


## Challenges in design methods: perspectives of design students

Mayank Mayookh  and V. Srinivasan

Indian Institute of Technology Delhi, India

 mayank.mayookh@design.iitd.ac.in

### Abstract

The aim of this study is to identify: (a) challenges in understanding and using design methods, and (b) features expected in an enhanced repository of design methods, by design students. These are identified through interviews and a survey. The major findings are (a) less (time for) practice leads to weak understanding and challenges in using design methods and (b) students expect to have a method recommendation system based on problem context. The findings from this study will guide in developing a user-centric, enhanced repository of design methods to aid design practice and pedagogy.

*Keywords:* design methods, design practice, design education, design pedagogy, design tools

## 1. Introduction

A design method is a prescriptive plan of action by which a class of design tasks can be tackled (Wallace, 2011). Design methods are developed primarily to formalize and externalize design processes, improve product quality, reduce time to market, reduce errors in development processes, shorten development time, etc. (Geis *et al.*, 2008; Guertler, 2018; Jagtap *et al.*, 2014). Design methods also provide a structure to a rather "fuzzy" and "open-ended" design process (Kramer *et al.*, 2017). However, the uptake of design methods in design practice is low for various reasons (Becerril *et al.*, 2019; Eisenmann and Matthiesen, 2020; Gericke *et al.*, 2022; Jagtap *et al.*, 2014). It is important to understand the causes and factors for this low uptake, with the intention of improving the use of design methods in practice.

Repositories and databases of design methods were developed: (a) to facilitate the proper selection and correct use of design methods (Acharya *et al.*, 2018), (b) to provide information on design methods in a compact manner (Vroom and Olieman, 2010), transferred impersonally (Ponn and Lindemann, 2006), and (c) to make design methods more accessible to the general public (Kramer *et al.*, 2017). It is argued that by providing appropriate information on design methods to designers, design methods can be better comprehended and used. Consequently, this can facilitate relevant selection and use of design methods. Therefore, it is important to identify information on design methods that is pertinent for their understanding and use. (Mayookh and Srinivasan, 2023) reviewed 16 repositories of design methods, and based on this review, proposed a need for a user-centric "enhanced" repository of design methods to support design practice and pedagogy. The overarching goal of this research is to develop and validate a user-centric, enhanced repository of design methods to support design practice and pedagogy. It is important to identify the challenges faced by the prospective users in understanding and using design methods, and further, the features they would expect to have in the enhanced repository. Prospective users of this enhanced repository which is intended to support practice and pedagogy include design students, design teachers, and design practitioners. The challenges faced by design students in understanding and using design methods and their expectations of the enhanced repository are described in this paper.

## 2. Literature review

The origin of design methods can be traced to the "Conference on Design Methods", held in London in 1962 (Margolin, 2010). It was the first time "design methods" received substantial academic recognition (Cross, 1993). Since then, the development of design methods as a design support has been a part of design research. Notwithstanding the benefits of design methods, there are challenges associated with understanding, and using design methods in practice.

Although design methods are developed with the intention of improving design practice, many methods are used only "occasionally or not at all", because they are too complex, have theoretical overload, require considerable effort to be implemented, and so, users are unable to see the advantages of many methods (Geis *et al.*, 2008). Hjartarson *et al.* (2021) reported that students at TU Denmark found design methods "overly complicated" and restrictive in their design work; these students faced challenges in understanding the correct use of methods in the context of the courses (where they are taught these methods), and how to use methods in a "productive" way. They also discovered that due to the lack of repeated experience of using the methods, the students were unable to build a proper understanding and competence to use these methods. Birkhöfer *et al.* (2002) stated that students generally have poor practical experience and so must design without sufficient knowledge. This lack of experience also makes it difficult for them to understand and estimate the value and merit of design methods. Jänsch and Birkhofer (2004) identified a list of problems faced by students in learning design methods, such as problems related to understanding design methods, the relation between a design task and a design method, verifiability of the quality of the results, and so on. They also reported that students do not understand the nature of design methods and are unable to adapt a design method to a new design task, and hence, fail. Daalhuizen *et al.* (2014) found, through a quantitative study, that students' initial assessment of the task at hand and their "method mindset" play a key role in the way they experience design methods. Researchers also reported the factors influencing the choice and usage of design methods, by design students (Gonçalves *et al.*, 2014; Person *et al.*, 2012). Person *et al.* (2012) reported - through a survey of 305 industrial design students - that both prior knowledge and preference for systematic methods influenced design method usage in different design activities. Gonçalves *et al.* (2014) surveyed design students as well as professional practitioners on the sources of inspiration (stimuli) and ideation methods used by them and reported that the use of text as a source of inspiration is neither favoured by students nor professional practitioners. They also reported that they were unable to find the reason behind the exaggerated use of certain ideation methods (like brainstorming).

