

DESIGN ENTREPRENEURS

IDENTIFYING THE ESSENTIAL SKILLS FOR INDUSTRIAL DESIGN STUDENTS TO BECOME DESIGN-ENTREPRENEURS

HERNÁN GREGORIO; DR. BYUNGSOO KIM

KANSAS STATE UNIVERSITY, USA

With the growing trend of design-intensive start-ups and entrepreneurs in the field of Industrial Design (ID), it is becoming more important to understand the skills and learning experiences ID students need to be successful in this career path. This study aims to identify the necessary skills and mindset for ID students to become successful design entrepreneurs. A secondary goal is to assess the current interests and skillset levels of ID students at the Authors' University. The authors conducted a literature review on entrepreneurial thinking and ID and developed a framework that focuses on key skills that are essential for students to possess in order to pursue design-entrepreneur initiatives. The proposed framework outlines eight teachable soft skills necessary for success in this field. To gain a comprehensive understanding of the current level of skills, interests, and potential educational gaps in design education, the authors used this framework to develop questions and conducted a survey of industrial design students at various academic levels. The survey results provide valuable insights into the skills currently present in design education, as well as those needed for design entrepreneurship. The paper also discusses the potential implications of these findings for the future of industrial design education.

Keywords: Industrial Design Skills, Entrepreneurship Skills, Entrepreneurial Thinking, Design Thinking, Design Education.

1. INTRODUCTION

In today's world, we interact with various objects daily, each of which has been designed to serve a specific function with distinctive forms, materials, colors, and finishes that enhance our way of life. The process of designing these objects falls under the field of Industrial design, which involves creating and developing products, systems, and services that improve people's lives, according to Industrial Design Society of America (IDSA, 2023). Designers use methodologies such as Design Thinking to understand user needs, identify problems, define design opportunities, and imagine and develop new solutions that satisfy human needs (IDEO, 2023). Although industrial designers can work in various settings, including corporations, independent design consultancies, or as freelancers, there is an increasing trend towards design entrepreneurship due to the widespread availability of technology and the rapid development of the internet (Thomas and Canning, 2015).

Entrepreneurship can be defined in many ways and can take on various forms, but essentially, it involves an individual or a small group of people who explore new opportunities to create an innovative business venture (Stanford, n.d.). In the realm of industrial design, J. Thomas and L. Canning (2015) have identified five emerging areas of design-entrepreneurship that require a specific mindset, skills, knowledge, and insights to achieve their full potential. These include the "*Designer Founder as Entrepreneur: Industrial Design Consultancy*," "*Designer Founder as Entrepreneur: Design/Development/Manufacturing*," "*Designer/Entrepreneur Participating in Online Co-creation*," and "*Designers Supporting Not-for-Profit Social Entrepreneurship*."

As suggested by Teixeira, (2010), although there is a growing interest among industrial designers in pursuing design entrepreneurship and developing design-intensive start-ups, current higher education academic programs in industrial design do not provide students with the necessary foundational

knowledge of business, marketing, and management. In recent years, the inclusion of business, marketing, and entrepreneurship courses in industrial design programs has been observed in at least 13 universities in the United States, according to Thomas and Canning (2015). However, while this effort may address the issue of lack of foundational knowledge in business, marketing, and management, it does not fully equip industrial designers with the *Entrepreneurial Mindset* (EM), and skills needed to succeed as entrepreneurs. According to Joshua et al., (2023), the EM is defined as a cognitive perspective that enables an individual to create value by recognizing and acting on opportunities, making decisions with limited information, and remaining adaptable and resilient in conditions that are often uncertain and complex.

This study aims to identify the skills that industrial designers need to become successful design-entrepreneurs, and to investigate how industrial design programs can better prepare students for this career path. To achieve this, the authors developed a framework that outlines eight essential skills required for success in the field of design entrepreneurship. This framework was used to develop survey questions that were administered to industrial design students at various academic levels, providing valuable insights into the skills needed for design entrepreneurship. The findings of this study have important implications for the future of industrial design education, which are also discussed in this paper.

2. MATERIALS AND METHODS

2.1 INDUSTRIAL DESIGN AND ENTREPRENEURSHIP SKILLS

With the purpose of identifying the necessary Industrial Design (ID) and Entrepreneurship skills needed to become a successful design-entrepreneur, the authors conducted literature review over the three of the most relevant scholarly databases: Web of Science, Scopus, and Google Scholar. While literacy in specific topics and hard skills are undoubtedly crucial for both Industrial Design and Entrepreneurship, our investigation primarily focuses on soft skills and mindsets. This is because these key factors are often neglected or undervalued in design education, and they serve as a crucial connection between the two fields.

