Proceedings of the Design Society, Volume 5: ICED25
https://doi.org/10.1017/pds.2025.10116

Consideration of values in design methodologies for value-driven design

Antoine Persehais[1,2,✉], Thierry Gidel[1] and Pierre-Emmanuel Fayemi[2]

[1] Université de Technologie de Compiègne, France, [2] Ikos Lab, France

✉ apersehais@ikosconsulting.com

ABSTRACT: This study examines the integration of values into design methodologies, essential for guiding value-driven design processes. Values, spanning ethical, economic, and functional dimensions, influence decision-making and project outcomes. Through Principal Component Analysis (PCA), five clusters of design methodologies were identified, each addressing distinct aspects of value integration. Interviews with designers highlighted challenges in defining, formalizing, and adapting values due to their inherent subjectivity and volatility. This study, by adopting a values-centered perspective, enriches our understanding of design methodologies and paves the way for more informed methodological choices across various contexts.

KEYWORDS: design methodology, decision making, systems engineering (SE)

1. Utility of values

Values play a key role in human decision-making, behavior, and practical reasoning (Brosch & Sander, 2015). They represent what individuals consider important and influences their choices across various domains, from personal relationships to political decisions (Brosch & Sander, 2015).
The value concept has many definitions; the concept of value-in-use and value-in-exchange, denotes the utility derived from an object, and the latter reflects the purchasing power that ownership confers (Smith & Wight, 2007). Additionally, surplus value highlights the difference between the product's values and the resources consumed in its creation (Marx, 1969). In business management, a robust value proposition must address both customer and organizational values, fostering sustainable value creation (Osterwalder & Pigneur, 2011). Finally, in Value-Sensitive Design (VSD), value encompasses the ethical and moral dimensions that are significant to individuals, ensuring that design processes align with human values (Friedman et al., 2017). The versatility in definition of "value" offers a wide range of interpretations and evaluation criteria.
In the realm of Systems Engineering (SE), "system value" is understood as the holistic impact of a system, which includes its multi-domain effects on processes, environments, and stakeholders (Lavi & Reich, 2024). However, this versatility often creates significant challenges when attempting to incorporate values into SE processes.
In response to these values challenges, design theories and methodologies (DTMs) have been widely developed to support designers in addressing technical problems and systematize the design process. To facilitate this process, values are often need as a reference to guide design choice. These values can take multiple forms to offer a holistic view, by evaluating economic, environmental, social, and technical perspectives as in Social Environmental Economical Engineering Framework methodology (i.e., SEEEF) (Ponnambalam et al., 2020). From a system engineering perspective, values have traditionally been defined by metrics such as functionality, performance, and cost (Lavi & Reich, 2024). These dimensions link values, functional requirements, and stakeholder needs, but modern interpretations in SE go well beyond these traditional boundaries. The concept now encompasses a broader, context-dependent understanding, shaped by the unique demands, constraints, and opportunities of specific environments and

stakeholder interactions (Lavi & Reich, 2024). Design methodologies, in general, have evolved in response to the increasingly specific and complex needs of industries (Schmitter, 1993). As products and processes become more intricate to meet the expectations of diverse stakeholders, methodologies have been continuously adapted to address a wide range of objectives. Sato (2019) highlighted their role in optimizing cost-effectiveness, addressing customer requirements, and defining clear objectives. Over time, these methodologies have also evolved to incorporate considerations such as social and environmental impacts into the design process (Ponnambalam et al., 2020). Within each methodology, values are purposefully aligned to achieve specific goals, underscoring their critical role in driving successful outcomes in design projects (Ross et al., 2010). This perspective reflects the values influence on processes, environments, and diverse stakeholder communities. This shift highlights the growing recognition of value's multidimensional and dynamic role in design and engineering practices (Lavi & Reich, 2024).

Building on this foundation, the dynamic nature of values underscores their significance throughout the design process. As Rianantsoa (2010) outlined, values are central to the design process, acting as both an input and an output, while being continuously shaped throughout the process itself. To make this complex concept more actionable instead of trying to define it and their interactions (which is a never-ending task), we propose to focus on a guiding question: What are values intended to serve? This perspective allows values to be characterized in terms of the attributes it embodies, or the integrative role it plays in project development. In bridging theoretical insights with practical application, a system engineering perspective provides a framework for exploring how values are constructed and applied.