Based on the review of repositories of design methods Mayookh and Srinivasan (2023) and literature on design methods (such as Boeijen *et al.*, 2014; Jones, 1980; Kumar, 2012; Martin and Hanington, 2012; Cross, 2000), it was found that most of the existing repositories aimed at improving design practice, with no explicit evidence of supporting design pedagogy. It was not evident from the literature whether the repositories were developed after eliciting the needs of their potential users. Consequently, Mayookh and Srinivasan (2023) felt that many of the issues associated with the repositories and the uptake of design methods could be solved by collecting and incorporating the needs of users, and therefore, proposed a need for a user-centric "enhanced" repository of design methods to support design practice and pedagogy. To build this user-centric repository, it is important to identify the challenges faced by prospective users in understanding and using design methods and the features they would expect to have in the "enhanced" repository of design methods.

## 3. Overall objective and research questions

The overarching goal of this research is to develop and validate an enhanced, user-centric repository of design methods to support design practice and pedagogy. Before developing, it is important to identify from the prospective users: (a) the challenges faced in understanding and using design methods, and (b) features to be supported in the enhanced repository. So, the following research questions are posed in this paper: (a) What are the challenges faced by prospective users in understanding and using design methods? and (b) What are the features to be supported in the enhanced repository of design methods?

The prospective users comprise design students, practitioners, and teachers. In this paper, the perspectives of design students are captured.

## 4. Methodology

To find answers to the research questions, an empirical study comprising interviews and a survey is carried out with design students. In this study, interviews of 20 design students and an online survey of 26 design students are conducted. These design students are Indian undergraduate and postgraduate students currently pursuing their Doctorate, Masters in Design, or Bachelors of Design in India, have undertaken at least one course on design methods, and have obtained their Bachelors or Masters from design, engineering, architecture, or arts. The interviews are semi-structured and conducted by the first author of this paper. A pilot study is conducted with 3 design students to estimate the time taken for interviews, and to check whether the questions are understandable and posed in a logical order. The questions for interviews (see Appendix A), which are formulated around the research questions along with some questions to capture the context of the challenges faced, are finalized after the pilot study. The interviews are either conducted in-person or online, with the audio recorded and notes documented by the interviewer (first author of this paper). The recordings of the interviews are transcribed automatically using MS Stream and the transcriptions are checked by the first author with the recording to ensure all utterances are captured correctly. The transcriptions are analyzed for the following: (a) information on design methods provided to students in academia, (b) problems faced by students in understanding and using methods, (c) preference of students to choose and use certain design methods over others, (d) features expected by students in the enhanced repository of design methods. To supplement the findings of the interviews and to check their veracity with more cases, an online survey is conducted. The survey questionnaire consists of a list of multiple-choice questions where more than one option can be chosen. The options for these questions are derived from the findings of the interviews; additionally, the respondents are also provided with the option of “Other” where they can type their opinion in case the given options do not suffice. The survey questionnaire is pilot-tested with 2 design students to estimate the ease of understanding of questions and the time it takes to complete the online questionnaire. The finalized questionnaire is shared in an online format with the design students which can be found in the reference (Mayookh and Srinivasan, 2024).

## 5. Results

The findings from the empirical study are described in the following sub-sections.

### 5.1. Interview findings

The interviews on average take 30-50 minutes. The first author of this paper checks the transcriptions for their correctness, and this takes approximately 40-50 minutes per interview. The findings of the analysis of transcriptions are summarised in Tables 1-5. The tables contain the issues or features and their frequency of repetition across the different interviews.

