BRIDGING SUBJECTIVE INTERPRETATION AND OBJECTIVE STRUCTURE IN DESIGN EDUCATION FOR INDUSTRIAL DESIGN ENGINEERING STUDENTS

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ABSTRACT

Teaching industrial design principles to engineering students poses distinct challenges. Unlike art or design students, engineering students often approach problems with a binary perspective, expecting definitive answers. This complicates engagement with design, where subjective interpretation and open-ended solutions are fundamental.

This paper presents work within an Industrial Design Engineering programme. The aim has been to clarify the design process by introducing a structured methodology, the Subjective-Objective Design Methodology (SODM), for articulating subjective decisions. The goal is twofold: to provide students with tools for self-reflection on design choices and to establish a shared framework that enhances communication between students and educators.

This methodology integrates semantic expressions - such as “modern,” “sporty” and “inclusive,” - with the attributes of physical products, including form, structure, material, dimensions, and surface properties. By merging “soft” values with tangible design properties, the methodology bridges subjective and objective elements of design. This approach enables students to embed meaning into their projects and provides a common language for discussing design choices in more objectively grounded terms.

Findings indicate that SODM, in the course Form Theory and Exploration, helps students express design intent more clearly, strengthens peer and educator interaction, and enables them to navigate the subjective nature of design within a structured, engineering-compatible framework. It also supports students' reflective awareness of their own design process and highlights the need for integrated visual communication training. The methodology has potential applications in other Industrial Design Engineering programmes seeking to introduce subjective design thinking earlier and more iteratively in a technical context.

Keywords: Design education, industrial design engineering, semantic expressions, structured methodology, design intention articulation

1 INTRODUCTION

A central question in this study is how a more structured methodology can support students in improving their ability to work with semantic expressions in design - both in general and particularly regarding how more abstract and intangible values can be translated into design properties.

Early observations in an Industrial Design Engineering programme at a Technical University revealed a distinct pattern in how students engaged with semantic expressions. When dealing with objective, measurable characteristics - such as transforming an object from "light" to "heavy" in character or from "fast" to "faster" - students found the process relatively intuitive. Discussions could focus on the degree of transformation, analyse the form-related manifestations of these expressions, and arrive at conclusions based on tangible design properties. However, when tasked with working with more abstract semantic expressions, such as "harmonious," students faced significantly greater challenges. Difficulties arose not only in form transformations but also in articulating the underlying thought processes - the design intentions - that informed their decisions. As a result, reasoning often remained subjective and based on personal opinion, lacking structured articulation.

From a pedagogical perspective, this posed a challenge. Without explicit formulation of design intentions, providing feedback and critique became increasingly difficult. Responses tended to become subjective and opinion-based**,** rather than grounded in an objectively comprehensible framework. This limitation underscored the need for a more structured methodology **-** one that could provide students with a clearer approach to working with semantic expressions in design while also offering a shared language for critique and discussion.

Recognising these challenges together with theoretical perspectives by Krippendorff (2006) and Muller (2001), a structured and transparent approach working with semantic expressions was introduced to enhance students' ability to articulate design intentions**.** The goal was twofold: first, to strengthen students' self-communication**,** enabling them to clarify and structure their thought processes; second, to establish a framework that facilitates clearer and more objective feedback**,** both from peers and educators. In doing so, SODM started to take form. A methodology that supports individual reflection while fostering collaborative critique and communication within the design learning process.

2 THEORETICAL FRAMEWORKS

The relationship between semantic meaning and physical attributes in design has been explored from multiple perspectives. Industrial design inherently balances form and function, yet one of the primary challenges lies in bridging subjective interpretation with structured methodologies that allow for design decisions to be articulated in a way that is meaningful both for designers and users. Two key theoretical contributions that provide a foundation for understanding this interplay are Klaus Krippendorff's exploration of design semantics and meaning attribution and Wim Muller's work on physical format attributes in design**.**

In *The Semantic Turn: A New Foundation for Design* (2006), Krippendorff examines how users interpret and assign meaning to design artifacts**.** His work explores how design functions beyond its materiality by considering its social, emotional, and functional dimensions. He introduces the concept of affordances, explaining how objects inherently suggest their use, and examines how aesthetic and cultural elements shape perceptions of value and desirability**.** Furthermore, Krippendorff emphasises the role of design in communicating identity and social status**,** illustrating how products act as carriers of cultural and symbolic meaning.

