context of interdisciplinary product development, designers are forced to spend a lot of time justifying their role and their design (Ardito *et al.*, 2014; Boivie *et al.*, 2006). Whereas it would be the task of management to give the design a voice and priority. However, management often fails in this prioritization task (Inal *et al.*, 2020). Wale-Kolade and Nielsen (2015) try to explain the discrepancy between existing awareness of the importance of design and the lack of action to implement design. According to their study, stereotyping, internalization of inequality and rationalization of status are factors for this discrepancy (Wale-Kolade and Nielsen, 2015).

Process: Challenges also arise from different understandings regarding the product development process itself. Designers do have a very specific way of working and follow an "open-ended approach". This is in contrast to the structured process of managers and the systematic figure-based approach of engineers (Pei, 2009). Finding the right balance between flexibility and formalization is a challenge (Micheli *et al.*, 2018). In general, for designers the result is important, but so is the process to get there. Underlying technology and materials for product form, function and aesthetics are carefully selected. Managers do not understand the process in the background of how good design is achieved and the necessary interplay of materials and technology. Furthermore, designers and managers diverge in their views about the necessary changes to the design during the development process. For designers, an initial design is already carefully developed and does only accept minor changes throughout the development process. For managers, it is quite normal that the characteristics of a product will change during the development process. This can lead to tensions when changes are made to a design which are perceived by designers as compromising, whereas this is a normal part of the development process for managers (Micheli *et al.*, 2012).

Integration: A survey among approx. 400 developers in the UX area showed that only about 20% were fully integrated into the interdisciplinary product development process. Another 20% said they were not involved at all or just to a minor extent (Inal *et al.*, 2020). Zhang *et al.* (2011) specifically examine the integration of marketing and design and come to similar conclusions. For all phases of the product development process, both marketing and design practitioners said that the current level deviates from the ideal level of integration (Zhang *et al.*, 2011). One reason could be that sometimes design departments are (intentionally or unintentionally) in an "isolated position" from the other product development teams (Kuijk, 2010). Micheli *et al.* (2018) observe a "silo mentality" in this regard. Especially the aspect of "too late" integration in the product development process is mentioned in the literature (Silveira *et al.*, 2021; Boivie *et al.*, 2006; Kashfi *et al.*, 2017). This is especially problematic because designers can make a valuable contribution, especially in the early phases of development - in the generation of ideas and the exploration of user needs. A lack of integration may also lead to the development of design concepts that are not in line with the technical constraints of engineers. Early involvement is even more important since in later design phases it is difficult or even impossible to make design changes. But even when designers are involved in early design phases, they can be less integrated in later phases (Kashfi *et al.*, 2017). In summary, although roles were defined, designers were often not a "natural part" of the product development process (Boivie *et al.*, 2006).

Language: Another challenge that is mentioned in the literature is role-specific language in interdisciplinary product development (Micheli *et al.*, 2012; Laursen, 2017). Such differences exist between managers and designers. Their language is not completely different but differs in the use of specific terms. Designers use "richer vocabulary" compared to managers. This can lead to substantial misunderstandings and challenges in trade-off decisions during product development (Micheli *et al.*, 2012). A survey among approx. 400 designers in the UX area showed that about 30% saw communication problems with developers (Inal *et al.*, 2020). Difficulties for designers exist especially in the transfer of aspects that go "beyond the functionality and technology of a product", for example, emotional or symbolic aspects (Laursen, 2017). Language is even more challenging in complex domains with domain experts using their language with specific acronyms (Chilana *et al.*, 2010). Additionally, designers and engineers use different representation methods. Engineers rely on calculations and technical specifications, designers argue their ideas with freehand sketches and drawings (Pei, 2009).

Design Freedom: Design freedom for designers is limited by various aspects. First and foremost, the magic triangle of project management (time, cost and quality) leads to challenges for designers. Time and cost are frequently mentioned challenges (Silveira *et al.*, 2021; Inal *et al.* 2020; Boivie *et al.*, 2006; Kuijk, 2010). Time pressure is usually high in product development projects (Kuijk, 2010). Financial resources are often not sufficiently available (Inal *et al.*, 2020). Freedom of design is increasingly restricted throughout the project since more of the available resources are spent (Kuijk, 2010). Also, a lack of designated professionals is reported (Silveira *et al.*, 2021). Time pressure and budget constraints have a major impact on the integration of users and thus on the implementation of a user-centered design (Kuijk, 2010). Designers are impaired in their creative work which ultimately leads to a sub-optimal design (Boivie *et al.*, 2006). Increased product complexity and limited mutability of underlying technology platforms can further restrict the freedom of design (Kuijk, 2010). Micheli *et al.* (2018) add that design freedom is sometimes additionally limited by management that thinks to know better about design.