A keyword-based search was conducted searching only for peer-reviewed articles in English, from the past ten years (2013 – 2023). The keywords were: “*industrial design*”, “*product design*”, “*entrepreneur*”, “*skills*”, “*mindset*”. The keywords were formatted as follows: {industrial design} AND “entrepreneur*”, “product design”, AND “skills*” AND “mindset”. The curled brackets are used for exact keywords; quotation marks indicate an approximate or loose phrase; the asterisk is a wild card that ensures that similar words are considered, for example, skills and skillsets. The findings of our search have given us two important insights. Firstly, we discovered a gap in the existing research as we were unable to locate any studies that link the skillsets needed for design-entrepreneurs from an Industrial Design perspective. Secondly, we realized that we need to continue our literature review, focusing on each discipline individually to develop a framework for future studies.

2.2 INDUSTRIAL DESIGN SKILLS

As a follow-up, we delved into the existing literature on the necessary skills, aptitudes, and mindset for individuals in the Industrial Design profession. This time employing the following keywords: “*Industrial*

Design, " *Design education*," " *Skills*," " *Mindset*," and " *Competencies*." Despite our efforts, the majority of the literature we came across did not serve our research aims. As a result, we turned to the National Association of Schools of Art and Design (NASAD) accreditation handbook, which provided a valuable reference for identifying the competencies, abilities, and skills that industrial design students should learn. Accredited institutions in the United States of America follow NASAD's handbook guidelines and standards for accreditation purposes, making it a reliable source for identifying the skill sets that designers should possess.

Our analysis began with a close reading of the list of 11 essential competencies, experiences, and opportunities described in the NASAD document (NASAD, 2022). From there, we curated and shortlisted the themes that addressed skills and abilities designers should have, removing two areas that focused on opportunities and experiences, as they were not relevant to the focus of our study. Upon scrutinizing the document, we categorized some of the sentences according to emerging themes, making the information more straightforward and thereby helping us (a) acquire a better comprehension of the essential skills that industrial designers should possess, and (b) determine the skills that can be taught.

The emerging themes for Industrial Design skills are:

1. Product Development: Ability to design products and systems.
2. Design tools: Ability to use technology and tools used to develop and disseminate design work.
3. Culture and Design History: Develop an understanding of Industrial Design history and sociocultural aspects of the profession.
4. Human Factors: Fundamental knowledge on user experience and human factors.
5. Research: Ability to perform research that informs the design practice.
6. Communication: Ability to develop and disseminate design work in multiple mediums and formats.
7. Professional practice: Understanding of ethics and intellectual property.
8. Versatility and business practice: Ability to understand needs and roles of stakeholders in a business environment associated with the design process.
9. Team work: Ability to work in interdisciplinary and multidisciplinary teams.

These emerging themes were later utilized to identify similarities and differences between industrial design skills and entrepreneurship skills.

2.3 ENTREPRENEURSHIP SKILLS

Through a systematic literature review, we identified key entrepreneurship skills deemed necessary in previous studies. Our search began by using specific keywords such as "*entrepreneurship competencies*", "*entrepreneur*", "*entrepreneurial mindset*", and "*skills*". We narrowed our search to the past decade and focused on literature reviews and highly cited papers, including those authored by Peschl et al. (2021), Kier and McMullen (2018), Davis et al. (2016), and Bacigalupo et al. (2016). Despite overlapping themes and different categorization methods, these articles provided valuable insights into essential entrepreneurial skills. We ultimately selected the framework developed by Margherita Bacigalupo, Panagiotis Kampylis, Yves Punie, and Godelieve Van den Brande titled "*EntreComp: The Entrepreneurship Competence Framework*," due to its high relevance, clear definitions, comprehensive

categorization of entrepreneurial skills, and an elevated number of citations (n=1080). The framework presents 15 competencies that are crucial for entrepreneurship and are divided into three categories: "*Ideas and Opportunities*," "*Resources*," and "*Into Action*." Its purpose is to guide educators, trainers, and policymakers in supporting the development of entrepreneurial competences in individuals and organizations. After conducting the literature review on entrepreneurial skills, we were able to (a) gain a better understanding of the specific skills that are essential for individuals to become successful entrepreneurs and (b) analyze and compare the skills that are unique to entrepreneurship with those that are shared with the industrial design profession.

The 15 entrepreneurship competencies according Bacigalupo et al. (2016) are:

1. *Spotting opportunities*
2. *Creativity*
3. *Vision*
4. *Valuing ideas*
5. *Ethical and sustainable Thinking*
6. *Self-awareness and self-efficacy*
7. *Motivation and perseverance*
8. *Mobilizing resources*
9. *Financial and economic literacy*
10. *Mobilizing others*
11. *Taking the initiative*
12. *Planning and management*
13. *Coping with uncertainty, ambiguity, and risk*
14. *Working with others*
15. *Learning through experience*

2.4 THE FRAMEWORK

After determining the required skills for each discipline, we summarized and classified the data to distinguish commonalities and distinctions between them. We meticulously analyzed, grouped, and sorted through the assortment of skills, leading us to recognize eight fundamental skills that a designer-entrepreneur ought to possess. These skills have been itemized in the Results section.

