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EDSE Informing Engineering Education and Method Development Through Industry Perspectives

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Introduction

Although researchers in engineering design continue to develop engineering design methods with the potential to enhance creativity and efficiency, these methods often fail to be adopted and gain traction in industry [1,2]. Many of these methods may be taught in university courses and this is often the first exposure to a given method for students. Some prior research has identified approaches and challenges related to design method adoption through a researcher's personal experiences [3], single-company case studies [4], and single design method case studies [5], which has resulted in fragmented insights with limited generalizability and little that can be leveraged to improve engineering education or methods development and deployment. There is little work investigating design method adoption in industry through broader systematic investigations. By examining the factors that influence the adoption and integration of new design processes broadly, this work aims to bridge the gap between academic innovation and engineering practice, providing empirical insights into the conditions under which new design methods are most likely to be adopted and sustained in industry. The results of this work offer industry insights into the catalysts and barriers influencing design method adoption while also providing method developers and educators with guidance on how to more effectively design and teach methods that lead to organizational impact.

Background

Engineering design and innovation are supported by a wide range of formalized methods that span individual and group ideation techniques through stage-gate methods. While several structured methodologies like Six Sigma, TRIZ, and Design Thinking, have achieved widespread adoption and institutionalization through training and integration into practice, many theoretically grounded approaches such as Biologically Inspired Design (BID) exhibit mixed adoption despite demonstrated benefits for novelty and functional diversity [6]. Prior research suggests that these adoption gaps may be driven less by the value of the methods themselves and more by systemic barriers such as search and abstraction challenges [7], and change resistance, particularly in the context of Model Based Systems Engineering adoption [5]. However, existing studies have examined these challenges within relatively narrow scopes, with investigations largely confined to specific regional contexts or to particular methodologies. The literature highlights a gap between the promise of advanced design methodologies and their consistent use in practice, motivating further investigation into mechanisms that may lower barriers or promote adoption. Faculty, too, must choose which methods to teach and use in design courses, and instructors have significant control over how methods are introduced and the design challenges to which they are applied. The objective of this research is to investigate the factors that shape the adoption of innovation methods in Fortune-500 companies' new product development process and translate effective adoption strategies into guidance for researchers, educators, and practitioners. Engineering innovative products and advancing solutions to complex societal challenges depends not only on methodological advancement, but on ensuring that these methods are meaningfully integrated into the practices of key innovation stakeholders.

Methodology

To better understand this adoption gap, exploratory semi-structured interviews were initially conducted with industry practitioners, managers, and executives to identify the organizational, methodological, and personal factors that impede and promote the adoption of new design methods [8]. These 33 interviews were conducted at three organizations across two companies operating in different industry sectors. Qualitative coding of these interview transcripts identified recurring organizational- and method-level catalysts and barriers. The individual codes were identified using an open-coding approach, only factoring in the interviews themselves so as to explore and form an understanding of the lived experiences of the interview participants. Initial results of the qualitative coding are presented by [8] while efforts to establish rigor in these results using intercoder reliability are currently underway. The interviews revealed that method adoption is shaped by a complex interaction of individual motivations, alignment between methods and organizational processes, and leadership support [8]. Insights from this qualitative analysis directly informed the construction of the survey instrument, with interview-derived factors translated into survey items through iterative refinement and consultation with survey design experts to ensure clarity, coverage, and construct alignment. A refined and targeted survey instrument was deployed during the Innovation Research Interchange (IRI) webinar to gather responses from a diverse set of industry professionals engaged in innovation and systematically assess the identified factors at a broader scale. 14 industry professionals working in the United States completed the survey, representing a broad range of technical, managerial, and leadership roles. Two responses were excluded due to incomplete data, resulting in a final sample of 12 participants. Table 1 shows the demographics of the survey responders.

Table 1. Participant Demographics (N = 12)

Characteristic	Category	n
Primary Role in Organization	Team Lead / Senior Engineer	6
	Entry-level / Individual Contributor	2
	First-line Supervisor / Operations Manager	1
	Middle Management	1
	Senior Leadership / Executive	2
Job Category (by Title)	Engineer (research, principal, senior)	4
	Manager (innovation, R&D, investment, product development)	5
	Director / Executive	3
Years in Current Industry	1–5 years	1
	5–10 years	1
	10–20 years	5
	20+ years	5
Gender	Male	7
	Female	4
	Not reported	1

The survey first asked participants which innovation or design methods they had used or learned about during their careers to prime their understanding of innovation methods. Participants selected all applicable options from a multiple-choice list. They were then asked whether they had worked

for an organization that had limited success or failed to adopt a new innovation method. Participants who responded “yes” were then prompted to reflect on a specific example and to select organizational-level and method- and training-related factors that impeded adoption. A link to a definitions document for the factors was available if participants chose to click it, if they had problems understanding the factors' meaning. Participants were then asked whether they had worked for an organization that had some or a high degree of success in adopting a new innovation method and, if so, to report factors that supported successful adoption.