This paper offers several key contributions to the understanding of values in design theories and methodologies (DTMs). First, it reviews the integration of values in existing DTMs, establishing a foundation for understanding their influence on design processes (Section 2). Next, it analyses research methods and value characteristics in DTMs, to uncover insights into the role of values (Section 3). Principal Component Analysis (PCA) is applied to interpret value characteristics in DTMs, completed by designer interviews were conducted to outline value considerations in industry interviews (Section 4). The findings are then discussed, emphasizing stakeholder values and the identifying value clusters (Section 5). Finally, the article concludes by proposing future research directions on the role of values in DTMs (section 6).

2. Values consideration in design methodologies

Design inherently revolves around the concept of value. Numerous methodologies exist to address values in design, each offering distinct strategies to guide project management and execution (Ross et al., 2010). At the core of the design process, every decision and action aim to generate values—either for the decision-maker, the stakeholders, or the broader context in which the product or system operates (Schöttle et al., 2018).

To support designers, a wide array of theories and methodologies has been developed and widely adopted. These frameworks facilitate the creation of products, processes, and systems that not only meet customer needs but also ensure technical feasibility as Design for X, optimize performance as the Taguchi method, and maintain cost-effectiveness as Concurrent Engineering. Values are both an input and an outcome of the design process, constantly evolving throughout the process itself (Rianantsoa et al., 2010).

As an input, values manifest themselves in various forms. It can be understood as the benefits or advantages derived from meeting specific needs and expectations (J. Huang et al., 2013). From the customer's perspective, values may take on a functional dimension, ensuring that a product or service effectively performs its intended function (Tosti, 2009). Alternatively, values might be economic, reflecting a customer's willingness to pay for a solution that satisfies their requirements (Tosti, 2009). In practice, the design process translates these notions of values into technical requirements, often shaped by the influence of stakeholders who participate in decision-making (Zhuang et al., 2017).

The design process is, fundamentally, a value creation process. By generating solutions that improve performance—through reductions in cost, weight, or time, or through increased efficiency—it continually shapes and refines values. Notably, values within the design process are dynamic, fluctuating predictably or unpredictably as decisions and iterations unfold (Halloran et al., 2009). To take these values' particularity into account, two main approaches exist : the linear process that allows designers to have a global vision of the project but considers that values can be fixed or predicted; and the iterative approach that allows values re-evaluation during the design process (Koca & Koç, 2020).

Historically, design methodologies emerged to address specific, often technical challenges (Tomiyama et al., 2009). These methodologies incorporate diverse interpretations and dimensions of value, which can sometimes lead to confusion, particularly for industrial practitioners. Deciphering which methodology best aligns with specific project requirements can become a significant challenge.
This study highlights that design is inherently a value-creation process, shaped by various methodologies that translate stakeholder expectations into technical requirements. Values, whether functional or economic, serve as both inputs and outcomes of the design process, dynamically evolving through iterations. However, selecting the appropriate methodology for a given project remains a challenge for practitioners, emphasizing the importance of understanding and integrating the multiple dimensions of value in design approaches.

3. Research method

Understanding and addressing the complexities of value-based design is crucial for developing effective and impactful design solutions. This work aims to examine how "value" is defined, interpreted, and embedded into the design process, as well as how designers can strategically utilize various methodologies to overcome challenges and achieve their objectives.
This study examines the role of values in design theories and methodologies (DTMs), with a focus on their integrative nature. The analysis includes DTMs identified in Tomiyama's work (2009) as a foundational reference. To ensure relevance to contemporary practices, the study also incorporates recent methodologies, including Design Thinking (Leifer et al., 2023) and Radical Innovation Design (Yannou & Cluzel, 2024). The primary objective is to classify DTMs into value clusters based on their typologies and characteristics to better understanding how values of theses clusters of methodologies are useful for and how they can be applied according to the specific needs of stakeholders.
The study was conducted in two steps to analyze the role of values within DTMs. The preliminary study involved constructing an analytical framework based on an extensive literature review, primarily grounded in the foundational work by Tomiyama et al. (2009). This allowed us to systematically identify relevant features and characteristics of DTMs. Rather than relying solely on the authors' expertise, the framework was initially derived from existing literature, and subsequently reviewed and validated by external researchers to ensure objectivity and comprehensiveness. Thus, the identified characteristics represent a structured synthesis of established knowledge, complemented by independent expert validation. This analytical framework enabled an exploration of how various methodologies address the complexities of value-based design, offering insights into their effectiveness in supporting design solutions.
The criteria were evaluated using a Likert scale and reviewed by two independent researchers to ensure alignment with the methodologies. To simplify the dataset while retaining key patterns, a Principal Component Analysis (PCA) was conducted. By highlighting major trends in the data, PCA provided a structured way to explore variations in design theory and methodology. This approach had three primary aims: (1) to identify relationships between methodologies and criteria, (2) to group methodologies with shared characteristics, and (3) to generate clear visualizations that enhance data interpretation.
To refine the analysis, the K-means clustering algorithm was applied, using the silhouette method to evaluate the quality of these clusters (Reza Edris Abadi et al., 2024; Sai et al., 2017).