2.5 SURVEY DESIGN

This study adopted a quantitative research approach, utilizing an anonymous and voluntary online survey with no compensation for participation. Prior to completing the survey, students were informed that there would be no negative consequences for declining participation. The study plan and survey questions were reviewed and approved by the IRB at Kansas State University under the IRB number IRB-11392

The survey consisted of three sections. The first section collected basic demographic information such as age, gender, academic year, and whether students were currently enrolled in industrial design and had taken or planned to take entrepreneurship courses.

The second section of the survey aimed to explore the participants' level of interest and perceived importance of entrepreneurship in design. Using a Likert scale, the survey asked a series of questions to measure these aspects. The Likert scale is a widely accepted method for measuring human attitudes in an empirical manner; it provides a framework for individuals to articulate their opinions or levels of agreement/disagreement on a set of statements related to the assessed attitude (Joshi, A., et al. 2015). Additionally, students were also asked if they identified themselves as an entrepreneurial person, and their preferred career path in design, whether it be working as a freelancer or consultant, starting their own business, joining a design studio, or working for a company. The survey questions and grouping are presented in the results section.

In the final section, the authors applied the Design-Entrepreneur framework (which will be introduced in the results section) to formulate a series of statements for the surveyors to assess using a Likert scale ranging from strongly disagree to strongly agree.

2.6 PARTICIPANTS

Between February and March 2023, the authors conducted an online survey that targeted both undergraduate and graduate students enrolled in the Industrial Design program at Kansas State University. The university's program is unique in that it offers a comprehensive 5-year Masters of Industrial Design program, which consists of three years of undergraduate studies and two years of graduate-level courses. Notably, the first year is a foundational year that follows a standardized curriculum across various disciplines, including Architecture, Regional and Community Planning, Landscape Architecture, Interior Architecture, and Industrial Design, where students complete shared projects and curricula. To ensure that the survey targeted the appropriate students, the authors focused on students who had entered the Industrial Design program during their 2nd through 5th years. The survey was sent to a total of 41 students and received 22 valid responses.

3. RESULTS

3.1 INITIAL LITERATURE REVIEW

The results of our initial literature review revealed that no previous research had been conducted on the specific topic of design-entrepreneurship, which provided a unique opportunity for us to delve deeper and develop a comprehensive framework. Our framework is expected to be a valuable tool for academia, government agencies, and industry professionals to gain a better understanding of the skills necessary to succeed as a design-entrepreneur. The next step was to carry out a discipline-specific literature review.

3.2 INDUSTRIAL DESIGN AND ENTREPRENEURSHIP SKILLS LITERATURE REVIEW

Through the second and third literature reviews conducted for this study, a comprehensive search for skills and competencies specific to industrial design and entrepreneurship was performed. This individualized approach enabled us to analyze and understand these skills separately, and then to unify them to better understand the overlaps and unique requirements of each discipline.

We found that both industrial design and entrepreneurship require a similar range of soft skills, including opportunity identification (the ability to identify and evaluate potential opportunities), idea generation and evaluation (the ability to generate and evaluate ideas), problem-solving (the ability to

identify and analyze problems and find effective solutions), planning and management (the ability to plan and organize work and resources), teamwork (the ability to collaborate effectively with others), perseverance (the ability to persist in the face of challenges and setbacks), management of uncertainty (the ability to cope with ambiguity and risk), learning through experience (the ability to learn from experience), and resourcefulness (the ability to find creative solutions to problems) among others. However, we also identified some unique skills specific to each discipline. For instance, industrial designers are expected to have strong product development skills, including an ability to identify and understand user needs and translate those into functional and aesthetically pleasing products, or understand product semantics. On the other hand, entrepreneurs are expected to have a solid understanding of business models, financial management, and risk-taking.

Furthermore, in our literature reviews, we found that Industrial design had a strong emphasis on skills associated with communication aspects, such as verbal, written, and visual presentation. While entrepreneurship had a strong emphasis on self-awareness and self-efficacy, motivation, and perseverance, and coping with uncertainty, ambiguity, and risk. However, in the authors' view, these skills are equally important for both disciplines.

After careful consideration and analysis, we summarized and categorized the identified skills to create a comprehensive list of essential skills a designer-entrepreneur should possess (see Figure 1). Our final list includes the following eight skills:

- 1 **Problem-Solving:** This skill refers to the ability to identify, analyze, and solve problems effectively.
- 2 **Product Development:** This skill involves the capacity to identify and comprehend user needs and translate them into functional and aesthetically pleasing products.
- 3 **Planning, Management, and Business:** This skill encompasses the ability to conduct thorough research, plan, and organize work, processes, and resources effectively.
- 4 **Resourcefulness and Versatility:** This skill highlights the capacity to find creative solutions to problems and adapt to changing circumstances.
- 5 **Teamwork:** This skill emphasizes the ability to collaborate effectively with others to achieve common goals, either in a multidisciplinary or interdisciplinary team.
- 6 **Perseverance:** This skill refers to the ability to persist in the face of challenges and setbacks.
- 7 **Understanding:** This skill entails the capacity to perform research and gain an understanding of the industry, market, and trends, as well as the ability to empathize with users and comprehend their needs.
- 8 **Communication:** This skill involves the ability to communicate effectively to all stakeholders, including verbal, written, and visual communication.