**Table 1. Information of design methods provided in academia**

Information	Frequency
Steps to implement methods	16
Method objective/definition	14
Made up examples/ examples not from industry or real-life projects	10
Examples of method implementation from industry (real-life projects)	5
Contexts that suit the method (domain of design problem i.e., engineering, architecture, medicine, and the like, types of stakeholders, available resources i.e., time, budget, and human resources, method input, and method output)	3
Method benefits and limitations	1
Methods that produce similar outputs	1

**Table 2. Challenges in understanding design methods**

Challenges	Frequency
No issues	13
Less practice/less time for practice leads to weak understanding	4
Confusion in steps/ large number of steps	3
Lack of skills for implementing a method creates challenges in method understanding	1
Challenges with data analysis/ analyzing method output	1
Example of method implementation does not provide sufficient clarity	1

**Table 3. Challenges in using design methods**

Challenges	Frequency
Challenges due to constraints associated with real problems (classroom implementation does not consider these)	6
Challenges with data collection/interaction with stakeholders	4
Challenges in team management/ working with teammates (individuals have their own ideas and biases)	3
Challenges in method selection/ unaware of methods pertaining to a certain design activity	3
Less practice/less time for practice leads to challenges in method usage	3
Issues due to lack of skills in using a method	2
Mismatch between examples and real scenarios/ unable to connect examples to the context of the problem at hand	1
Issues with data analysis/ analyzing method output	1

**Table 4. Preference for some design methods over others**

Reason(s) for method preference	Frequency
Familiarity with a method/ prior experience of using a method	9
Easy to understand and use	7
Less number of steps and rules to follow	3
Accessibility of resources (manpower, stationery, etc.)	2
Suggested/ recommended by peer(s)/teacher(s)/course instructor(s)	2
Less analysis involved	1
Suitable for teamwork	1
Less time consumption (in method execution)	1

**Table 5. Features expected in an enhanced repository of design methods**

Expected feature(s)	Frequency
Method recommendation based on problem context (domain, constraints, stakeholders, etc.)	14
Examples of method usage from industry (real-life) projects	7
Detailed information on methods (time required for execution, no. of people required, material and stationery required, input, output, related methods, etc.)	6
Videographic/ pictorial information (low to no text)/ Demo of method implementation (video graphics)/ aid for method visualization	5
Methods to have a proper arrangement (structure)	3
A customer support/ discussion forum for methods	2
Provision to check method understanding/knowledge	2
Simple/concise method description	2
References to information provided and information should be from reliable sources	2
Easy method access	1
Provision for validating project result	1

## 5.2. Survey findings

The online survey on average takes around 6 minutes, 41 seconds to complete. The findings from the analysis of the online survey are summarised in Tables 6-10.

**Table 6. Information of design methods provided in academia**

Information	Frequency
Steps to implement the method	22
Examples of method usage from industry (real-life projects)	19
Contexts which suit the method (domain of design problem i.e., engineering, architecture, medicine and the like, types of stakeholders, available resources i.e., time, budget and human resources, method input, and method output)	12
Method objective/aim	11
Made up examples/ examples not from the industry or real-life projects	10
Method benefits and limitations	9
Methods that produce similar outputs	7
No information was provided but learned solely through practice	4

**Table 7. Challenges in understanding design methods**

Issues	Frequency
Less practice/less time for practice leads to a weak understanding	21
Confusion in steps/ large number of steps	11
Challenges with data analysis/ analyzing method output	10
Lack of skills for implementing a method creates challenges in method understanding	7
Example of method implementation does not provide sufficient clarity	7
No issues	0

**Table 8. Challenges in using design methods**

Issues	Frequency
Less practice/less time for practice leads to challenges in method implementation	17
Issues with team management	16
Challenges faced in data collection/interaction with stakeholders	12
Challenges in method selection/ unaware of methods pertaining to a certain design activity/ lack of understanding of which method works well in which situation	11
Issues with data analysis	9
A mismatch between examples and real scenarios/ unable to connect examples to the context of the problem at hand	8
Issues due to lack of skills for implementing a method	4
Issues due to constraints associated with "Real" design problem	3

**Table 9. Preference for some design methods over others**

Reason(s) for method preference	Frequency
Familiarity with the method/ prior experience of using the method	13
Less time consumption (in method execution)	13
Suitable for teamwork	11
Suggested/ recommended by peer(s)/ teacher(s)/ course instructor(s)	11
Easy to understand and use	10
Less number of steps and rules to follow	9
Accessibility of resources (manpower, stationary etc.)	9
I don't have a preference and treat all design methods equally	7
Less analysis involved	2