3.1. Type of Design Theory Methodology

The first characteristic analyzed is the classification of DTMs as either theories, methodologies, or methods/tools. Although most DTMs primarily align with one category, they can exhibit features of multiple classifications. This study defines these terms according to the framework proposed by Schofer (2015) based on Vadcard (1996), Araujo (2001) and Lahonde (2010) work.

- **Theory**: Descriptive models as well as overall process descriptions of prescriptive models of reasoning processes. A theory can be the basis of methods/tools and heuristics.
- **Methodology**: A, at least partially, prescriptive or normative system of methods.
- **Method/tool**: Elementary components of a methodology leading to concrete results, which can be used as input in other steps of the methodology."

In this paper, the DfX methodology is used as an illustrative example to demonstrate the reasoning process and to provide a concrete depiction of how the matrix was constructed.

It is recognized that DfX spans all three categories: theory, methodology, and tool. Its prescriptive nature enables it to guide engineers through structured design processes while providing tools to enhance reliability (G. Q. Huang, 1996).

3.2. Typology of value

The second characteristic analyzed is how design methodologies address different value typologies, emphasizing the integration of **technical**, **economic**, and **social-environmental** dimensions. Recent frameworks, highlight the importance of balancing societal impacts, environmental concerns, and engineering design with economic considerations (Halbe & Adamowski, 2023; Ponnambalam et al., 2020). Building on these insights, this classification aims to help designers select methodologies aligned with the specific values they seek to prioritize, supporting informed, value-driven design decisions.
DfX offers a structured approach to address these values. Economically, it supports production at both large and small scales, ensuring adaptability across different manufacturing contexts (Bralla, 1999; G. Q. Huang, 1996). Technically, it enhances process reliability and accelerates design cycles (Crowe & Feinberg, 2017). Socially and environmentally, it considers product lifecycles and diverse user contexts but gives limited attention to communication in design (Hauschild et al., 2004).

3.3. Identifying the target audience for values

Understanding the target audience of a design methodology — whether it is directed towards designers, organizations, or end-users — is crucial for effective product development and successful implementation. Customer-centered design approaches, often require organizations to adapt their structures to better meet **customers'** needs (Pemberton & Blickstein, 1999). Effective design methodologies must align with a **company's** specific products, processes, and organizational context to create values (Ernzer & Birkhofer, 2003). **Designers**, as the primary users of these methods, rely on them to shape their cognitive frameworks and mental models (Daalhuizen, 2014). Prioritizing **designer** needs can lead to more effective methodologies, improving their selection, scalability, and continuous refinement (Ernzer & Birkhofer, 2003).
In the case of DfX, designers are the primary users of this methodology, with limited emphasis on direct benefits to customers or companies (G. Q. Huang, 1996).

3.4. Iterative values consideration?

The **linear process** enables designers to gain a comprehensive understanding of the project and its context, along with the various perceptions and stakeholder values involved. Conversely, an **iterative approach** in evaluating and integrating values provides flexibility to adjust and refine these values dynamically throughout the process, as illustrated by Koca & Koç (2020).
DfX incorporates the iteration approach both within and across design phases. For instance, tools like FMEA can be employed in DfX to refine reliability iteratively. Customers' feedback, though marginally integrated, can inform iterative improvements in the design process (Nigel Bevan, 1999).

3.5. Situations and contexts for applying the methodology

DTMs are not used uniformly throughout the design process, as their application varies based on project needs and stages. Baldwin and Chung (1995) emphasize the importance of design methodology management to ensure **appropriate tool selection and execution sequence**.
DfX is most effective when applied early in the design process because decisions made during initial phases using DfX have significant downstream implications, influencing production and lifecycle outcomes (Chiu & Okudan, 2010).

3.6. Ways to apply Design Theories and Methodologies (DTMs)

Design methodologies significantly influence the design process, but their impact varies based on **how they are applied**. Indeed, due to the complexity of design problems, it can happen that one methodology alone does not give full support to reach a desired end and so in this case a combination of several methodologies is used (Albani et al., 2016). This methodological choice is not neutral: it reflects underlying values, whether ethical, social or environmental, influencing not only the final product, but also its meaning and impact.