Knowledge: A lack of necessary design knowledge is another challenge mentioned in the literature (Inal *et al.*, 2020; Kuijk, 2010; Kashfi *et al.*, 2017; Boivie *et al.*, 2006). Limited knowledge is reflected by a lack of qualified professionals or simply a lack of experience of the roles involved. In several cases, roles intended for designers are filled by other roles without a design background (e.g. usability testers with a marketing research background). Their limited background in design negatively influences method application and therefore the design of the product (Kuijk, 2010). In addition to limited knowledge about design, a lack of domain-specific knowledge appeared to be a challenge, especially in complex domains (Chilana *et al.*, 2010). Inal *et al.* (2020) see fewer knowledge gaps among designers, but rather in key non-design roles of interdisciplinary product development. Asked about the extent to which UX is known amongst top managers in their organization, about 400 UX experts expect that approximately 40% of top managers are "not familiar" or "probably not familiar" with the concept of UX. For developers and marketing responsible, the estimate is still around 25% (Inal *et al.*, 2020).

4 DISCUSSION

Our research shows that the role of design and especially its successful implementation in interdisciplinary product development is associated with various challenges. They range from a lack of knowledge about design to the integration of design. The variety and the fundamental nature provide at least an initial explanation of why only selected companies succeed in incorporating design into their products in an interdisciplinary product development environment. Even recent publications show that companies are still having difficulties in leveraging the benefits of design. Consequently, we see the need for further investigations and more directed support for organizations.

To further complete the picture of the presented work, an even more extensive literature review should be conducted. Our literature review is based on an initial set of relevant publications in the context of design and interdisciplinary product development. From an extended literature review, it should be possible to develop an even more comprehensive and detailed picture of already known challenges, their significance and focal points in current research approaches. Furthermore, and in line with the further research need stated by Kashfi *et al.* (2017), it is necessary to conduct an in-depth literature study to examine the different approaches and drivers that address the identified challenges. Publications from design management should also be considered.

Additionally, we already see three promising research directions. One research direction is to develop a better understanding of the underlying causes and mechanisms for the identified challenges in design. Micheli *et al.* (2012) provide initial explanations why designers and managers do have different conceptualizations of design. Laursen (2017) undertakes similar research with designers and engineers. Overall, the challenges remain rather superficially examined. For example, it could be interesting to investigate more in detail why design is not given the necessary priority, although there is awareness of its importance. Wale-Kolade and Nielsen (2015) provide only initial explanations. The second research direction is about cause-and-effect relationships. Only Kuijk (2010) tried in his work to retrospectively build causal chains between challenges in the context of interdisciplinary product development and specific design inadequacies of the final product. For the other investigated

publications the impact of the identified challenges on the final product design remains unknown. A basis for this approach could be the work of [Badke-Schaub and Frankenberger \(1999\)](#) who developed a structured approach for analyzing factors in interdisciplinary product development that influence product cost, quality and time.

Our research revealed a limited research approach in previous literature. Focus was mostly on interview-driven cross-sectional studies. This leads us to the third possible research direction, going more in the direction of longitudinal and observational studies. This research direction should be understood as complementary to the two previously mentioned research directions. This finding is in line with the need for different research methods as stated by [Micheli et al. \(2012\)](#) and [Kuijk \(2010\)](#). [Micheli et al. \(2012\)](#) see the need to move more in the direction of ethnographic studies. With this approach, more detailed observations of the interaction between designers and managers would be possible. [Kuijk \(2010\)](#) mentions the need for a "live case study" which examines a product development project in real-time. This approach is less dependent on the "recollection and interpretation of interviewees" and delivers a much more comprehensive picture of the situation ([Kuijk, 2010](#)). Furthermore, such studies should also be conducted with a broader set of different roles and departments (design, engineering, marketing, etc.).

5 CONCLUSION

Companies are continuously looking for a competitive advantage in their global competition arena. A growing number of companies see the design of their products as a key differentiator. For companies, the benefits of design are manifold and promise successful products, brands and economic success. Nevertheless, shaping the role of design in an interdisciplinary product development environment is still a major challenge for organizations. This paper shed a light on the existing challenges from an organizational and interdisciplinary product development perspective. First, design and design-related definitions and interpretations in literature were presented. Based on this, and in line with the organizational and interdisciplinary perspective on design, a valid understanding of the term for this paper was derived. The core of this paper is to answer the question about specific challenges for design in interdisciplinary product development. Based on a literature review, seven main challenges were identified: Conceptualization, prioritization, process, integration, language, design freedom and knowledge. To be able to better assess the evidential value and further necessary research, we analyzed the literature concerning the research approach along pre-defined characteristics. The focus of current publications is on interview-driven cross-sectional studies. Investigating underlying causes and mechanisms, developing cause-effect relationships and adopting longitudinal and observational studies were identified as further research directions. Based on a more comprehensive understanding, it is possible to derive more elaborated methods to strengthen the role of design in interdisciplinary product development.

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