**Table 10. Features expected in an enhanced repository of design methods**

Expected feature(s)	Frequency
Videographic/ pictorial information (low to no text)/ Demo of method implementation (video graphics)/ aid for method visualization	21
Method recommendation based on problem context (domain, constraints, stakeholders, etc.)	20
Examples of method implementation from industry or real-life projects	17
Detailed information on methods (time required for execution, no. of people required, material and stationery required, input, output, related methods, etc.)	16
Methods to have a proper arrangement (structure)	14
Easy method access (minimum no. of clicks)	11
References to information provided/ information should be from a reliable source	10
A customer support/ discussion forum for methods	10
Provision to check method understanding/knowledge	9
Simple/concise method description	8
Provision for validating project result	7

### 5.3. Inference

It is observed from the interview transcriptions that most students were taught the objective(s) of design methods, steps in methods, and examples of use. From the survey, it is observed that most students were taught steps for using methods, examples of usage, the context of use, objective(s) of the design methods, and benefits and limitations of design methods.

While interview results show that most students face no issues in understanding and using design methods, some face challenges due to less practice or less time for practice and confusion in steps for method implementation. Similar responses are found in the survey. The majority of students faced challenges in analyzing the data collected from design methods. In the case of challenges faced in method implementation, it is found, through the interviews, that most of the constraints to design method implementation, such as budget, time, and human resource constraints, are either not there during the classroom projects or students do not take the management of these resources seriously during these projects. Therefore, the students are unable to develop an understanding of how to tackle the challenges imposed by the constraints associated with real industrial projects. On the other hand, the survey shows that students faced challenges in method implementation due to less practice or less time for practice, which is similar to the observation for challenges in method understanding. Apart from this, the students also faced challenges associated with team management, data collection, and data analysis, selecting methods for a design task for a given problem context, and challenges associated with their inability to connect examples to the context of the problem they are working on.

Results from both the analysis of the interviews and the survey show students prefer design methods based on their familiarity or prior experience of using them. It was followed by ease of understanding and using a method (from interviews) and the method which takes a lesser time in execution, suitable to be used by a team rather than an individual, and methods suggested by their peers or teacher(s) (from survey). In the case of features expected by students in the enhanced repository of design methods, a majority of students reported, in both the interviews and the survey, that they expect a mechanism for method recommendation based on the context of the design problem (such as the domain of design problem i.e., engineering, architecture, medicine and the like; types of stakeholders; constraints i.e., time, budget and available human resources; method input; method output) and examples of method implementation from industry or real projects. However, in the case of the survey responses, a majority of respondents also expect to have videographic/ pictorial information with less textual information and/or videographic demo of method implementation with aid for method visualization, detailed information on design methods (such as time required for execution, no. of people required, material and stationery required, input, output, related methods, etc.), and method arrangement within the repository to have some structure.

One of the reasons for this variation of responses, in interviews and the survey, can be that the interviewees belong to the same institute while the survey respondents were from at least 4 different

institutes, and hence, different instructors. Further, the reason for most of these challenges can be (a) time-bound courses, which have a fixed number of lectures and must end at a predetermined time, and therefore these courses and the overall semester curriculum provide less time for practice, experimentation, and exploration to students, and (b) students are not being exposed to the problems taken from industry and associated constraints. Exposing students to such mock problems can build an understanding of managing budget, time, and other resources and the skill of working in a team.