DfX supports multidisciplinary teamwork, as it can integrate with other methodologies and tools to address diverse challenges. For example, DfX can combine with tools like FMEA to enhance design reliability while addressing economic and technical dimensions (Crowe & Feinberg, 2017).

3.7. Incorporating stakeholders in the process

Stakeholder involvement is a critical aspect of design methodologies, because "all organizations [. . .] were founded by people and run by people for the sole purpose of delivering value to their stakeholders" (Tosti, 2009). To analyze stakeholder integration, this study applies Freeman's stakeholder decomposition framework (2018) to identify the stakeholders considered in the design process.
In the context of DfX, stakeholder integration is relatively limited. While firms play a central role in decision-making, primary and secondary stakeholders, such as customers and suppliers, are only marginally incorporated, according to the Freeman classification (G. Q. Huang, 1996).

4. Research results

This section presents the outcomes of the Principal Component Analysis (PCA), which was conducted to identify global trends in the characteristics influencing values within Design Theories and Methodologies (DTMs). Additionally, it examines how design frameworks incorporate and manage these values throughout the design process.

4.1. Principal component analysis (PCA)

The conducted PCA led to a representation of all DTMs within the space defined by the first three principal components, providing a visualization of the methodologies and their interrelationships based on the analyzed characteristics.

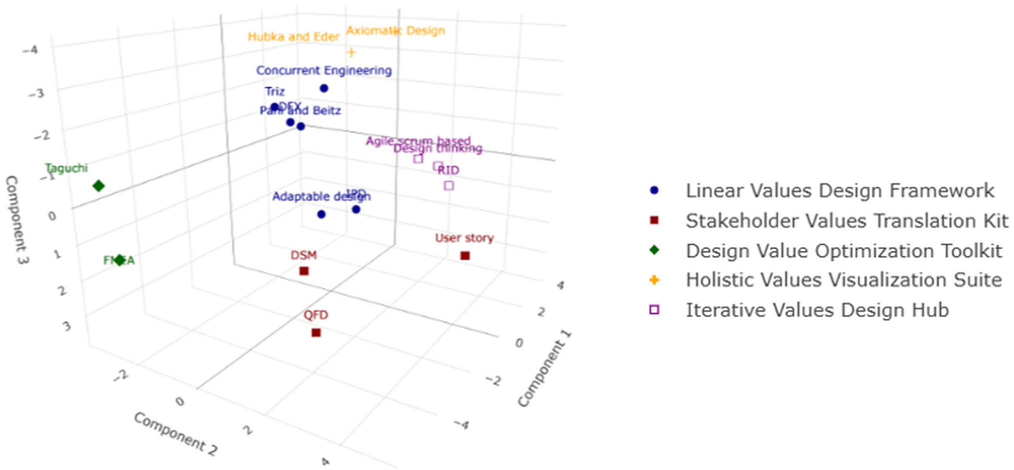

Figure 1. PCA on DTMs on values consideration

Figure 1 reveals that five clusters of values in DTMs can be made regarding the characteristics defined previously. A reading proposal of the cluster's characteristics have been made in table 1.

Table 1. Cluster spotlight: names, distinct traits, and emblematic DTMs

Clusters name	Clusters characteristics
Linear Values Design Framework	Linear design methods assume that values are fixed, pre-existing and can therefore be identified and systematically translated throughout the design process. These methods propose a structured, steps by steps approach to shape the design process. E.g. Pahl and Beitz

(*Continued*)

Table 1. Continued.

Clusters name	Clusters characteristics
Stakeholder Values Translation Kit	Methods that support designers in translating stakeholder needs into technical specifications enable the transformation of complex data into concrete, actionable information. This approach facilitates data-driven decision-making throughout the design process. E.g. QFD
Design Value Optimization Toolkit	Design optimization methods focus on one or a few values attributes, such as cost or performance, enabling designers to adopt an optimization-driven approach by reducing design challenges to achieve targeted improvements. E.g. Taguchi
Holistic Values Visualization Hub	Holistic design methods acknowledge the multiplicity of interrelated values that must be considered throughout the design process. These approaches provide tools to visualize and aggregate diverse values at key stages of the design process, thereby supporting decision-making. E.g. Axiomatic Design
Iterative Values Design Hub	Methods that regard values as context-dependent and co-constructed through stakeholder interaction support designers in organizing their design process around an iterative approach. This approach effectively addresses the volatility and evolving nature of values. E.g. Design Thinking

These clusters provide a framework for better understanding how values of the different methodologies are useful for and how they can be applied according to the specific needs of the interested parties. Nevertheless, their practical implementation may come with certain challenges, which will require further empirical validation

4.2. Interview

Independently of our investigation into the application of design theories and methodologies (DTMs) in industrial practice. One-hour recorded, semi-structured interviews were conducted with ten industrial designers. The interviews focused on participants' perspectives regarding the concept of values within design projects, specifically examining the interactions among values, stakeholders, and decision-making processes. The format involved a consistent set of open-ended questions, encouraging participants to elaborate freely on their experiences and perceptions, thus capturing a diverse range of viewpoints on the abstract nature and practical integration of values in their design practices.