While Krippendorff focuses on how users interpret and assign meaning to design artifacts, Muller, in *Order and Meaning in Design* (2001) shifts the perspective toward how form, structure, material, dimensions, and surface properties influence both the aesthetics and functionality of a product. He highlights the hierarchical role of form in shaping user perception, demonstrating how structural organisation contributes to both function and expressive quality. The material properties of an object not only define its technical performance but also create aesthetic and emotional associations, an aspect further reinforced by surface characteristics such as texture, gloss, and colour. Muller also discusses how abstract values can be embedded within tangible design elements, bridging the gap between subjective intentions and objective physical expressions**.**

While Krippendorff and Muller approach design from different angles, their work intersects in the connection between tangible product attributes and perceived meaning. Krippendorff introduces a semantic dimension, exploring how design is interpreted in social and emotional contexts, while Muller provides a structured framework for analysing how physical properties influence form. Together, these perspectives help inform methodologies that integrate subjective design interpretation with structured decision-making**,** which is central to the Subjective-Objective Methodology presented in this paper.

3 KEY FACTORS IN ESTABLISHING AND DEVELOPING THE SODM

Building on Krippendorff's focus on semantic dimensions and Muller's structured analysis of physical attributes, this section outlines the core factors that guided the development of the SODM in bridging subjective interpretation with objective structure.

A recurring challenge among Industrial Design Engineering students was the difficulty of working with abstract semantic intentions - those not readily tied to measurable attributes. While this has been addressed conceptually in previous sections, its practical implications became evident in students' early design formulations. To support this process, Krippendorff's categorisation of semantic expression was introduced to help students move beyond intuition by expanding their vocabulary and encouraging more deliberate reflection on how abstract values such as inclusivity or elegance might be explored and expressed.

One pedagogical exercise required students to write form-driving statements, outlining not only what a design should express but also what it should actively avoid. For example: *"Harmonic as in continuous and sweeping surfaces rather than surfaces with sharp creases and folds."* This approach, while valuable in clarifying intent, often proved limiting by focusing narrowly on form as a singular dimension. As students encountered difficulties relating such expressions to deeper structural and material choices, the need for an expanded framework became increasingly clear. Muller's physical attributes, previously introduced, provided the necessary extension. By explicitly connecting form, material, surface, and proportion to expressive intent, students were able to articulate design meanings with greater clarity and complexity. Rather than substituting intuition, this structured method supported a more deliberate and communicable design reasoning process.

In recent years, the course Form Theory and Exploration has provided first-year master's students with opportunities to continuously refine and clarify this SODM, enhancing its clarity and applicability. The following section outlines how this methodology is operationalised in design education practice.

4 IMPLEMENTATIONS OF THE SODM

The SODM is currently taught and applied in the course Form Theory and Exploration. While structured in its foundation, it is designed to be open, exploratory, and adaptable, encouraging students to iteratively refine their design concepts while maintaining analytical clarity. This flexibility allows them to both define and evolve their form-related thought processes, ensuring that creativity remains an integral part of their structured design work.

A key objective of the methodology is to help students establish well-defined form intentions while maintaining a flexible and iterative approach to design articulation. Central to this process is the *Subjective-Objective Design Matrix*, which enables students to systematically connect semantic expressions with physical attributes. By integrating verbal and visual elements, the matrix provides both a structured analytical framework and a tool for exploration, ensuring that students do not only define their design intent but also refine and challenge it through iteration.