## 6. Discussion

The objective of this study is to understand the issues faced in understanding and using design methods, and to identify the features expected in an enhanced repository of design methods, from design students. The findings reported by analyzing the transcriptions of interviews and responses to the online questionnaire bear similarities and differences with existing research. [Hjartarson et al. \(2021\)](#) conducted semi-structured, online interviews with 12 students and recent graduates of TU Denmark. They identified the negative experience of method use and how it can affect a student's well-being. They observed that students find design methods "overly complicated" and restrictive in their design work. This bears resemblance to the observations in this paper: Indian students also reported challenges in confusion in steps of methods and sometimes lacked necessary skills to use some methods. According to [Hjartarson et al. \(2021\)](#), due to the lack of experience in using the methods, students were unable to build a proper understanding and competence to use design methods. Similarly, [Birkhöfer et al. \(2002\)](#) stated that students generally have poor practical experience, and this lack of experience makes it difficult for them to understand and estimate the value and merit of design methods. In this study also it was observed that less practice or less time available for the practice of a design method usage leads to weak or poor understanding of design methods and results in challenges while using them. [Jansch and Birkhofer \(2004\)](#) recorded the questions and comments of 20-30 mechanical and industrial engineering students in a design course for 2 semesters and identified problems faced by them in learning design methods. They observed that if students are not able to adapt a design method to any new design task, they try to transfer methods from lecture examples to any new design task. In this study, the Indian students reported challenges in method selection for a particular design task and challenges due to mismatch between examples given in lectures and the design problem they solve or their inability to connect examples from lectures to practice. In terms of the features desired in an improved repository of methods, a mechanism for method recommendation is reported as the most expected feature in this study. This was also promulgated by [Fuge et al. \(2014\)](#) and [Gericke et al. \(2016\)](#). When it comes to preference of design methods for a particular design activity, [Person et al. \(2012\)](#) reported students preferred design methods based on their prior knowledge of using the methods, which is sustained by the findings of this study. The findings of this study highlight the need for a videographic, low in text representation of design methods. This supports the findings of [Gonçalves et al. \(2014\)](#) that the use of text as a source of inspiration is neither favoured by students nor professional practitioners.

The existing work on challenges in design methods is based on observations in European universities. However, the work presented in this paper is based on the findings in Indian universities. To the best of the knowledge of the authors, this is the first time such a study is undertaken in India. The other major difference is the subjects of the observation. In the existing literature, the courses on design methods were undertaken by engineering students, whereas in the Indian universities used in this study, the courses on methods were undertaken by design students who can also have a non-engineering background. Since this study aims to identify the challenges faced by design students in understanding and using design methods in general, the authors did not focus on any specific design methods or repositories.

### 6.1. Implications

The perspectives of the design students (and the other stakeholders), i.e., challenges faced by them in understanding and using design methods and the features expected by them, will be used to structure the information on design methods and the containing repository of design methods, to make them user-centric. It is expected that this user-centricity of the repository will ensure its usability and utility to support design practice and pedagogy in industry and academia. Moreover, apart from the reported expected features, the challenges mentioned by students will also decide what features will be

incorporated within the repository of design methods, for example, students reported that less practice or less time for practice leads to challenges in design method understanding and implementation, a possible feature that can mitigate this issue is a platform for design method practice, and challenges in resource management can be mitigated by a resource management tool within the repository.

The scope of the challenges (of understanding and using design methods) identified in this paper is not confined to the purpose of building the enhanced repository of design methods. The challenges can be used as the basis to improve the quality of education of design methods in India by improving and redefining the ways of design method teaching and learning in academic institutions, eventually leading to improved design practice in both academia and industry.

## 6.2. Limitations

The findings of this study are based on the experiences of 46 students (interview: 20 and survey: 26). More interviews and surveys are planned to be undertaken. Surprisingly, the responses in the survey are more detailed than in the interviews. In the interviews, open-ended questions are posed and there is a chance that the interviewees could not recollect and share all their experiences. The responses in the interview are used as options in the multi-select questions in the survey. In the survey, the respondents must choose relevant options and in case the given list of options is inadequate or does not capture all their experiences, they must choose the option of "Others" and fill their opinions. It is assumed the respondents did not randomly select the given options. It is interesting to note that no respondent chose the "Others" option.

Bearing the limitations, this study is the first of its kind to understand: (a) the content of design methods taught in Indian academia, (b) the challenges faced by Indian design students in understanding and using design methods, (c) the parameters that affect their choice of use of methods, and (d) the features they would expect in the enhanced repository of methods. These perspectives as well as the perspectives of the other stakeholders i.e., design practitioners and teachers, will help in building a user-centric, enhanced repository of design methods to aid design practice and pedagogy.

## 7. Summary, conclusions, and future work

This study is conducted to identify: (a) challenges faced by design students in understanding and using design methods, and (b) features expected by design students in an enhanced repository of design methods. These are gathered through interviews and a survey of Indian design students. The major findings of this study are:

- a) Most students are taught the definition, objective, steps for using, and examples of usage of design methods.
- b) Many students opine that less practice or less time for practice leads to weak understanding and challenges in using design methods.
- c) Most students choose design methods for a design activity based on familiarity or prior experience of using the methods.
- d) Majority of students expect to have a method recommendation system based on problem context (domain, constraints, stakeholders, etc.)