Each of these skills is crucial for success in the designer-entrepreneur field, and together they form a comprehensive set of competencies that can guide the development of educational programs and training initiatives for individuals interested in pursuing this career path.

DESIGNER-ENTREPRENEUR FRAMEWORK



Figure 1 The figure depicts the combination of Industrial Design skills, represented by blue tags (totaling nine skills), and Entrepreneurship skills (Bacigalupo et al., 2016), represented by red tags (totaling fifteen skills), in order to illustrate the composition of the eight design-entrepreneur skills in the proposed framework.

3.3 SURVEY RESULTS

The survey questions were developed according to the proposed framework. Out of the total number of students who received the survey, 23 industrial design students answered. However, one response was incomplete and therefore excluded from the study. The remaining 22 completed surveys consisted of 15 male and 7 female students. The age range of the participants was between 20 to 24 years old, with 4 students being 20 years old, 6 students being 21 years old, 7 students being 22 years old, 3 students being 23 years old, and 1 student being 24 years old. Out of the participants, 10 were at the undergraduate level, including 3 sophomores and 7 juniors. The remaining 12 participants were graduate-level students, with 7 being seniors and 5 being in their graduate year.

The survey responses in the following sections indicate the participants' perceptions of their problem-solving, product development, planning, management, and business, resourcefulness, and versatility, teamwork, perseverance, and understanding skills, using a Likert scale ranging from "Strongly Disagree" to "Strongly Agree." Only seven of the eight skills in the framework were included in the survey. The authors did not evaluate communication skills in this survey since all the surveyed students had completed at least three semesters of courses that covered the fundamentals and advanced techniques necessary for developing visual, verbal, and oral communication skills.

3.3.1 Problem-Solving

Table 1: Questions related to problem-solving skills according to the Likert scale.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I can easily synthesize the information relevant to design challenge and find solutions	0	0	1	17	2
I can easily spot opportunities from given challenges from various perspectives to come up with multiple solutions.	0	1	7	8	4
I am good at taking initiative to find problems that are very challenging to solve.	0	2	6	8	4
I can come up with alternative solutions to given problems and evaluate the generated ideas for a better solution.	0	0	1	15	4

Table 1 presents the statements associated with problem-solving skills. In terms of problem-solving, the majority of respondents generally rated themselves high in their ability to synthesize information relevant to a design challenge and find solutions, with 2 participants strongly agreeing, 17 participants agreeing and only 1 “Neither agreeing nor disagreeing. However, they were less confident in their ability to spot opportunities from given challenges from various perspectives to come up with multiple solutions, with 4 strongly agreeing, 8 agreeing, 7 neither agreeing nor disagreeing and 1 disagreeing. We identified similar results associated with taking the initiative to find problems that are very challenging to solve, with 4 students strongly agreeing, 8 agreeing, 6 neither agreeing or disagreeing, and 2 disagreeing. Finally, respondents rated very high in their confidence to come up with alternative solutions to given problems and evaluate the generated ideas for better solutions with 4 strongly agreeing, 15 agreeing, and only 1 neutral.

3.3.2 Product Development

Table 2: Questions related to product development skills according to the Likert scale.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am a strong believer in my design skills and talents.	0	2	7	6	5
When I receive critical criticism, I'm skilled at gathering useful information and connecting it to improve my design.	0	2	4	10	4
I am good at executing my design based on critical feedback.	0	1	4	12	3

Regarding product development, the results were more distributed but with most respondents being confident about their abilities. In terms of believing in their skills and talent, 5 students strongly agreed and 6 agreed with the statement while 7 were neutral and 2 disagreed. Moreover, 10 participants agreed or strongly agreed that they were skilled at gathering useful information and connecting it to improve their design when they received critical criticism, and only 4 neither agree or disagree and 2

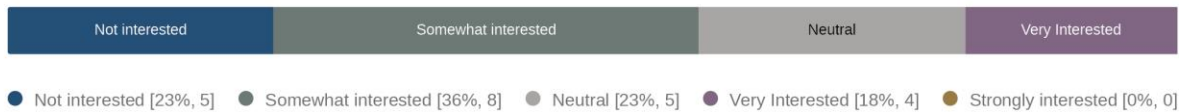
disagree. Additionally, 15 participants agree or strongly agree that they were strong in their design skills and talents and only 4 stayed neutral and 1 disagree.