4.2.1. The value concept

One of the key insights from our interviews was the difficulty participants faced in articulating their own definitions of values.

> *"I think that everyone has their own definition of values and that it changes according to their field of activity and the problems they have to deal with."*

Despite these challenges, all the professionals we interviewed identified similar characteristics when describing the concept of value. Their responses offered valuable insights into how values can be defined within the context of a project.

Firstly, all participants emphasized that values are context-dependent, meaning it may for the same stakeholder depending on the situation. This variability arises because values encompass both tangible and intangible dimensions. These findings align closely with the conclusions presented in Lavi article (2024), further reinforcing its framework.

Another recurring observation was that values are inherently a multidimensional concept. It can represent diverse aspects, such as economic considerations, social impacts, or functional requirements.

> *'Value is the reason why we do projects, it's to generate value; it can be economic value or even sometimes by providing value to humans.'*

One participant specifically highlighted how values are incorporated into projects through detailed specifications. While this approach reduces risks, it also significantly limits flexibility during the project lifecycle:

"When I worked in the car industry, it was very complicated to manage values. We really followed the classic V cycle [. . .] the specifications were extremely detailed and almost never varied according to the customer. [. . .] Values came down to two objectives: Obtain the minimum performance required by the specifications with the maximum profits on the cost of the product."

This perspective underscores the tension between maintaining rigid specifications and adapting to emerging needs to foster innovation. It also illustrates how values can become narrowly defined, especially in industries like automotive, where economic and performance metrics often dominate considerations of values. Finally, it is interesting to underline that expert designers focus as much on how values are applied in the design process as on defining their ontology.

4.2.2. Values formalisation

This subjectivity of values concept makes it difficult to translate stakeholders' values in technical requirement and also to establish a clear hierarchy of it. Indeed, several manufacturers have expressed concerns about the way in which values are formalised. It emerged that 80% of the companies formalise values without using specific methodologies or tools despite the importance to work on non-biased values to obtain a relevant design; but we can also notice that some of them are trying to integrate tools to translate stakeholder values into technical specification in their design process. Even if tools exist to formalise values, one of the designers mentioned that:

'When I start a project, I need to have a rough idea in my head of the amount of values I'm trying to capture'.

4.2.3. Stakeholder Values Monitoring

Regarding the monitoring of stakeholder values, 70% of participants reported that they only monitored these values marginally, primarily based on project specifications. The remaining 30% indicated that they attempted to monitor stakeholder values as best as they could through an iterative process, allowing them to present results to some stakeholders and take their feedback. However, they noted that even when meeting with customers occur, the distinction between customers and end-users can complicate the targeting and addressing of end-user values.

4.2.4. Experience of values volatility

A significant concern highlighted during the interviews was the volatility of stakeholder values and its implications for project outcomes. Several participants shared troubling experiences where stakeholder values shifted between the definition of technical specifications and the project's completion. These unforeseen changes, left undetected and unaddressed, resulted in increased project costs, extended timelines, and frustration among project teams.

The interviews underscore that the concept of value in design projects is both complex and often inadequately defined. To address this, organizations could benefit from adopting more systematic approaches to identifying, formalizing, and continuously monitoring values, while staying vigilant to shifts in stakeholder priorities. Enhancing the understanding and prioritization of values not only has the potential to improve process repeatability but also to minimize biases in decision-making.

One participant noted:

'With agile operation, we test prototypes with end users, gather information and refine requirements. This means we don't waste time going in the wrong direction. If needs change, we can adjust accordingly, and this can be done at different stages. Above all, this approach allows us to adapt to customers' needs, which can vary.'

This feedback emphasizes the importance of iterative and adaptive approaches, such as agile methodologies, to align better with the dynamic nature of stakeholder values and expectations.

5. Discussion

This study aimed to categorize Design Theories and Methodologies (DTMs) through the lens of values, offering a context-sensitive perspective on their application and efficacy.

