MORE-THAN-HUMAN DESIGN PEDAGOGIES IN INDUSTRIAL DESIGN: A SYSTEMATIC REVIEW

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ABSTRACT
Calls for a shift from anthropocentric approaches toward a more-than-human (MtH) perspective in design have emerged in response to environmental crises and rapid technological developments. Despite the expanding theoretical foundation of more-than-human design (MtHD), its practical application in industrial design remains limited, with a gap between theory and practice evident in its education. To foster the discipline-specific discussion on current pedagogical applications of MtHD, we conducted a systematic review of 29 papers from four databases that present examples and proposals for integrating MtHD into industrial design education. Two main findings emerge. First, although scholars share methods, tools, and theoretical frameworks, implementations rarely extend beyond early design phases such as immersion, and they provide limited evidence of long-term impact or applicability. Second, most papers rely on reflective accounts rather than systematic assessment of educational interventions, raising questions about transferability and measurable outcomes. We therefore argue for comparative process and product outcomes along with more rigorous evaluation of pedagogical practices to better articulate and communicate the value of MtH approaches in industrial design education.

Keywords: More-than-human design, industrial design, pedagogy, teaching, entanglement

1 INTRODUCTION
Social, ecological, and technological challenges resulting from the Anthropocene are compelling designers to act on multiple fronts. As an emerging paradigm developed in response to these issues, the more-than-human (MtH) perspective [7, 24] proposes moving beyond anthropocentric approaches by de-centering humans within the design process. This shift responds to address environmental crises, the growing influence of systems-oriented design thinking, and rapid technological changes that blur the distinctions between human and machine agency [11].
Building on posthumanism [12, 13] and various perspectives stemming from science and technology studies such as Actor Network Theory [15], the theoretical foundations of more-than-human design (MtHD) have expanded over the last decade, with a marked increase in scholarly contributions in the past five years.
Despite this growing theoretical base, the practical application in industrial design remains limited with methods and processes still underdeveloped [6]. This situation poses challenges for the profession grounded in practice.
A gap between theory and practical application is also evident in industrial design education. While there are ongoing curricula reformations [4] and a number of programs trying to incorporate MtHD in their pedagogical content [21, 23, 26], educators also share concerns about the long-term application and limited impact on design practice [1].
Within this scholarly context, the main contribution of our paper is to start a discipline-specific discussion on the current pedagogical applications of MtHD in industrial design education. To this end, we conducted a systematic review of 29 papers addressing the application of MtH perspectives in design education relevant to industrial design to answer two research questions: how MtH is applied in industrial design education and how it is made actionable.

2 METHOD
We conducted a systematic review following PRISMA workflow outlined by Moher et al. [19] to examine existing pedagogical work and discussions on MtH as they relate to the industrial design.

Searches were conducted across four databases. These were Web of Science, Scopus, ACM Digital Library, and Design Research Society (DRS) Digital Library.
The search query included three keyword groups: 1) terms related to MtH, 2) design as the term to indicate the field of study, and 3) terms associated with education. MtH related terms were iteratively refined to maximise relevance. We also kept the field of study term broad to avoid overlooking relevant work. All keywords were searched in the article abstracts which are shared in Table 1.

Table 1. Keywords used in the search query, with AND between rows

MtH related	"more-than-human" OR posthuman* OR "post-human" OR nonhuman OR "object-oriented ontology" OR multispecies OR “multi-species”
Field of study	design*
Education related	educat* OR teach* OR instruct* OR pedagog* OR curriculum OR studio OR student*

The search was conducted on 24 November 2025 and yielded 780 articles. Figure 1 presents the details of the paper inclusion and exclusion process. We excluded papers in languages other than English, workshop extended abstracts, entire proceedings volumes (i.e. compiled books without article-level indexing), and whole books (while including relevant chapters where applicable). However, individual peer-reviewed conference papers were included when they could be identified and accessed at the article level. We also eliminated papers from architecture, landscape architecture, interior design, and art, as their professional applications differ significantly from industrial design practice and their content was not relevant to industrial design education. Instead, we included papers addressing industrial design, product design, human-computer interaction, graphic design, communication design, interaction design, service design, and product-service systems and design more broadly without a disciplinary focus. Because our focus was on the educational implementation of MtHD, we included papers reporting studies carried out with students for education purposes, pedagogical experiences shared by scholars, and discussions on design education.
We reviewed 44 full papers that we initially considered eligible. Twenty were excluded during this stage. On the other hand, by examining the references of remaining papers, we identified five additional studies to include in our corpus.