Results and Discussion

The survey results were analyzed to evaluate the degree to which organizational and methodological-related factors impact method adoption within their organizations. Six participants reported having experienced limited success or failure in adopting an innovation method, whereas only two reported experiencing some or high levels of successful adoption, suggesting that experiences with limited or failed adoption of innovation methods were more common or possibly more salient among participants than experiences with successful adoption. This imbalance indicates that barriers to adoption may be more memorable or prevalent in industry contexts than enablers, particularly among experienced professionals. While innovation methods are frequently introduced, their success may have limitations.

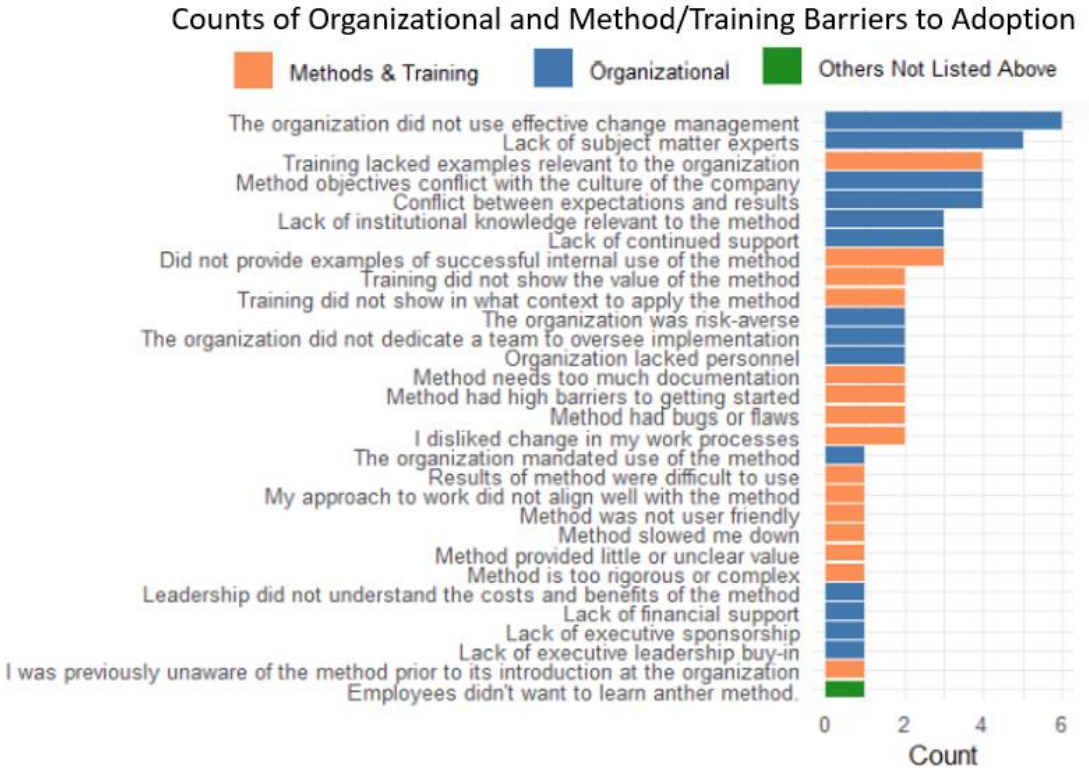

Figure 1. Counts of organizational-level, method- and training-related, and other factors contributing to limited or failed adoption of innovation methods.

Figure 1 shows the responses related to limited or failed adoption (n = 6) and revealed that barriers were perceived to be predominantly organizational rather than method-specific. This could be an artifact of the methods being refined prior to broad implementation by an

organization. The most frequently cited impediment was ineffective change management, followed by a lack of subject matter expertise and misalignment between training materials and the organization's context. Participants also reported cultural misalignment and conflicts between expectations and outcomes. These findings suggest that innovation methods may fail not because of inherent flaws in the methods themselves, but due to inadequate organizational infrastructure, poor contextualization, and insufficient long-term commitment. This pattern reinforces prior qualitative findings that method adoption is a systemic challenge involving leadership, incentives, and process integration [7,8].