Despite its contributions, the methodology employed in this study exhibits certain limitations. The criteria used, while offering meaningful insights, lack the granularity needed to capture the full complexity of DTMs, particularly in industrially dynamic or interdisciplinary settings. Moreover, the relatively narrow sample of DTMs analyzed raises concerns about the representativity of the proposed framework. Expanding this dataset and refining the analytical dimensions would be necessary to enhance the robustness and universality of the findings.

The Principal Component Analysis (PCA) approach was effective in identifying clusters of DTMs based on value considerations; however, the interpretive power of the PCA depends heavily on the coherence and comprehensiveness of the selected variables.

Future iterations of this work should incorporate additional dimensions, such as temporal aspects of value evolution or cross-sectoral applicability, to further validate and extend the proposed typology, improving the framework's stability, and thus, its universality.

Findings from the interviews corroborate the identified value clusters, yet they also reveal discrepancies between theoretical frameworks and industrial practices. The relatively small and homogenous sample size raises questions about representativeness. Expanding the number of interviews would provide a more comprehensive understanding of the variability in design practices. Such an expansion would also allow for testing whether the perspectives gathered align with the identified PCA clusters and proposed categories. A broader and more robust study could validate these preliminary insights, refining the classifications and strengthening the overall conclusions.

6. Conclusion

This explorative study investigates Design Theories and Methodologies (DTMs) based on their consideration of values. It proposes a typology that identifies five distinct clusters, aiming to provide preliminary insights and lay the groundwork for further empirical validation and refinement. The proposed clusters—Linear Values Design Framework, Stakeholder Values Translation Kit, Design Value Optimization Toolkit, Holistic Values Visualization Hub, and Iterative Values Design Hub—offer a spectrum of approaches to value integration. These clusters highlight the balance between stability and adaptability, showcasing methodologies that address both fixed and evolving stakeholder needs. By adopting this values-centered perspective, the presented approach converges towards a deeper understanding of how methodologies can be strategically employed across diverse design contexts.

The interviews conducted in this study confirmed that formal design methodologies are rarely applied consistently in everyday practice, particularly regarding the consideration of values. While practitioners acknowledged their values, they expressed a significant need for accessible and adaptable methodological guidance. This gap highlights the complexity of incorporating stakeholder values into design processes. Values are inherently subjective and dynamic, often shifting throughout a project's lifecycle.

This observation aligns with the findings from the PCA analysis. Particularly regarding a cluster of methodologies designed to respond to evolving stakeholder expectations. Such methodologies appear to be emerging as a critical feature in dynamic industrial contexts. By incorporating mechanisms to address shifting priorities, these approaches demonstrate adaptability and relevance within complex and rapidly changing project ecosystems.

To address the need for adaptable methodological guidance, we propose exploring a hybrid approach that leverages the unique strengths of five identified clusters, which span from more rigid to more flexible methodologies. In the context of value management, two contrasting paradigms often emerge: one where values are defined at the outset and remain static throughout the project, and another where values are continuously reassessed and adapted as the project progresses. While the first paradigm offers stability, it may lead to misalignment between the product and stakeholders' expectations as initial assumptions are flawed or simply evolved. Conversely, the second approach, while enabling responsiveness to evolving needs, can result in frequent re-evaluations, potentially slowing down the project and conflicting with the goal of maintaining efficiency.

The five clusters we propose in this research aim to address these challenges, offering a spectrum of solutions that can be tailored to the needs of the project.

The Linear Values Design Framework cluster provides a predictable, linear approach to integrating values, assuming that values are fixed and pre-existing. This structured, step-by-step methodology ensures that values can be systematically identified and translated throughout the design process. The Stakeholder Values Translation Kit cluster aids in translating stakeholder needs into technical specifications, transforming complex data into concrete, actionable information and facilitating data-driven decision-making. The Design

Value Optimization Toolkit cluster focuses on optimizing specific design aspects, such as cost or weight, enabling designers to adopt an optimization-driven approach to achieve targeted improvements. The Holistic Values Visualization Hub cluster acknowledges the multiplicity of interrelated values that must be considered throughout the design process, providing tools to visualize and aggregate diverse values at key stages, thereby supporting decision-making. Finally, the Iterative Values Design Hub cluster structures the design process iteratively, accommodating the volatility and evolving nature of values through stakeholders' interactions and ensuring adaptability throughout the project lifecycle.