4.1 The SODM - Step-By-Step

To support students' exploration and articulation of design intent, the SODM follows a structured but adaptable process:

1. **Semantic Mapping and Expansion**
    a) Students identify 1-3 core semantic expressions (e.g., sporty, elegant, inclusive) that define their initial design intent.
    b) Using Krippendorff's categorisation as both a structured reference and a catalyst for broader perspectives, students expand their list with related and complementary expressions, enriching their conceptual scope.
2. **Selection of Key Semantic Expressions**
    a) As students refine their design direction, they narrow their selection to three key semantic expressions that most accurately align with their intended form and aesthetic vision.
    This step ensures focus and precision, preventing semantic overload - where too many overlapping or vague expressions have tendency to the blur the intended design direction.
3. **Establishing Relationships in the *Subjective-Objective Design Matrix* (Figure 1)**
    a) The selected semantic expressions are placed in the first column of the matrix.
    b) The physical attributes of design - form, structure, material, surface, and proportions - are placed as headers, according to Muller.
    c) Each cell in the matrix is filled with a verbal description of how a specific physical attribute expresses a given semantic value. These descriptions are then translated into visual references by selecting or creating images that best illustrate the relationships identified in the matrix.

Figure 1. Student example of Subjective-Objective Design Matrix

4. **Visual Translation and Iterative Refinement**
   Through continuous refinement of verbal descriptions and visual representations, students are able to adjust and deepen their interpretations, ensuring both accuracy and creative flexibility. Multiple iterations strengthen both precision and adaptability, positioning the matrix as a tool for ideation as well as later validation.

This structured SODM provides students with a systematic yet flexible approach to articulate their design intentions, bridging subjective semantics with objective physical attributes. By integrating verbal and visual references, the process deepens students' understanding of design semantics, enhances communication between students and educators, and strengthens the analytical foundation for their design decisions. Ultimately, this approach ensures that both creativity and structured reasoning are embedded throughout the design process, equipping students with a clear and communicable framework to support their future professional practice.

5 EVALUATIONS OF THE SODM THROUGH STUDENT REFLECTIONS

From an educator's perspective, the SODM has significantly improved students' ability to engage with, reflect upon, and articulate abstract "soft" values in their design process. The structured approach has facilitated a clearer understanding of semantic expressions, making it easier for students to incorporate them into their design intentions in a more precise and deliberate manner**.**
Additionally, the methodology has had a notable impact on feedback and critique sessions, both from an educator's and a peer-review perspective. The structured framework provides a common reference point**,** making discussions more focused, relevant, and comprehensible. As a result, students receiving critique are better equipped to interpret, process, and apply feedback, leading to more informed design iterations. This has also made the critique process more constructive and manageable for students. To assess the methodology's validity and effectiveness from a student perspective, a survey with five targeted questions were administered to nine first-year master's students of European origin. This section summarises the main findings and evaluates the methodology's impact on bridging subjective design values with tangible design elements.

5.1 Bridging Abstract Concepts and Physical Attributes

A recurring insight was the SODM's capacity to translate abstract semantic expressions - like "inclusivity" or "warmth" - into concrete design parameters. Students noted that systematically mapping semantic values onto features such as form, material, and dimensions helped clarify design intentions. However, several participants voiced concerns that trying to convert complex, subjective ideas into definitive form-driven statements risked oversimplifying the creative process or restricting exploratory design thinking.

5.2 Visual Representation and Communication

Many students struggled to find images that accurately captured nuanced expressions such as "openness," often relying on multiple sources or iterative refinement. While those adept at visual search tools found this process beneficial, others required more guidance to source and interpret relevant imagery. Students agreed that integrating pictures and sketches into the SODM encouraged more focused discussions with peers and educators, helping them articulate their ideas and receive meaningful feedback.

5.3 Balancing Structure and Exploration

Participants highlighted the SODM's positive influence on communication - particularly in peer critiques - by providing a shared language for evaluating design intent. Despite these benefits, some students felt that strictly adhering to the methodology sometimes limited their ability to explore alternative design avenues. They suggested introducing the SODM early in the design process allowing more iteration so it could serve as an ideation catalyst rather than just a validation tool (if used later in the process).

5.4 Summary of Findings

Overall, the student reflections suggest that the SODM successfully bridges subjective and objective dimensions of design, enhancing clarity in design intent and improving feedback sessions. However, the tension between structured guidance and free-form creativity indicates a need for greater flexibility. Refinements such as earlier implementation, expanded visual resources, and iterative checkpoints may further enrich both the creative process and the final design outcomes.

