CMF AND SUSTAINABLE DESIGN STRATEGIES: A WORKSHOP TO INSPIRE STUDENTS THROUGH COLOUR, MATERIALS AND FINISHING SELECTION

L. Sossini, F. Papile, B. Del Curto

Politecnico di Milano (ITALY)

Abstract

The growing focus on sustainability and environmental responsibility has created a need for a more integrated approach. Designers require the right tools to evaluate materials based not only on their technical properties, life cycle and ecological impact, but also on their aesthetic qualities. Teaching colour, material and finish selection, as well as the related production processes, is therefore fundamental to the professional development of new designers. These aspects are often left at the end of the creative process, following considerations of form and function. In this context, CMF (Colour, Material and Finish) design is an approach that enables the coordination, selection, and balancing of aesthetic and functional design attributes. The advantages of applying CMF design in today's context are manifold, allowing young designers to address the different levels of product definition: formal, functional, emotional, and, potentially, to leverage the adoption of sustainable design strategies.

Therefore, this contribution explores a trial to develop a design tool that guides students through the CMF process by increasing their awareness of the sustainable implications of their design choices. To achieve this, researchers defined a template to guide students towards defining the project's colour, material, and finish characteristics related to sustainable design strategies. The template, tested in a two-week workshop, supports the students in the CMF selection step by step, considering aesthetic-sensorial properties, performance, processability, and life cycle. The efficacy of the format has been assessed through two anonymous surveys, conducted at the beginning and end of the workshop.

The activity led the whole class to reflect on the project's depth and focus on selecting colours, materials, and finishes as elements that affect the sustainability of their design choices. At the end of the workshop, most students were happy with the activity and expressed a willingness to reuse some elements of the template. The students emphasised how the template provided a guide for evaluating and justifying design choices while also leading them to reflect on the implications these may have for sustainability. This study demonstrates how integrating CMF design and sustainability can become a powerful educational opportunity, equipping new designers with tools and critical thinking skills for today's and tomorrow's challenges.

Keywords: CMF design, Sustainable Design Strategies, Design Tool, Workshop-based learning, Design Education.

1 INTRODUCTION

The original design development was inspired by the Bauhaus principle of “form follows function”; today, the definition of an artefact goes far beyond its purely functional aspects. Form becomes an expression of function and aesthetics, linked to cultural, emotional, and sensory aspects [1]. Contemporary design integrates symbolic and perceptual dimensions, transforming the object into a vehicle for complex meanings. It is no longer just a matter of fulfilling a functional requirement: the definition of an artefact encompasses considerations that must take into account the entire product system on multiple levels. Furthermore, the increasing focus on sustainability and environmental responsibility requires a more integrated approach, in which designers have the appropriate tools to evaluate materials not only from an aesthetic point of view but also for their technical properties, life cycle, and ecological impact.

In this context, a fundamental aspect of designer training is the selection of materials, colours, and finishes. However, these elements, which should accompany the concept generation process from the outset, are often neglected or only addressed at a later stage [2]. Nevertheless, materials and manufacturing processes deeply affect a designed product's formal and functional aspects. Furthermore, in today's increasingly complex context, where design must inevitably address sustainability, the selection of materials and production processes must take place in parallel with the formal creative process [2]. Designers must learn to harmoniously integrate all the necessary requirements to achieve the best possible result.

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CMF (Colour, Material and Finishing) design presents itself as a possible design approach in which the aesthetic element balances the functional aspect [3], allowing the entire concept generation process to be followed from the brief stage onwards. However, despite the potential of CMF design, this approach is still not widely used in design courses. The main reason is its relatively recent origin and highly practical nature, which limited its integration into traditional training courses. Although it has been adopted in the corporate world's "Colour and Trim" divisions [4], it has never been officially introduced or clearly defined in terms of tools and processes. The acronym CMF is generally attributed to Clino Trini Castelli in the 1980s. However, the first recorded use of this acronym in academia dates back to 2005 [5]. Due to its recent emergence and primary focus on corporate dynamics, CMF has only established itself as a proper design approach in recent years. Today, opportunities for sharing and dissemination are found through specific courses and master's programmes, such as the Master's in Sensory Surface Design at POLI.Design, the Colour, Material and Finish Design Online Short Course at Central Saint Martins and the Colour and Materials Design programme (MA and MFA) offered by the College for Creative Studies in Detroit.

The literature on CMF design remains limited, and professionals in the field hold a significant portion of the knowledge. Nevertheless, the potential for teaching CMF design is high, as it allows the development of the overall vision that should be part of every contemporary designer's skill set. Integrating formal, material, and production choices from the outset enables students to tackle complex projects systematically and responsibly. The main contributions have come from material selection, colour theory, and the study of production processes [5]. However, there is still a lack of an integrated vision that includes sustainable, cultural, sensory, and emotional aspects, capable of generating a critical and comprehensive perspective.