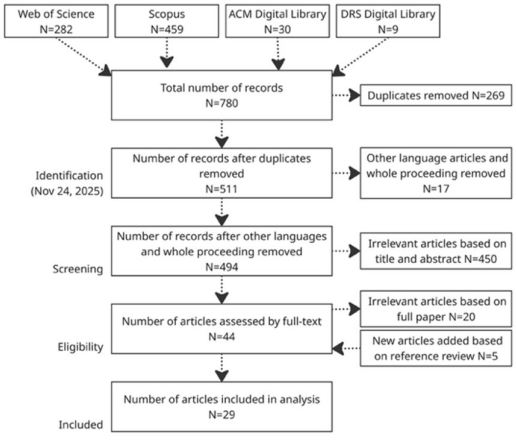

Figure 1. Article selection process flowchart

We conducted a qualitative analysis of the selected papers, complemented by a basic quantitative analysis mostly limited to their bibliographic information (e.g., publication year, number of citations). Coding categories were defined through team discussions based on trends observed in the literature. The resulting codebook consisted of four sections with a total of 24 coding categories: 1) bibliographic data (8 categories), 2) aspects of the MtHD pedagogical approach (9 categories), 3) paper methodology (5 categories), and 4) notes (2 categories). We distributed the papers equally among the authors and open coding was conducted for each category. The lead author then reviewed all coded content, grouped the codes in discussion with the rest of the team. Due to space limitation, we present a portion of the results

below. A complete list of 29 papers (instead of citing all individually, only representative examples are included to illustrate patterns) and the final codebook are available upon request.

3 RESULTS AND DISCUSSION

3.1 Corpus overview

Our corpus includes 29 papers, with conference papers the most common publication type (15 papers, including one poster). The corpus also includes nine journal articles and five book chapters.

The largest number of papers appeared in 2024 (N=10). The earliest paper in our database is by Morrison and Chisin [20] from 2017. This is also the most cited paper in the corpus (41 citations in Google Scholar as of the end of February 2026).

Only five of the articles explicitly define their field as industrial design or report studies involving industrial design students (sometimes with students from other disciplines). The remaining papers either do not specify a particular discipline, or they situate their work within fields such as human–computer interaction, technology studies, speculative design, creative sustainability, sustainable design, interaction design, UX and interface design, and product–service systems.

Five studies report work at the undergraduate level and seven at the graduate level, while four involve a mix of undergraduate and graduate students. The remaining papers either do not specify the educational level or discuss design education more generally.

3.2 Emphasising immersion as a gateway to MtHD

Across the corpus, studies primarily address the early phases of design, including *empathise*, *define*, and *ideate*. While some studies extend to the prototyping phase, the nature of this prototyping often differs from prototyping practices typically associated with conventional industrial design.

Across the reviewed papers, immersion-based activities emerge as the dominant entry point to MtHD. Many studies operationalise MtH perspectives through exercises targeting the *empathise* phase of design, repositioning students in relation to other species, nonhuman entities, ecosystems, or material systems. In terms of strategy, these approaches rely primarily on perspective-shifting activities such as increased interaction with nature [e.g., 18], multispecies ethnographies [e.g., 27], speculative scenarios [e.g., 16], and material explorations [e.g., 3]. This emphasis is not surprising, as many of the papers in our corpus focus on pedagogical work involving living beings (e.g., animals and plants) and natural phenomena (e.g., the natural world and environmental resources) and require empathy with nonhumans.

Most pedagogical implementations introduce MtHD through experiential reframing encouraging students to de-centre human perspectives before ideation or prototyping. This immersion is frequently facilitated through activities that prompt students to reconsider relationships among humans, objects, environments, and other living systems. These activities often draw on methods borrowed from other fields or adapt existing design tools for MtHD purposes. Examples include Tsing et al.'s [25] "arts of noticing" used to develop a better understanding of "marginalised things" [8]; speculative toolkits such as "Who Lives in the Future" [14], which encourage students to imagine alternative futures involving nonhuman stakeholders; and role playing with specially designed and prototyped probes to experience the world as if from a certain animal [18]. Such activities are typically framed as ways to challenge anthropocentric assumptions and cultivate sensitivity to interdependence and entanglement within design contexts.

At the same time, immersion activities tend to remain concentrated in the exploratory stages of the design process. In many cases, the pedagogical emphasis lies on reframing the problem space rather than advancing toward technically or commercially viable outcomes.