These findings highlight the issues related to design method understanding and use by design students in Indian academic institutions. This study is planned to be conducted with more design students, design practitioners, and design teachers. Their combined perspectives will help to identify relevant features that will be eventually incorporated to build the user-centric, enhanced repository of design methods to aid design practice and pedagogy. However, the scope of these findings is not confined to the purpose of building the enhanced repository. This data can be utilized to enhance the standard of design method education in India, by improving how design methods are taught and learned in academic institutions. This, in turn, will lead to improved design practice in both industry and academia.

The envisaged enhanced, user-centric, repository of design methods is planned to be developed, implemented, and tested in the Indian context, for its usability and utility to support design pedagogy and practice. If it is successful, it will be shared with the international stakeholders and will be improved based on their feedback.



## References

- Acharya, S., Chatty, T., Ranjan, B.S.C., Ghadge, K., Bharath, P.A. and Chakrabarti, A. (2018), "InDeaTe 3.0: an ontology based, generic design process guidance web-tool", Proceedings of the DESIGN 2018 15th International Design Conference, Vol. 15, pp. 137–148, <https://dx.doi.org/10.21278/idc.2018.0456>.
- Becerril, L., Guertler, M. and Longa, E. (2019), "Developing design methods - A conceptual requirement framework", Proceedings of the International Conference on Engineering Design, ICED, Vol. 2019-Augus No. AUGUST, pp. 1463–1472, <https://dx.doi.org/10.1017/dsi.2019.152>.
- Bella Martin and Bruce Hanington. (2012), *Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*, Rockport Publishers.
- Birkhöfer, H., Kloberdanz, H., Berger, B. and Sauer, T. (2002), "Why Methods Don't Work and How To Get Them Work.", *Engineering Design in Integrated Product Development*, pp. 29–36.
- Boeijen, A. van, Daalhuizen, J. and Zijlstra, J. (2014), *The Delft Design Guide*.
- Cross, N. (1993), "A History of Design Methodology", *Design Methodology and Relationships with Science*, No. 1979, pp. 15–27, [https://dx.doi.org/10.1007/978-94-015-8220-9\\_2](https://dx.doi.org/10.1007/978-94-015-8220-9_2).
- Daalhuizen, J., Person, O. and Gattol, V. (2014), "A personal matter? An investigation of students' design process experiences when using a heuristic or a systematic method", *Design Studies*, Vol. 35 No. 2, pp. 133–159, <https://dx.doi.org/10.1016/j.destud.2013.10.004>.
- Eisenmann, M. and Matthiesen, S. (2020), "Identifying reasons for a lack of method application in engineering design practice - an interview study", Proceedings of the Design Society: DESIGN Conference, Vol. 1, pp. 2495–2504, <https://dx.doi.org/10.1017/dsd.2020.261>.
- Fuge, M., Peters, B. and Agogino, A. (2014), "Machine learning algorithms for recommending design methods", *Journal of Mechanical Design, Transactions of the ASME*, Vol. 136 No. 10, <https://dx.doi.org/10.1115/1.4028102>.
- Geis, C., Bierhals, R., Schuster, I., Badke-Schaub, P. and Birkhofer, H. (2008), "Methods in practice - A study on requirements for development and transfer of design methods", Proceedings DESIGN 2008, the 10th International Design Conference, No. 1997, pp. 369–376.
- Gericke, K., Eckert, C. and Stacey, M. (2022), "Elements of a design method - a basis for describing and evaluating design methods", *Design Science*, Vol. 8, pp. 1–28, <https://dx.doi.org/10.1017/dsj.2022.23>.
- Gericke, K., Kramer, J. and Roschuni, C. (2016), "An exploratory study of the discovery and selection of design methods in practice", *Journal of Mechanical Design, Transactions of the ASME, American Society of Mechanical Engineers (ASME)*, Vol. 138 No. 10, <https://dx.doi.org/10.1115/1.4034088>.
- Gonçalves, M., Cardoso, C. and Badke-Schaub, P. (2014), "What inspires designers? Preferences on inspirational approaches during idea generation", *Design Studies*, Vol. 35 No. 1, pp. 29–53, <https://dx.doi.org/10.1016/j.destud.2013.09.001>.
- Guertler, M.R. (2018), "How to design methods for application - Empirical insights from industry", Proceedings of International Design Conference, DESIGN, Vol. 3, pp. 1161–1172, <https://dx.doi.org/10.21278/idc.2018.0169>.
- Hjartarson, B., Daalhuizen, J. and Gustafsson, K.F. (2021), "the Dark Side of Methods – an Exploration of the Negative Effects of Method Use and Method Reflection in Design", Proceedings of the Design Society, Vol. 1 No. August, pp. 3001–3010, <https://dx.doi.org/10.1017/pds.2021.561>.
- J. Christopher Jones. (1980), *Design Methods: Seeds of Human Futures*, John Wiley & sons, London.
- Jagtap, S., Warell, A., Hiort, V., Motte, D. and Larsson, A. (2014), "Design methods and factors influencing their uptake in product development companies: A review", Proceedings of International Design Conference, DESIGN, Vol. 2014-Janua, pp. 231–240.
- Jänsch, J. and Birkhofer, H. (2004), "The gap between learning and applying design methods", Proceedings of International Design Conference, DESIGN.
- Kramer, J., Poreh, D. and Agogino, A. (2017), "Using thedesignexchange as a knowledge platform for human-centered design-driven global development", Proceedings of the International Conference on Engineering Design, ICED, Vol. 1 No. DS87-1, pp. 101–110.
- Margolin, V. (2010), "Design Research: Towards a History", in Durling, D., Bousbaci, R., Chen, L., Gauthier, P., Poldma, T., Roworth-Strokes, S. and Stolterman, E. (Eds.), *Design and Complexity - DRS International Conference 2010*, Montreal, Canada, pp. 7–9.
- Mayookh, M. and Srinivasan, V. (2023), "A Review of Repositories of Design Methods", in Chakrabarti, A. and Singh, V. (Eds.), *Design in the Era of Industry 4.0, Volume 1. ICORD 2023. Smart Innovation, Systems and Technologies*, Vol 343., Springer, Singapore, pp. 1205–1215, [https://dx.doi.org/10.1007/978-981-99-0293-4\\_97](https://dx.doi.org/10.1007/978-981-99-0293-4_97).
- N. Cross. (2000), *Engineering Design Methods- Strategies for Product Design*, 5th ed., Wiley.
- Person, O., Daalhuizen, J. and Gattol, V. (2012), "Forming A Mindset: Design Students' Preconceptions About The Usefulness Of Systematic Methods", Proceedings Of 14th International Conference On Engineering And Product Design Education, BELGIUM.