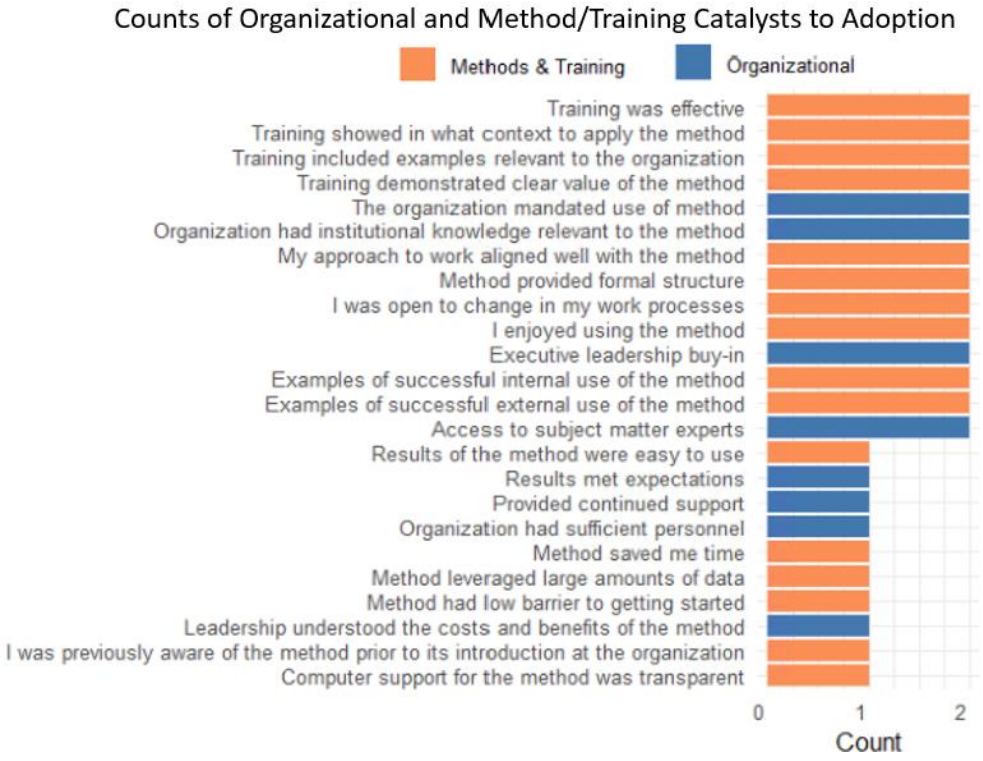

Figure 2. Counts of organizational-level, and method- and training-related factors contributing to some degree or a high degree of success in adopting innovation methods. Results from only 2 participants. No other factors were listed by the participants

Successful adoption experiences as seen in Figure 2 were reported by only two participants and are therefore interpreted as exploratory rather than representative. Interestingly, successful adoption was associated with more method- and training-specific factors, such as effective and context-specific training, clear demonstration of method value, and method providing more structure. Some organizational factors were also selected by both participants such as access to subject matter experts, mandated use, institutional knowledge, and executive support. Participants also emphasized personal openness to change, enjoyment of using the method, and alignment between the method and their existing work practices. Both organizational-level support and method-level characteristics may be necessary to support adoption, however, a larger sample size is necessary to confirm this hypothesis. For industry, reducing organizational barriers, particularly those related to change management, training relevance, and leadership engagement, may be a more impactful strategy than further refinement of innovation methods

alone. The results suggest that many of the barriers to innovation method adoption observed in industry, such as unclear value, poor contextualization, and lack of sustained support, are likely to arise in academic settings as well. Participants frequently emphasized the importance of training that demonstrates when and how a method should be applied, as well as alignment between the method and existing workflows, which parallels challenges faced by students learning design methods. Simply exposing students to design methods may be insufficient, and instruction should emphasize contextual relevance, clear value for task outcomes, and reinforcement through assignments and evaluation. Professors need to consider the design problem and the tasks students are being asked to complete, and how well the methods being taught demonstrate their value. One area highlighted by this work that is frequently not addressed in many of the popular design books, and often not in the literature about a given method, is what contexts the methods are effective for. This is an area the design research community likely needs to address, and faculty should attempt to address this while teaching. Faculty are often aware of the situations and types of design problems methods are more effective for. Additionally, the role of leadership and organizational support observed in industry maps to the instructional role of faculty, suggesting that consistent expectations, feedback, and visible endorsement are critical for sustained method use in educational environments.

Conclusion

These preliminary results from 12 participants suggest an asymmetry between barriers and catalysts with barriers to adoption more widespread and frequently encountered. The relative scarcity of reported success cases highlights how recall and reporting may be influenced by cognitive biases, with unsuccessful outcomes more readily remembered than successful ones. Preliminary evidence highlights that barriers to innovation method adoption are predominantly organizational, while successful adoption appears to require the simultaneous alignment of method value, organizational context, and sustained support, however, further sample size is required to confirm this hypothesis. Insights from this research can inform both curricular approaches and professional development strategies, ultimately preparing future engineers not just to generate new design methods and processes, but to champion and implement them effectively in practice. For example, students need to be taught that successful implementation of a new method requires more than simply demonstrating its effectiveness. For example, training must use relevant examples to the context, and it is more effective if leadership supports the adoption. The study has several limitations that should be considered when interpreting the results. The small sample size limits generalizability and restricts the findings to descriptive, exploratory insights intended to guide hypothesis generation for future work. The work is also based in the US and reported barriers reflect industrial, educational, and organizational norms specific to the U.S. context and may differ in regions with distinct innovation cultures, regulatory environments, or organizational hierarchies. Career stage may also influence the types and intensity of barriers encountered, and future research should examine and model these relationships explicitly. In addition, the definition of “successful adoption” may have been interpreted differently across participants, potentially contributing to the small number of reported success cases and underscoring the need for clearer operationalization in future work. Additional survey data collection is planned to strengthen and extend the findings.

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