3.3.3 Planning, Management, and Business

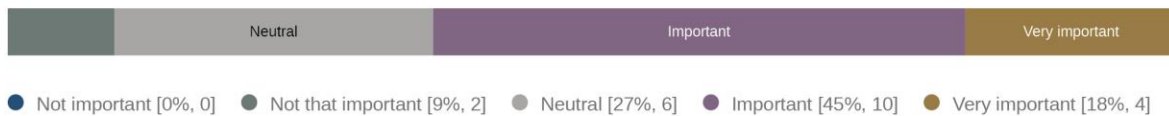
Did you take classes on entrepreneurship or business?



Are you interested in economics and business management?



How do you think of the importance of entrepreneurship in design?



Would you identify as an entrepreneurial person?



Which option appeals to you more when it comes to your career in design: working as a freelance or consultant, starting your own business, joining a design studio, or working for a company?

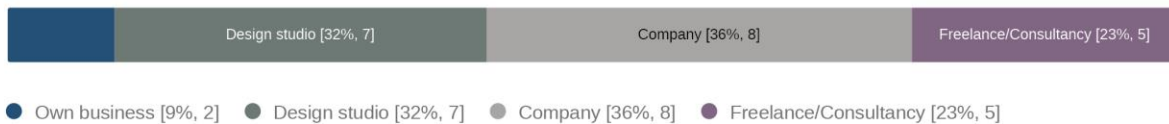


Figure 2: Survey responses of students interests in entrepreneurship and business and future career choices.

In relation to planning, management, and business, the majority of students (82%, n=18) had taken courses in this area, while only a minority of students (14%, n=3) did not have any prior training or coursework in this field. A small percentage of the surveyed students (5%, n=1) indicated that they were planning to take courses in business, suggesting a potential interest in further developing their knowledge and skills in this area.

The survey results reveal a noteworthy inclination towards business and entrepreneurship among the student population; a significant percentage (63%) of respondents considered entrepreneurship to be important or very important in the field of design, with only a small fraction (9%) indicating that it is not important. In addition, a majority of the students (59%) agreed or strongly agreed to being identified as an entrepreneurial person. Despite this interest in business and entrepreneurship, the majority of students (68%) expressed a preference for traditional career paths, such as working for a company or a

design studio. Only a small percentage (9%) reported an interest in starting their own business or pursuing freelance/consultancy work.

Table 3: Questions related to planning, management, and business skills according to the Likert scale.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am good at thinking beyond the current context and come up with better solutions for the future.	1	2	8	8	1
I am good at gathering required resources to execute a solution.	0	1	4	12	3

Table 3 displays the responses obtained for two questions pertaining to Planning, Management, and Business. For the first question, *"I am good at thinking beyond the current context and come up with better solutions for the future,"* a narrow majority of the respondents (9) either agreed or strongly agreed with the statement, a close number of students neither agree or disagree (8) and three students disagree or strongly disagree.

In the second question *"I am good at gathering required resources to execute a solution."* The majority of the participants agreed or strongly agreed with the statement with only 4 staying neutral and 1 disagreeing. These results suggest that the surveyed participants possess some level of competence in gathering resources and executing solutions but do not have strong skills when it comes to thinking beyond the current context to come up with better solutions for the future.

3.3.4 Resourcefulness and Versatility

Table 4: Questions related to the resourcefulness and versatility skills according to the Likert scale.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am able to develop purposeful ideas even with a limited budget and economic constrains	0	3	4	11	2
I am good at trying multiple ideas to solve given problems even with limited resources	0	4	4	9	3
I excel when my project has a lot of constraints because I can work around them and find creative solutions.	1	2	4	9	4

In regard to the skills of Resourcefulness and Versatility, the results suggest that the majority of the participants agreed or strongly agreed that they can develop purposeful ideas even with limited budgets and economic constraints. Specifically, 13 participants agree or strongly agree, 4 stayed neutral, and only 3 participants disagree with the statement.

Similarly, the majority of the participants (9 agreed and 3 strongly agreed) reported that they are good at trying multiple ideas to solve given problems even with limited resources. On the other hand, only 4 participants disagreed and 4 stayed neutral with this statement.

In terms of excelling in projects with constraints, the results were more varied. While 9 participants agreed and 4 strongly agreed that they can work around constraints and find creative solutions, 2 participants disagreed and 1 strongly disagreed.

Overall, the results suggest that the participants feel confident in their ability to work with limited resources and constraints to develop purposeful ideas and solve problems. However, it is worth noting that there is some variability in the responses in comparison to the results in other skills.