By combining elements of these clusters, the proposed hybrid approach holds promise for creating a flexible and comprehensive toolkit tailored to the unique demands of each project. Future research should focus on expanding the dataset of DTMs and interviews to validate and refine the proposed typology. By bridging theoretical constructs and practical needs, this study lays the groundwork for methodologies that are both contextually relevant and resilient to the dynamic demands of modern design practice.

References

Albani, A., Raber, D., & Winter, R. (2016). A Conceptual Framework for Analysing Enterprise Engineering Methodologies. *Enterprise Modelling and Information Systems Architectures*, 1:1–26 Pages. https://doi.org/10.18417/EMISA.11.1

Araujo, C. (2001). Acquisition of Product Development Tools in Industry: A Theorectical Contribution. https://www.researchgate.net/publication/320474559_Acquisition_of_Product_Development_Tools_in_Industry_A_Theorectical_Contribution_PhD_Thesis_-_Technical_University_of_Denmark_2001

Baldwin, R. A., & Chung, M. J. (1995). A formal approach to managing design processes. *Computer*, 28(2), 54–63. https://doi.org/10.1109/2.348000

Bralla, J. G. (1999). Design for manufacturability handbook (2nd ed). McGraw-Hill.

Brosch, T., & Sander, D. (Éds.). (2015). Handbook of Value: Perspectives from Economics, Neuroscience, Philosophy, Psychology and Sociology. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198716600.001.0001

Chiu, M.-C., & Okudan, G. E. (2010). Evolution of Design for X Tools Applicable to Design Stages: A Literature Review. *Volume 6: 15th Design for Manufacturing and the Lifecycle Conference; 7th Symposium on International Design and Design Education*, 171–182. https://doi.org/10.1115/DETC2010-29091

Crowe, D., & Feinberg, A. (Éds.). (2017). Design for Reliability. CRC Press. https://doi.org/10.1201/9781420040845

Daalhuizen, J. J. (2014). Method Usage in Design: How methods function as mental tools for designers [Delft University of Technology]. https://doi.org/10.4233/UUID:4AC01165-C6B5-4057-A2FE-3418907F251E

Ernzer, M., & Birkhofer, H. (2003). Life cycle design for companies—Scaling life cycle design methods to the individual needs of a company. Ds. *DS 31: Proceedings of ICED 03, the 14th International Conference on Engineering Design, Stockholm*, 393–394 (exec.summ.), full paper no. DS31_1629FPD.

Freeman, R. E., Harrison, J. S., & Zyglidopoulos, S. (2018). Stakeholder Theory: Concepts and Strategies. *Elements in Organization Theory*. https://doi.org/10.1017/9781108539500

Friedman, B., Hendry, D. G., & Borning, A. (2017). A Survey of Value Sensitive Design Methods. Foundations and Trends® in Human–Computer Interaction, 11(2), 63–125. https://doi.org/10.1561/1100000015

Halbe, J., & Adamowski, J. (2023). Bridging technical, ecological and social–economic knowledge in engineering design. *Proceedings of the Institution of Civil Engineers - Engineering Sustainability*, 176(2), 106–114. https://doi.org/10.1680/jensu.21.00063

Halloran, J., Hornecker, E., Stringer, M., Harris, E., & Fitzpatrick, G. (2009). The value of values: Resourcing co-design of ubiquitous computing. *CoDesign*, 5(4), 245–273. https://doi.org/10.1080/15710880902920960

Hauschild, M. Z., Jeswiet, J., & Alting, L. (2004). Design for Environment—Do We Get the Focus Right? *CIRP Annals*, 53(1), 1–4. https://doi.org/10.1016/S0007-8506(07)60631-3

Huang, G. Q. (1996). Developing Design For X Tools. In G. Q. Huang (Éd.), *Design for X* (p. 107–129). Springer Netherlands. https://doi.org/10.1007/978-94-011-3985-4_6

Huang, J., Zhou, C., & Han, W. (2013). Assessing Competitive Advantage Based on Customer Satisfaction and Customer Value. *2013 10th International Conference on Service Systems and Service Management*, 12–17. https://doi.org/10.1109/ICSSSM.2013.6602629

Koca, E., & Koç, F. (2020). Example of iterative process in upcycled clothing design: Unused neckties and upholstery scraps. *The Research Journal of the Costume Culture*, 28(6), 890–911. https://doi.org/10.29049/rjcc.2020.28.6.890

Lahonde, N. (2010). Optimisation du processus de conception: Proposition d'un modèle de sélection des méthodes pour l'aide à la décision. https://www.semanticscholar.org/paper/Optimisation-du-processus-de-conception-%3A-d'un-de-%C3%A0-Lahonde/00eb134b3cd9b20dafb271d2a6244b3ccd46c1ef

