MAPPING TRENDS IN U.S. INDUSTRIAL DESIGN EDUCATION: SYSTEMATIC REVIEW OF MASTER THESES/FINAL PROJECTS

Byungsoo KIM and Yuanqing TIAN
North Carolina State University, United States of America

ABSTRACT
This study aims to understand emerging trends in recent theses/final projects (2022 to 2024) from the U.S. master's programmes in Industrial Design. The study conducted a systematic review to analyse the theses/final projects. 94 theses/final projects from the 10 universities were reviewed based on inclusion/exclusion criteria. The results of the paper include the trends of 1) research types, 2) topic of interest, 3) targeted user group types, 4) product and outcome types, 5) technology involvement, 6) utilised research methods and terms, and 7) relationship of the identified trends. By mapping out the trends of recent ID master theses/final projects, this study contributes to reflecting and shaping the evolving landscape of ID education.

Keywords: Design education trends, master thesis, final project, research methods, design and research topics

1 INTRODUCTION
Industrial Design (ID) education has broadened significantly to address complex issues emerged in today's world. This transition responds to technological, social, and cultural shifts, aligning with the pursuits and concerns of contemporary ID students. Also, rapid advancements in technologies and a growing interest in research-driven design opportunities allows ID students to explore complex issues related to human behaviour, advanced technologies, nature, and society. This study aims to understand emerging trends in recent theses/final projects (2022 to 2024) from the U.S. master's programmes in ID.

2 RESEARCH QUESTIONS
Main research question, "What trends can be observed in the outcomes of documented theses and final projects over the past three years?" was posed for this study. Secondary research questions are developed as follows: RQ1. Which types of design research (Research Through Design or Research for Design [1]) have been conducted for recent thesis/final projects? RQ2. What have been the main topics of interest of the recent thesis/final projects? RQ3. What user groups have been targeted from the recent thesis/final projects? RQ4. What types of outcomes have been produced from the recent thesis/final projects? RQ5. What are the advanced technologies utilised in the recent thesis/final projects? RQ6. Which methodologies and terms have been used for the recent thesis/final projects? And RQ7. What are the relationships between the identified trends?

3 METHODOLOGIES
A systematic review process was employed in a structured manner as follows: 1) framing questions, 2) identifying relevant work, 3) assessing the quality of studies, 4) summarising the evidence, and 5) interpreting the findings [2], [3].
Using search engine on the Industrial Designers Society of America (IDSA) website (Keywords: "Industrial Design," Location: "All," Degrees Offered: "Masters," NASAD Accredited: "All") [4], 17 universities were identified as having an ID Master's Programme. The collected documents, about 150, were reviewed to be sorted out based on the inclusion criteria. The theses/final projects must have committee chair(s) from the ID department [5] and have been accomplished from 2022 to 2024.
The collected documents were carefully reviewed for analysis and coding. To answer other RQs, the summarised keywords or predefined coding for each category were documented in different excel

sheets. More detailed clarifications are included in Section 4, Results. A thematic analysis was conducted to qualitatively synthesise the collected data [6]. Any adjustments were discussed and resolved collaboratively by the authors throughout both coding cycles.

4 RESULTS

Based on the inclusion criteria, 94 theses/final projects (number of theses=89, final projects=5) documented from 10 different university systems were selected for review. The universities are as follows: Auburn University (Auburn), University of Cincinnati (Cincinnati), Georgia Institute of Technology (GT), Iowa State University (ISU), Ohio State University (OSU), Purdue University (Purdue), Rochester Institute of Technology (RIT), Syracuse University (Syracuse), University of Oregon (U Oregon), and University of Illinois Urbana-Champaign (UIUC). In response to the seven secondary RQs, the following sections show a basic descriptive statistical analysis results manifesting the central tendency of each reviewed category with statistical results of percentages.

4.1 Types of design research

The reviewed documents were categorised into Research Through Design or Research for Design [1]. 73.4% of the theses/final projects focused on Research for Design, emphasising the development of new artifacts or services. Meanwhile, 26.6% of the reviewed documents took a Research Through Design approach, aiming to contribute to the body of knowledge within the design or education field. When observing the yearly trend, the proportion of Research Through Design has steadily increased: 20.93% in 2022, 24.14% in 2023, and 38.10% in 2024. This highlights the growing emphasis on academic design research in recent theses and final projects.

4.2 Topics of interest

The collected data regarding topics of interest were further refined into nine topics of interest [7][8][9]. Table 1 summarises the theme labels, their descriptions, and statistical results. Note that certain theses/final projects were identified to have two themes crossed, resulting in double counts of data (total double counted n=154).