3.3.5 Teamwork

Table 5: Questions related to teamwork skills according to the Likert scale.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
After I make a mistake, I readily admit it and try my best to make amends.	0	0	1	15	4
I work well in inter/multidisciplinary teams.	0	3	4	11	2
When I settle on a solution, I implement it regardless of other’s negative feedback.	1	10	7	1	1
I am good at leading a team and inspiring team members to embrace their ideas.	0	4	5	6	5

Table 5 presents the results related to Teamwork skill. The first row of the table indicates that the majority of the participants (19) agree or strongly agree that are good at admitting when making a mistake and trying their best to make amends, only 1 student remained neutral. This is a very positive result as staying honest and ready to admit mistakes is a key component for the successful development of any company.

The second row of the table shows more distribution in the results with 13 students agreeing or strongly agreeing with the statement that they work well in inter/multidisciplinary teams and with 4 students staying neutral and 3 disagreeing. Although lower than expected, this is still a very positive result, the ability to work with others from diverse backgrounds and disciplines is essential for design-entrepreneurs.

The third row of the table indicates that the majority of participants (10) disagreed with the statement "When I settle on a solution, I implement it regardless of others' negative feedback". This is a positive result, as it suggests that participants are open to feedback and are willing to consider alternative solutions. However, the 7 participants who neither agreed nor disagreed with the statement require further investigation to understand their perspective on this matter. It is also worth noting that 2 students agree and strongly agree with the statement.

Finally, the last row of the table indicates that the majority of participants (11) agreed or strongly agreed that they are good at leading a team and inspiring team members to embrace their ideas. This result is promising, as it suggests that a significant proportion of participants possess the necessary skills and qualities to effectively lead and motivate a team. However, it is also worth noting that 4 students disagreed with the statement and 5 stayed neutral.

3.3.6 Perseverance

Table 6: Questions related to perseverance skills according to the Likert scale.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am good at maintaining an optimistic attitude throughout the design process.	2	4	4	6	4
I am good at learning from mistakes and using them as lessons to be better.	0	2	3	9	6
I am good at staying put in uncertain, ambiguous, and risky environments.	1	4	4	7	4

The first row of table 6 shows the responses to the statement *"I am good at maintaining an optimistic attitude throughout the design process."* The majority of participants (6) agreed with this statement, whereas 4 participants strongly agreed, 3 stayed neutral, 4 participants disagreed and 2 strongly disagreed. The analysis reveals that the participants demonstrated a moderate level of optimism, indicating that this may be one of the weaker areas among the competencies assessed. A strong mindset and a positive outlook are crucial traits for successfully navigating uncertainty and overcoming challenges in the design process.

The second row of the table shows the responses to the statement *"I am good at learning from mistakes and using them as lessons to be better."* The majority of participants (9) agreed with this statement, and 6 participants strongly agreed, and only 2 disagreed, indicating that overall, the surveyed students have a growth mindset and are willing to learn from their mistakes to improve their skills.

The third row of the table shows the responses to the statement *"I am good at staying put in uncertain, ambiguous, and risky environments."* Most of the participants (13) agreed or strongly agreed with this statement, while 5 participants disagreed or strongly disagreed. This suggests that participants have some ability to deal with uncertainty and risk, which is an essential trait in the fields of industrial design and entrepreneurship. However, the number of participants who strongly disagreed with this statement indicates that some individuals may struggle with the ambiguity and risk inherent in design projects.

3.3.7 Understanding

Table 7: Questions related to understanding skills according to the Likert scale.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I believe there are two sides to every issue and attempt to consider both.	0	1	4	7	8
I find it easy to put myself in somebody else's shoes.	1	0	6	11	2
I am good at listening to other's perspectives and deciding how best to proceed with the idea.	0	0	3	16	1

Table 7 presents the results for the "Understanding" skill, which includes the ability to consider multiple perspectives and empathize with others.

A majority of participants (15) either agreed or strongly agreed with the statement that indicated that there are two sides to every issue, and they attempt to consider both, only 4 students stayed neutral and 1 disagreed. This result is encouraging since it shows that they have a good understanding of the

importance of considering different viewpoints when analyzing a problem or dealing with complicated issues.

The second row shows the responses to the statement *"I find it easy to put myself in somebody else's shoes."* The majority of participants (13) agreed or strongly agreed with this statement, indicating that they have the ability to empathize with others. However, there were also 6 participants who neither agreed nor disagreed, and one that strongly disagreed, suggesting that there may be some variability in the participants' ability to empathize.

The third row of the table shows the responses to the statement *"I am good at listening to other's perspectives and deciding how best to proceed with the idea."* The vast majority of participants (17) agreed or strongly agreed with this statement, suggesting that they possess the necessary skills to listen and evaluate other perspectives when making decisions.