Lavi, E., & Reich, Y. (2024). Cross-disciplinary system value overview towards value-oriented design. *Research in Engineering Design*, 35(1), 1–20. https://doi.org/10.1007/s00163-023-00418-2
Leifer, L., Lewrick, M., & Link, P. (2023). Toolbox de design thinking: Les 50 outils indispensables (Illustrated édition). PEARSON.
Marx, K. (1969). Theories of surplus value. *Lawrence & Wishart*.
Nigel Bevan. (1999). Design for Usability. *Proceedings of HCI International*.
Osterwalder, A., & Pigneur, Y. (2011). Aligning Profit and Purpose Through Business Model Innovation (p. 61–76).
Pemberton, S., & Blickstein, J. (1999). Editorial. *Interactions*, 6(1), 4. https://doi.org/10.1145/291224.313008
Ponnambalam, K., Seifi, A., & Mousavi, J. (2020). Design Is How We Change the World! Can We Do It in Socially, Environmentally and Economically Acceptable Ways? *Synthesizing Design Tools for This Utopian Concept*. https://doi.org/10.20944/preprints202008.0047.v1
Reza Edris Abadi, Mohammad Javad Ershadi, & Seyed Taghi Akhavan Niaki. (2024). A Clustering Approach for Data Quality Results of Research Information Systems. *ResearchGate*. https://doi.org/10.1108/IDD-07-2022-0063
Rianantsoa, N., Yannou, B., & Redon, R. (2010). Concept-to-Value: Method and Tool for Value Creation in Conceptual Design. *Volume 5: 22nd International Conference on Design Theory and Methodology; Special Conference on Mechanical Vibration and Noise*, 175–184. https://doi.org/10.1115/DETC2010-28324
Ross, A., O'Neill, M. G., Hastings, D., & Rhodes, D. (2010, août 30). Aligning Perspectives and Methods for Value-Driven Design. *AIAA SPACE 2010 Conference & Exposition. AIAA SPACE 2010 Conference & Exposition*, Anaheim, California. https://doi.org/10.2514/6.2010-8797
Sai, L. N., Shreya, M. S., Lakshmi, B. J., Madhuri, K. B., & Subudhi, A. A. (2017). Optimal K-Means Clustering Method Using Silhouette Coefficient. *International Journal of Applied Research on Information Technology and Computing*, 8. https://doi.org/10.5958/0975-8089.2017.00030.6
Sato, A.-H. (2019). An Approach to Product Design Involving Heterogeneous Stakeholders. 14, 33–49. https://doi.org/10.1007/978-981-10-7194-2_3
Schmitter, E. (1993). The implications of industrial systems' complexity on methodologies for system design and evaluation. *Proceedings of 5th International Workshop on Petri Nets and Performance Models*, 192–201. https://doi.org/10.1109/PNPM.1993.393451
Schofer, M. (2015). Processus et méthodes pour la résolution de problèmes interdisciplinaires et pour l'intégration de technologies dans des Domaines fortement Basés sur la Connaissance.
Schöttle, A., Arroyo, P., & Christensen, R. (2018). Demonstrating the Value of an Effective Collaborative Decision-Making Process in the Design Phase. 899–909. https://doi.org/10.24928/2018/0500
Smith, A., & Wight, J. B. (2007). An inquiry into the nature and causes of The wealth of nations. *Harriman House*.
Tomiyama, T., Gu, P., Jin, Y., Lutters, D., Kind, Ch., & Kimura, F. (2009). Design methodologies: Industrial and educational applications. *CIRP Annals*, 58(2), 543–565. https://doi.org/10.1016/j.cirp.2009.09.003
Tosti, D. T. (2009). Customer experience and value: A performance view. *Performance Improvement*, 48(1), 37–44. https://doi.org/10.1002/pfi.20047
Vadcard, P. (1996). Aide à la programmation de l'utilisation des outils en conception de produit. https://artsetmetiers.primo.exlibrisgroup.com/discovery/fulldisplay/alma991000139159708026/33ENSAM_INST:ENSAM
Yannou, B., & Cluzel, F. (2024). Radical Innovation Design. *EDP Sciences*. https://doi.org/10.1051/978-2-7598-3066-4
Zhuang, J., Hu, M., & Mousapour, F. (2017). Value-Driven Design Process: A Systematic Decision-Making Framework Considering Different Attribute Preferences From Multiple Stakeholders. *Journal of Solar Energy Engineering*, 139(2), 021001. https://doi.org/10.1115/1.4035059