Table 1. The definition and statistical results of Topics of Interest

Topics of Interest	Description	Frequency	Percentage
Consumer Products, Services, and Systems	Design for consumer-focused products, services, and integrated user experiences.	35	37.2%
Education, Learning, and Working	Tools and technologies supporting education, skill development, and learning assistance.	27	28.7%
UX, Interface, and Interaction	Focus on user experience, interaction, and intuitive interface design across platforms.	21	22.3%
Health, Wellness, and Ergonomics	Innovations in healthcare, wellness, assistive technologies, and ergonomic design to enhance quality of life.	20	21.3%
Sports, Gaming, and Play	Designs that enhance recreation, entertainment, active lifestyles, and interactive consumer experiences.	19	20.2%
Mobility, Travel, and Transportation	Solutions that improve transportation, accessibility, and overall mobility experiences.	11	11.7%
Social, Cultural, and Ideological Impacts	Exploration of social, cultural, and ideological effects within design and technology.	10	10.6%
Sustainability and Environment Concerns	Efforts towards environmental responsibility and sustainable design practices.	9	9.6%

Public Spaces, Community, and Accessibility	Enhancements in community spaces, public engagement, and accessible design.	2	2.1%

4.3 Targeted user groups

Five themes of targeted user group types emerged. See Table 2 for detailed descriptions and statistical results. Note that certain documents involved more than one user group, such as combining both demographic and occupational factors, resulting in double counts of data (total double counted n=106).

Table 2. The definition and statistical results of Targeted User Groups

Targeted User Type Theme	Description	Frequency	Percentage
Occupational-based Users	Based on professional or vocational roles.	35	37.2%
Demographic-based Users	Based on demographics, such as age, gender, ethnicity.	22	23.4%
Minors & Underrepresented Users	Based on limitations and vulnerabilities, such as health concerns or accessibility challenges.	20	21.3%
Activity-based Users	Based on specific activities or interests.	18	19.1%
General Public	No specific constraints for targeted users.	11	11.7%

4.4 Product and outcome types

The product type and the outcome type were identified during the attribute coding, each including four types (see Table 3). The product type refers to the proposed design concept in the project, while the outcome type refers to the delivered prototype formalities. Certain documents delivered product and outcome types in combination, such as a physical product (P) with a mobile App (D), and both Experimental Prototype (EP) and Appearance Model (AM) [5] (Product type total n=94, outcome type total double counted n=146). See Table 3 for statistical results.

Table 3. The definition and statistical results of Product and Outcome Types

Product Type	Description	Frequency	Percentage	Outcome Type	Description	Frequency	Percentage
P	Physical Product	39	41.5%	PR	Presentation Rendering	54	57.4%
C	Combined Product	25	26.6%	EP	Experimental Prototype	50	53.2%
N	Non-Product	16	17.0%	AM	Appearance Model	24	25.5%
D	Digital Product	14	14.9%	ADR	Guidelines, Framework, Theories	18	19.1%

4.5 Technology involvement

In total, 29 (30.8%) of documents involved emerging technologies, encompassing in total five themes as described in the following Table 4 [10]. Five documents involved more than one technology type such as using both sensor technology and AI tools. See Table 4 for statistical results.

Table 4. The definition and statistical results of Technology Involvement

Technology Theme	Description	Frequency	Percentage

Smart Sensing and Health Monitoring Applications	Tools and devices that monitor environmental and physiological conditions, geared towards health and personal data insights.	9	31.0%
AI and ML Applications	AI-driven systems and their applications across virtual, interactive, and health-focused settings, including AI for generative tasks, virtual assistants, and interactive tools.	8	27.6%
IoT and Networked Devices	Connected devices / systems that enable networked functionalities and enhanced user interactivity through IoT and related smart technologies.	7	24.1%
Immersive and Interactive Technologies	Technologies that create interactive, immersive experiences through VR, AR, and digital interfaces.	5	17.2%
Advanced Fabrication and Material Innovation	Material manipulation and innovative fabrication, particularly in textiles, printing, and custom parametric designs.	5	17.2 %

4.6 Utilised methods and terms

The thematic analysis revealed methods and terms utilised to identify users' needs and develop design solutions (see Table 5). Note that most theses/final projects involved more than one method and design/research term, resulting in double counts of data (total double counted n=263).

Table 5. Methods and terminologies categorised by themes

Theme	Methods/Terms	Frequency	Percentage
Design and Prototyping	Prototyping, Cut and Sew, Patterning, 3D Printing, Sketch + Illustration, High-fidelity Prototype, Low-fidelity Mock-ups, Rapid Prototyping, Foam Making, Resin 3D Printing	69	26.2%
Interview and Observation	Interviews (general), Semi-Structured Interviews, Ethnography through Observation and Informal Interviews, Observation, User Observation	45	17.1%
Analysis and Evaluation	Thematic Qualitative Data Analysis, Hierarchical Task Analysis, Competitive Analysis, Comparative Analysis, Evaluation (Interview), Coding Analysis, Form Development, Heuristic Evaluation	33	12.5%
User and Usability Testing	User Testing, Usability Testing, Pilot Testing, Testing Environment	30	11.4%
Survey and Questionnaire	Survey, Survey Questionnaire, Online Survey, Feedback Survey, Screener Survey	26	9.9%
Collaborative and Participatory Design	Co-Design, Participatory Design, Speculative Design, Focus Group	22	8.4%
Case Study and Literature Review	Case Study, Literature Review, Supplementary Case Study	17	6.5%
Journey Mapping and Persona Development	User Journey Map, Journey Map, Persona, Customer Journey Mapping	13	4.9%