This tendency is also reflected in the types of prototypes reported. 12 of the 29 papers in the corpus report some form of prototyping. However, most of these outputs take the form of speculative narratives, conceptual artifacts, or scenario-based propositions rather than fully developed design solutions. Across cases, prototyping consistently takes the form of discursive outputs, for example, Beach and Fox's [2] students developed speculative value scenarios and design fiction artifacts (e.g. a digital zine and future-oriented design proposals) exploring human–nonhuman relations under climate change. These outputs function as discursive prototypes rather than technically resolved or industrially feasible solutions. This pattern is further reflected in Bergström et al. [3], wherein they share an exploration in which prototyping centres on hands-on experimentation with renewable gluten plastic, where students generated diverse material samples and exploratory artifacts by allowing the material to guide the creative process. Here, prototyping operates as an empathy-building, arts-based inquiry, foregrounding material agency and

sensory engagement, rather than as the development of functionally specified, production-ready industrial design outcomes.
This pattern also appears in Camozzi et al.'s study [5], where prototypes include storyboards, species cards used for embodied role-play, low-fidelity video prototypes, and artifacts taken outdoors for experimentation. For instance, students created species cards that prompted them to act as kelp, starfish, or other beings to understand ecosystem interdependence, and they developed simple physical prototypes that were tested at the water's edge or in local natural environments. These function primarily as pedagogical and relational tools to cultivate ecological awareness, rather than as technically developed products.
Consequently, the outcomes are often not viable products in the traditional industrial design sense, but conceptual explorations illustrating alternative relationships between humans and nonhuman actors. This pattern is further reflected in the limited coverage of later design stages. Within our corpus, only three studies address the testing phase of design. For instance, in Genç et al.'s study [10], testing involved implementing the card toolkit in a design course with 23 students to assess its ability to stimulate creative engagement with more-than-human perspectives, rather than evaluating the feasibility, durability, or performance of developed prototypes. Similarly, in another work [22], students engaged in iterative prototyping and testing of AI-enabled concepts within a studio course. However, the reported testing concerns how experiential exercises influenced students' design thinking and understanding of AI, as assessed through written reflections and interviews, rather than structured validation of prototype functionality, user experience, durability, or industrial viability. In this sense, testing operates as pedagogical iteration and reflective inquiry rather than as technical, comparative, or performance-based evaluation of design outcomes.
This raises questions about the potential implementation and industrial feasibility of the outcomes presented. Overall, the findings suggest that MtHD in industrial design education is currently operationalised primarily as an epistemic shift rather than as a transformation of the entire design process. Across cases, immersion is effective for reframing but rarely translates into implementation. While immersion effectively destabilises anthropocentric assumptions, its translation into later-stage decision-making, feasibility evaluation, and production considerations remains underdeveloped.

3.3 Reflective focus rather than systematic assessment

A second pattern concerns the methodological traditions underlying MtHD pedagogical research. The majority of the papers are strongly practice-based, reflective, and exploratory in nature. They document studio-based experiments, teaching interventions, workshops, or pedagogical reflections in which educators describe how MtHD perspectives were introduced and interpreted within specific course contexts.
In our corpus, only ten papers report explicit data collection methods, and only seven describe a data analysis strategy. This suggests that knowledge is often generated through situated practice, reflective inquiry, and iterative experimentation. Design projects (i.e., studio assignments or workshops) provide fertile ground for testing new concepts, reframing design problems, and encouraging students to engage with unfamiliar perspectives. As a result, many papers emphasise pedagogical experimentation and conceptual exploration as valuable outcomes in themselves, often presenting experiences as cases without being methodologically grounded in formal case study approaches.
This orientation also reveals a limited level of systematic assessment of educational outcomes. Few studies employ structured evaluation frameworks, and assessment is typically limited to reflective or qualitative feedback rather than comparative or performance-based measures. None of the studies in the corpus report comparative pedagogical research or longitudinal tracking of student learning. Evidence of impact is typically inferred from project descriptions [e.g., 18], instructor reflections [e.g., 2], outcome documentation [e.g., 17], or student feedback [e.g., 9] rather than from formalised assessment strategies or clearly defined learning metrics.
This methodological tendency suggests that MtHD pedagogy is currently in an exploratory stage characterised by strong pedagogical innovation but limited empirical consolidation. The reviewed studies demonstrate considerable interest in integrating more-than-human perspectives into design education, yet they rarely attempt to evaluate the long-term effectiveness, transferability, or scalability of these approaches.
Finally, MtHD pedagogies are rarely discussed at the level of broader curriculum design. Most implementations appear as individual studio projects, workshops, or short-term course modules rather

than as integrated curricular strategies spanning multiple semesters or program structures. This suggests a need for scaffolded integration across courses, where MtHD principles are revisited at increasing levels of technical and methodological complexity.