- Ponn, J. and Lindemann, U. (2006), “CiDaD - A method portal for product development”, 9th International Design Conference, DESIGN 2006, pp. 1221–1228.
- Mayookh, M. and Srinivasan, V. (2024), “Research Survey: Perspectives of Design Students”, available at: <https://forms.office.com/pages/responsepage.aspx?id=S1xNYsVFIkGM0ETw-E6UXSq0jspZ1XVJrS4GXEJyX-5UMkpSNTJDSkFNMIrcWdk5RFNkV0FDOFBWMy4u> (accessed 15 February 2024).
- Vijay Kumar. (2012), 101 Design Methods, John Wiley & Sons, New Jersey.
- Vroom, R.W. and Olieman, A.M. (2010), “the Development of an Industrial Design Engineering Wiki : Wikid”, TMCE2010 Symposium, pp. 1449–1464.
- Wallace, K. (2011), “The Future of Design Methodology”, The Future of Design Methodology, pp. 239–248, <https://dx.doi.org/10.1007/978-0-85729-615-3>.

## Appendix A

The questions for the interviews are as follows:

1. What is your educational background?
2. Did you take any course on design method implementation during your education?
3. What information about a design method was provided to you (in the course undertaken) to enable you to use design methods?
4. What challenges did you face in learning design methods?
5. Did you undertake any design projects during the course?
6. Can you walk me through the projects?
7. What challenges did you face while implementing design methods in the projects?
8. Why did you use only some methods in the design projects? Why not other methods?
9. What makes a design method easy to use? Why?
10. Were you provided with any repository or database of design methods during the course?
11. If I provide you with a design method repository, what features would you expect in it?