4. DISCUSSION

In this study, our aim was to enhance the current literature on the competencies necessary for industrial designers to effectively transition into design-entrepreneurs. By conducting a thorough analysis of the unique skills and competencies required in both industrial design and entrepreneurship, we have formulated a comprehensive framework that presents a holistic perspective on the essential skills industrial designers must possess in order to thrive as successful design-entrepreneurs. Identifying these skills is of utmost importance, as it allows individuals and organizations to prioritize and concentrate on the most relevant and crucial competencies needed. These skills include Problem-Solving, Product Development, Planning, Management and Business, Resourcefulness and Versatility, Teamwork, Perseverance, Understanding, and Communication. This framework serves as a valuable resource for educators, practitioners, and policymakers who are interested in developing programs or policies that can support the transition of industrial designers to design-entrepreneurship.

4.1 Survey Analysis

One of the key elements of this study is the survey that was developed based on the presented framework.

The survey results demonstrate a predominantly positive outlook, indicating that students feel well-prepared in most of the eight assessed skills. This outcome is consistent with expectations, given that a substantial proportion (82%) of the participants had received prior instruction in entrepreneurship and business, and that the majority (55%) of the participants self-identified as having an entrepreneurial mindset. It is noteworthy to mention that the Industrial Design program at Kansas State University has been intentionally structured to emphasize entrepreneurship, with students required to complete a minimum of two core entrepreneurship courses offered by the Business College. Some students even pursue a minor in entrepreneurship, further demonstrating the program's dedication to cultivating entrepreneurial skills and knowledge.

Regarding Problem-Solving skills, it is evident that the majority of students demonstrated a high level of proficiency in synthesizing information and developing solutions to given problems. However, the results indicate that students are less confident in their ability to identify opportunities. This may indicate a lack of understanding of the early phases of the design process and how to conduct research effectively to identify valuable design and business opportunities. This could be addressed by emphasizing problem-identification efforts during the research phases of the design process.

In the domains of Product Development and Resourcefulness and Versatility, students' perceptions of their design skills and abilities were considerably divergent. A significant proportion of students (9 students) disagreed or remained neutral regarding their design skills and aptitude, indicating a possible lack of confidence in their abilities. When it came to executing their designs based on critical feedback, however, the majority of students concurred or strongly agreed, indicating an open-minded attitude that welcomes constructive criticism and incorporates adjustments to improve their designs. In addition, the results of the survey revealed that students demonstrated exceptional resourcefulness and adaptability when confronted with limited budgets, resources, and constraints. This ability to modify and remain flexible within such constraints is of the utmost importance for design-entrepreneurs, as it enables them to quickly adapt to different circumstances and iterate on their ideas until they arrive at the best solutions (Maritz, A., Perényi, Á., & Waal, G.A., 2021). These results highlight the importance of developing students' conviction in their design abilities and nurturing an open-minded attitude toward receiving and implementing feedback. In addition, the demonstrated resourcefulness and adaptability indicate that the students have the potential to excel as design-entrepreneurs by navigating constraints and addressing design challenges creatively.

In the field of Planning, Management, and Business, the results suggest that although students may not necessarily pursue entrepreneurial ventures, they acknowledge the significance of acquiring expertise and abilities in entrepreneurship and business as part of their education. As educators, it is essential to ensure that students are adequately prepared to succeed in a variety of career paths available to industrial designers, whether these paths align with or deviate from conventional expectations. Offering a comprehensive education is key to providing students with all the necessary knowledge, skills, and tools for them to succeed regardless of their career choices.

Regarding Teamwork and Perseverance skills, the results of the survey indicate that students are well-prepared to generate solutions within inter- and multidisciplinary teams. Students' confidence in undertaking leadership roles within a team, on the other hand, exhibited an intriguing divide. This division may be due to a lack of knowledge, lack of self-confidence, or individual personality traits. There is a need for additional research to fully comprehend the implications of these findings, as design-entrepreneurs are frequently responsible for managing teams with diverse expertise (Libânio, C.D., & Amaral, F.G. 2013). Incorporating leadership courses into the design curriculum could equip students with the necessary skills and self-assurance in this area.

In addition, it appears that students may struggle to maintain a positive outlook throughout the design process and to persevere in uncertain, ambiguous, and risky circumstances. This suggests a potential lack of proficiency in the "perseverance" skill, which is crucial for effectively leading a company and a team. Working for a small business requires significant responsibilities and the mental fortitude to overcome obstacles and challenges (Duran-Whitney, M. 2004). Therefore, the results indicate that a greater emphasis must be placed on developing students' confidence and perseverance. Establishing a positive studio culture that encourages a resilient mindset and provides students with the necessary support they need to overcome obstacles could be an effective method for achieving this objective. It would be crucial that this culture be fostered not only by the willingness and motivation of professors and staff but also by the students' attitude and mindset, which should promote mutual assistance and collective success.

In terms of the Understanding skill, students exhibited a noteworthy inclination towards considering multiple perspectives and demonstrating empathy. These qualities hold significant value for design entrepreneurs, as comprehending user needs and desires is essential for devising novel and impactful solutions. The outcomes of the survey imply that our program's robust emphasis on design thinking and user research effectively equips students with the skills necessary to excel as empathetic designers. Although the survey conducted in this study provided valuable insights into the present skill levels of the student population, it is important to acknowledge that other methods may provide a more accurate depiction of true student performance. As Industrial Design is a practice-driven discipline, it is important to consider additional evaluation methods that can more comprehensively assess students' performance, skills, and knowledge.