4 CONCLUSION

This study examined how MtH perspectives are currently being introduced and operationalised in industrial design education through a systematic review. The critical review of the corpus indicates a strong reliance on perspective-shifting methods and systems-level analysis as primary means for communicating entanglements and incorporating MtHD into design pedagogy. Educators frequently employ observation, role-playing, and speculative exercises to operationalise MtH perspectives within the design process. However, these efforts are largely concentrated in the immersion phases of design and rarely extend to later stages such as prototyping and testing. When combined with the limited use of systematic assessment methods, this raises concerns about the long-term impact and transferability of MtHD pedagogies across educational contexts.

These findings highlight the need to extend MtHD beyond immersion and conceptual reframing into later design stages. This includes considering how MtH principles might inform later stages of design development, decision-making, and implementation, as well as how they intersect with production constraints, business models, and broader socio-technical systems.

Building on these findings, we outline a preliminary trajectory for integrating MtHD across the industrial design process. First immersion-based framing should be translated into design criteria, where nonhuman perspectives inform requirements and decision making. Second, prototyping should extend beyond discursive exploration toward materially and technically situated experimentation, incorporating constraints such as fabrication, lifecycle considerations, and system interactions. Third, testing should include comparative and performance-based evaluation, not only reflective learning outcomes. Finally, these stages should be distributed across curricula rather than being isolated within individual studios. This trajectory does not prescribe specific methods but proposes how MtHD can extend beyond early-stage engagement toward implementation within industrial design education.

Future research should build on this trajectory by developing assessment frameworks capable of measuring MtHD learning outcomes, conducting longitudinal studies of student development, and examining how MtH perspectives intersect with industrial practice, including questions of feasibility and industry engagement. By synthesising current pedagogical approaches and identifying key gaps, this review argues for a more systematic and transferable development of MtHD pedagogies within industrial design education.

REFERENCES

[1] Barendregt W., Bekker T., Berger A., Dalsgaard P., Eriksson E., Frauenberger C., Friedman B., Giaccardi E., Hansen A.-M., Jensen R. H., Light A., Lindley J., Nicenboim I., Nilsson E. M., Redström J., Sontopski N., Wakkary R., Wiberg M. and Yoo D. The Future of More-Than-Human Design: A Computing Practice in Crisis? 2025. In *Adjunct Proceedings of the Sixth Decennial Aarhus Conference: Computing X Crisis*, Aarhus, Denmark, August 2025. https://doi.org/10.1145/3737609.3747092.

[2] Beach M. W. and Fox T. Value Sensitive Speculative Design: Exploring More-Than-Human Relations in the Age of Climate Catastrophe. *Interaction Design and Architecture(s) Journal*, 2022, 51, 111–131. https://doi.org/10.21606/learnxdesign.2019.05024.

[3] Bergström J., Pietarinen H. and Miettinen S. More-Than-Human Empathy in Arts-Based Material Research Processes. In *Empathic Service Design: Challenges in Design, Analysis and Services*, Sarantou M., Jylkäs T. and Miettinen S. (Eds.), 2025, 185–199 (Bloomsbury).

[4] Brosens L., Raes A., Octavia J. A. and Emmanouil M. How Future Proof is Design Education? A Systematic Review. *International Journal of Technology & Design Education,* 2023, 33(2), 663–683. https://doi.org/10.1007/s10798-022-09743-4.

[5] Camozzi Z., St Pierre L. and Falk C. Activating Design for Biodiversity. In *Pluriversal Design Conference Series*, July 2021, 213-225.

[6] Coskun A., Cila N., Nicenboim I., Frauenberger C., Wakkary R., Hassenzahl M., Mancini C., Giaccardi E. and Forlano L. More-Than-Human Concepts, Methodologies, and Practices in HCI. In *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems* (*CHI EA '22*), New Orleans, LA, USA, 2022, 1–5. https://doi.org/10.1145/3491101.3516503.