Expert Review and Validation	Expert Review, Expert Interviews, Validation Testing	8	3.0%

4.7 Relationship among topic, product, and outcome types

A further analysis explored the relationship among the topics of interest, product types, and outcome types, as shown in the Sankey Diagram (Figure 1). Conventional ID project topics typically lead to physical, digital, or combined product types, with delivering tangible outcomes (e.g., EP, AM, and PR) accounted for 70.21% in total. Besides, a considerate portion (17.02%) of outcomes were non-product designs (N) with non-tangible deliverables (mainly ADRs). This ratio outperforms the pure digital product designs (D) (14.90%). These ADR outcomes are primarily associated with the themes of "Education, Learning, and Working", "Social, Cultural, and Ideological Impacts", and "Sustainable and Environmental Concerns", in a more conceptual and heuristic design space.

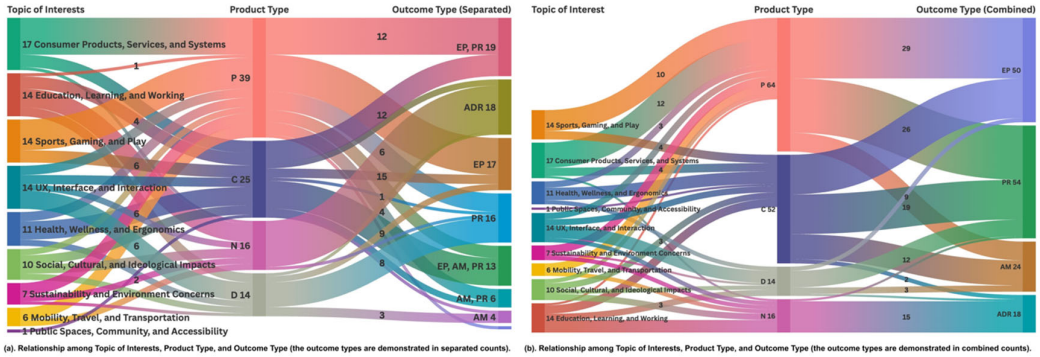

Figure 1. Sankey Diagram of relationship among topic of interests, product type, and outcome type

5 DISCUSSIONS

5.1 Design for or through research

The results highlight the growing emphasis on academic design research. 50% of schools integrated Research for Design [OSU (77.8%), ISU (71.4%), Cincinnati (54.5%), Auburn (50%) and GT (18.2%)], with GT showing rapid growth (0% in 2022, 2023 and 33.3% in 2024). Programmes could benefit from a structured curriculum that explicitly differentiates and teaches both approaches. This emphasis on design research in ID graduate level not only enriches academic experience but also broadens career prospects, equipping students to pursue roles as design researchers in addition to traditional practitioner roles.

5.2 Topics of interest and growing trends

Following the growing emphasis on academic design research, the study discovers a trend of multiple microscopic topics beyond traditional tangible design topics. ID graduate education is shifting toward broader and conceptual problem spaces, influencing graduate design project paradigms and outcomes. In addition, Trends highlight a shift to user-specific designs over general public solutions—a direction likely to grow with advances in technology and personalisation. The findings reveal a rising integration of the diverse qualitative methods, new terminologies and technologies. Non-product deliverables—such as guidelines, frameworks, and heuristics—are increasingly featured in ID master's final curations. This trend aligns with the emerging focus on "service design" in the ID education field [11].

5.3 Educating Specialist vs generalist

U Oregon specialised in sports, gaming, and playing, while other universities' documents were fairly well distributed in different topics of interest. It would be interesting to investigate the curriculum and courses differences between U of Oregon and other universities in future studies.

Also, the findings highlight cross-disciplinary topics, diverse user types, and the integration of multiple technologies, reflecting a trend toward both specialisation and inclusivity in ID topics. Educators can use this as inspiration to encourage students to explore infinite design opportunities and frame projects through a mix-and-match approach across themes, including niche and specialised markets.

6 CONCLUSIONS

This study, by reviewing the recent three-year ID master theses/final projects of 10 US programmes, maps out several distinct trends in multiple design aspects. The results highlight the growing trends of academic design research and expanding beyond conventional ID project outcomes. The insights from this study can steer future ID theses by illustrating how to match thematic interests with specific user groups and stressing a move toward targeted, human-centred design that foregrounds technology, sustainability, culture, social impact, and the expanding influence of AI on both process and concept. In general, this study expects to provide insights to ID design educators to adapt to contemporary and future design pedagogy in directing a broadened landscape of master programmes.

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