One potential approach could be to implement the skills identified in the framework developed in this study as a benchmark for evaluating students' design projects and assignments. By incorporating these specific skills into the evaluation criteria, instructors can more accurately assess the extent to which students are able to demonstrate the desired competencies and effectively apply them in real-world design challenges. Furthermore, by utilizing a range of evaluation methods, instructors can gain a more accurate understanding of students' performance and ensure that they are well-equipped to succeed as design professionals in the future. The authors believe that this framework could set the basis for further studies in the fields of design and entrepreneurship.

5. CONCLUSION

The framework developed in this study offers a comprehensive approach to assessing the skills and competencies required for students in the Industrial Design program to become design-entrepreneurs. The survey results provide valuable insights into the strengths and weaknesses of current students in these areas, which can be used to inform future curriculum development and evaluation. Moreover, this study bridges the gap between disciplines by highlighting the similarities and small but crucial skillset differences. This knowledge can benefit educational practices, incubators, and corporations seeking to promote intrapreneur initiatives.

For educational practices, the identified framework can serve as an excellent basis for developing new courses or interdisciplinary collaborations. In the context of incubators, it could provide a useful guideline for understanding design-entrepreneur skills from an industrial design perspective, facilitating the development of design-intensive startups. For companies, the study can assist in understanding their workforce and promoting out-of-the-box thinking within the company.

Overall, this study contributes to the growing body of research on the skills and competencies necessary for success as a design-entrepreneur. Future studies can explore (a) strategies for implementing and teaching these skills in an industrial design and entrepreneurship class, (b) alternative methods of assessing the student population to understand the level of skills, and (c) conducting case studies to better bridge the gap between industrial design and entrepreneurship disciplines.

6. REFERENCES

Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). *EntreComp: The entrepreneurship competence framework*. Luxembourg: Publication Office of the European Union, 10, 593884.

- Davis, M. H., Hall, J. A., & Mayer, P. S. (2016). Developing a new measure of entrepreneurial mindset: Reliability, validity, and implications for practitioners. *Consulting Psychology Journal: Practice and Research*, 68(1), 21.
- Duran-Whitney, M. (2004). Understanding Occupational Stress and Mental Health in Aspiring Small Business Owners. IDEO design thinking. IDEO. (n.d.). Retrieved April 9, 2023, from <https://designthinking.ideo.com/>
- Maritz, A., Perényi, Á., & Waal, G.A. (2021). The Importance of Resilience and Flexibility of Entrepreneur Characters for Coping with a Crisis Situation. A Systematic Literature Review During Covid-19. *European Journal of Business and Management*.
- NASAD. (2022). National Association Schools of Art and Design Handbook 2022-2023, NASAD, <https://nasad.arts-accredit.org/wp-content/uploads/sites/3/2023/03/AD-2022-23-Handbook-Final-02-28-2023.pdf>
- Libânio, C.D., & Amaral, F.G. (2013). Design Professionals Involved in Design Management: Roles and Interactions in Different Scenarios: A Systematic Review.
- Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert Scale: Explored and Explained. *Current Journal of Applied Science and Technology*, 7(4), 396–403. <https://doi.org/10.9734/BJAST/2015/14975>
- Joshua J. Daspit, Corey J. Fox & S. Kyle Findley (2023) Entrepreneurial mindset: An integrated definition, a review of current insights, and directions for future research, *Journal of Small Business Management*, 61:1, 12-44, DOI: 10.1080/00472778.2021.1907583
- Kier, A. S., & McMullen, J. S. (2018). Entrepreneurial imaginativeness in new venture ideation. *Academy of Management Journal*, 61(6), 2265-2295.
- Peschl, H., Deng, C., & Larson, N. (2021). Entrepreneurial thinking: A signature pedagogy for an uncertain 21st century. *The International Journal of Management Education*, 19(1), 100427.
- Teixeira, C. (2010). The entrepreneurial design curriculum: Design-based learning for knowledge-based economies. *Design Studies*, 31(4), 411-418.
- Thomas, J., & Canning, L. (2015). The value of creativity: implications for industrial design and design entrepreneurship. In *Embracing Entrepreneurship Across Disciplines* (pp. 149-170). Edward Elgar Publishing.
- What is entrepreneurship? | Stanford online. (n.d.). Retrieved April 9, 2023, from <https://online.stanford.edu/what-is-entrepreneurship>
- What is Industrial Design? Industrial Designers Society of America. (2023). Retrieved April 9, 2023, from <https://www.idsa.org/about-idsa/advocacy/what-industrial-design/>