[7] Coulton P. and Lindley J. G. More-Than Human Centred Design: Considering Other Things. *The Design Journal*, 2019, 22(4), 463–481. https://doi.org/10.1080/14606925.2019.1614320.
[8] Eriksson E., Nilsson E. M., Hansen A.-M., Yoo D. and Bekker T. Teaching for More-Than-Human Values and Perspectives in Technology Design. In *More-Than-Human Design in Practice*. Rosén A. P., Salovaara A., Botero A. and Søndergaard M. L. J. (Eds.), 2024, 223-236 (Routledge).
[9] Gaziulusoy İ. and Berglund E. Transitions to Multispecies Futures in the Design Classroom. In *DRS2024*, Boston, MA, USA, 2024. https://doi.org/10.21606/drs.2024.781.
[10] Genç Ç., Bertran F. A., Buruk O. O., Jung S., Spors V. and Hamari J. Shroom Cards: Playful Exploration of Human Positionalities for More-Than-Human Design. In *Companion Proceedings of the 2024 Annual Symposium on Computer-Human Interaction in Play* (*CHI PLAY Companion '24*), New York, NY, USA, October 2024, 97–103. https://doi.org/10.1145/3665463.3678784.
[11] Giaccardi E., Redström J. and Nicenboim I. The Making(s) of More-Than-Human Design: Introduction to the Special Issue on More-Than-Human Design and HCI. *Human–Computer Interaction*, 2025, 40(1–4), 1–16. https://doi.org/10.1080/07370024.2024.2353357.
[12] Haraway D. J. *When Species Meet*, 2008 (Univ of Minnesota Press).
[13] Hayles N. K. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*, 2017 (University of Chicago Press).
[14] He S., Jiao Z. and Zhang R. "Who Lives in the Future"?: A Toolkit for Imagining Inclusive and Posthuman Future Characters as an Approach to Design Fiction. *Futures*, 2026, 175, 103735. https://doi.org/10.1016/j.futures.2025.103735.
[15] Latour B. *We Have Never Been Modern*, 1993 (Harvard University Press).
[16] Lee W.-C., Chen Z.-R. and Liang R.-H. Exploring MacGuffin Interactions in IoT Smart Objects: A Narrative Approach to Design Education Research. *International Journal of Art & Design Education*, 2025, 1-21. https://doi.org/10.1111/jade.12595.
[17] Liepert S., Ruecker S. and Brakke A. Design for the Nonhuman. In *DRS Learn X Design Conference,* Ankara, Turkey, July 2019. https://doi.org/10.21606/learnxdesign.2019.05024.
[18] Metcalfe D. Stepping Out of the Classroom and into the Worlds of Other Species. In *More-Than-Human Design in Practice*, Rosén A. P., Salovaara A., Botero A. and Søndergaard M. L. J. (Eds.), 2024, 237-248 (Routledge).
[19] Moher D., Liberati A., Tetzlaff J., Altman D. G. and The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLOS Medicine,* 2009, 6(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097.
[20] Morrison A. and Chisin A. Design Fiction, Culture and Climate Change. Weaving Together Personas, Collaboration and Fabulous Futures. *The Design Journal*, 2017, 20(sup1), S146–S159. https://doi.org/10.1080/14606925.2017.1352704.
[21] MOVA. Teaching More-than-human Perspectives in Technology Design. Retrieved March 1, 2026 from https://morethanhumandesign.eu/.
[22] Murray-Rust D., Lupetti M. L., Nicenboim I. and van der Hoog W. Grasping AI: Experiential Exercises for Designers. *AI & Soc,* 2024, 39(6), 2891–2911. https://doi.org/10.1007/s00146-023-01794-y.
[23] Nilsson E. M., Barendregt W., Jensen R. H., Hansen A.-M., Yoo D. and Eriksson W. Navigating a New Direction in HCI Education: Challenges of Teaching More-Than-Human Perspectives. In *Proceedings of the 7th Annual Symposium on HCI Education* (*EduCHI '25*), July 2025, Bloomington, IN, USA, 1–7. https://doi.org/10.1145/3742901.3742907.
[24] Anton Poikolainen Rosén, Antti Salovaara, Andrea Botero, and Marie Louise Juul Søndergaard (Eds.). *More-Than-Human Design in Practice*, 2024 (Routledge).
[25] Tsing A. L., Bubandt N., Gan E. and Swanson H. A. (Eds.). *Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene*, 2017 (Univ of Minnesota Press).
[26] VASE. Teaching for Values in Design. Retrieved 1 March 2026 from https://teachingforvaluesindesign.eu/.
[27] Vergani F. and Di Liberto F. Designing from the Plants' Perspective. A Field Case Study in Urban Forest of "La Goccia." In *DRS2024*, Boston, MA, USA, 2024. https://doi.org/10.21606/drs.2024.1052.