6 DISCUSSIONS

As it stands, the SODM is taught alongside other methodologies that partially address subjective and objective aspects of design. Although currently introduced in the second half of the course, several students emphasised that an earlier introduction - potentially earlier in the degree programme - would allow more time for exploration and iteration. Embedding the methodology at the early stages of the design process could reduce cognitive dissonance when transitioning between conceptual ideation and form development. It would also support a more consistent integration of subjective perspectives throughout the entire workflow, rather than confining semantic considerations to the latter stages of design. By embedding the methodology earlier in the workflow, students could continuously explore and validate design intentions.

The results presented in *Evaluations of methodology through student reflections* highlight the methodology's capacity to help students bridge abstract semantic concepts with tangible design attributes, aligning well with Krippendorff's perspective on how users interpret meaning and Muller's structured framework for analysing form. By systematically mapping expressions such as "warmth" or "inclusivity" onto parameters of form, material, and proportions, students gained a clearer sense of design intent. Student reflections also indicated an increased awareness of their own design processes. Several noted that articulating intent through the matrix helped them identify inconsistencies between their initial goals and evolving design choices, prompting earlier and more deliberate adjustments. Furthermore, the SODM enables more precise communication between students and educators, fostering a shared language for discussing subjective and objective elements.

At the same time, the students' reflections underscore potential challenges. While the methodology effectively clarified design intentions, some participants felt creativity could be constrained when abstract concepts are reduced to definitive form-driven statements. The call for early introduction of the SODM, coupled with iterative checkpoints, suggests that embedding the methodology throughout the entire design process - rather than at a single, late stage - would better serve both ideation and evaluation. This is also supported from a teaching perspective, as previously observed in course development. From a teaching perspective, the methodology also improved the quality of dialogue between students and educators. By grounding subjective intentions in a shared visual and verbal framework, discussions moved beyond opinion and toward constructive critique. One student noted that using the matrix made their presentation feel "more anchored and specific," which helped them receive more targeted feedback. Furthermore, visual representation proved crucial. Students who were experienced at using digital resources or sketching found it easier to translate semantic values into coherent imagery. Those less experienced expressed a need for guidance on sourcing or interpreting visuals. This variation in visual skill had a direct impact on how confidently students engaged with the methodology. While some used visual exploration to refine and validate their semantic intentions, others hesitated to fully commit to form decisions due to uncertainty in visual translation.

This highlights that visual literacy is foundational to the successful application of the SODM and should be developed as an integrated part of design education, complementing the semantic-physical mapping. Future adaptations of the methodology could include structured tutorials on image selection and interpretation, thereby bolstering students' confidence in linking concept to form.

Overall, these findings demonstrate how the proposed methodology not only facilitates more objective critique sessions but also highlights the importance of flexibility. In practical terms, providing multi-stage, iterative feedback can ensure that abstract expressions evolve organically alongside form development. Such a refinement would make the framework an even more valuable ideation tool.

7 CONCLUSIONS

This paper explored a structured methodology, as developed in the course Form Theory and Exploration, for integrating subjective semantic values with objective physical attributes in Industrial Design Engineering education. The findings indicate that the developed SODM enhances students' ability to articulate and justify design choices, providing a clear framework for semantic-physical integration and improving feedback interactions between students and educators.

Nevertheless, ambiguity remains between structure and creative freedom. While providing a common language and analytical framework can significantly improve communication and feedback, it may also risk constraining the more exploratory aspects of form development. A key recommendation is to integrate the methodology from the early stages of design ideation. Doing so would give students more opportunity for iterative development, reinforce subjective perspectives as a continuous thread throughout the process, and reduce the cognitive shift often required when translating abstract values into physical form. In parallel, strengthened visual literacy support would help students better articulate their intentions through imagery and improve their ability to communicate meaning during critique and reflection. More broadly, this underscores the importance of embedding visual research and communication training as a core component of design education.

Given the limited sample size and course-specific context of this study, future research should aim to validate the findings through broader implementation across different educational programmes. Comparative studies could explore how cultural contexts influence the interpretation of semantic expressions. Additional investigations may also expand the methodological scope to include attributes such as colour theory or user-centred semantics, further enriching the framework's applicability.

In conclusion, balancing structure and interpretive freedom remains an essential task for design educators seeking to equip engineering students with both technical rigor and creative depth - a task that SODM meaningfully advances.

REFERENCES

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