This research stems from these issues and reflections. The experimentation presented here is part of a broader doctoral thesis that explores CMF design as a lever for defining artefacts capable of guiding users towards sustainable practices. The aim is to provide students with a design framework that guides them in integrating CMF tools into their creative process, promoting a more conscious and multidimensional approach to design. The study presented, therefore, aims to test an initial framework proposal and investigate how it is received by students, as well as the reflections it stimulates.

2 METHODOLOGY

The framework and associated assessment tests were carried out within the design laboratory of the Master's degree programme in Integrated Product Design. As part of the design course, students were asked to design artefacts for work breaks. After the concept generation phase, the CMF design activity was presented halfway through the course. This part of the course lasted two weeks and was designed as an intensive workshop, with theoretical lectures and design reviews. During this time, the students selected colours, materials, and finishes based on the concept definition phase, and related their choices to sustainable design strategies. Approximately 36 students were involved, working in groups of 2-3 or individually, depending on the project. The workshop aimed to exploit CMF analysis to accomplish material, technology, and sustainability-related elements of the designed concept, creating two versions of the same product by CMF (an incremental and a disruptive one).

Over the two weeks, there were four days of classroom attendance with teachers and students, with a fifth day dedicated to presentations. Specifically, on the day the activity was launched, an introductory presentation was given, presenting the framework template and introducing theoretical insights into material selection and the CMF approach.

The introductory presentation covered the fundamental concepts of CMF design, together with insights into material selection. During the presentation, the lecturer provided students with tools and methodologies for approaching material selection, as well as an in-depth explanation of the template provided. This gave students the opportunity to gradually familiarise themselves with this approach and then experiment with it in a practical way using the template.

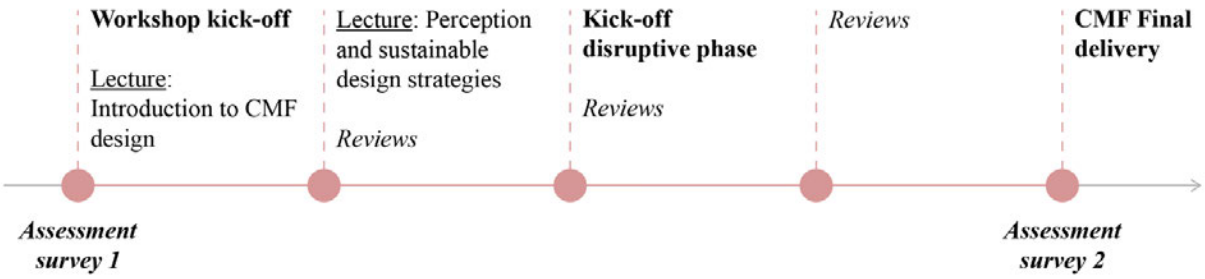

Figure 1: Workshop timeline. Image by the authors

On the second day, a more specific presentation on perception and sustainable design strategies was provided. The second presentation, hence, focused on perception and its influence on interaction with the product. Reflections were presented on multisensory interaction and how certain colours, finishes, textures, etc., could be achieved at the production level. The starting point was “La pelle del design [The skin of design]” [6]. Alongside these more practical aspects, elements related to sustainability were also introduced, with a focus on sustainable design strategies that emphasised the role of materials.

On both days, after the theoretical contribution (which lasted about two hours), there was a design review phase involving students and the teaching staff. The revisions were carried out throughout the day, seeking to provide the students with as many suggestions as possible. On the third day in the classroom, a more disruptive phase of using the template was launched. During this phase, the project parameters were adjusted to encourage students to think creatively and exploit CMF design to innovate their design concepts. Depending on the type of project, different design themes were defined, such as the forced use of a specific material, customisation for a particular company, or a change in context. The following days were therefore devoted to reviewing both projects, with the aim of arriving at the final day with templates that were as detailed as possible. On the final day, the students presented the activity results, highlighting the differences between the two outcomes. The presentations were shared via PowerPoint or PDF presentations projected in front of the whole class. Following the presentation, a discussion was held with the entire teaching staff.

Two assessment surveys were carried out at the beginning and end of the template activity. The first took place at the start of the workshop to frame students' background knowledge and understanding of the topic. The second took place at the end of the two weeks to gather opinions on the effectiveness of the activity.

2.1 Template

The template was based on existing literature on CMF design [3][6], material selection [7][8], and strategies for sustainable design [9]. The activity, organised in sequential stages, involved defining colours, materials, and finishes, and declaring sustainability intentions. The authors provided students with a template in IDML format, which could be edited in InDesign, a software provided by the university.

The first section was an introductory part that described the concept, its main components, and referenced the identity defined in the concept phase. The second step analysed the first component through a description and a sketch. The colour was analysed using a strategic analysis (meaning or broad application strategy), a functional analysis (NCS, RAL, or Pantone), and a hedonic analysis (mood board). The next step was to analyse the finish using the same colour logic from strategic, functional, and hedonic points of view. At the end of this first part, the students were asked to define the manufacturing processes they intended to use to obtain the specified colours and finishes. Then they moved on to describing the material. The functional analysis included Ashby's table of functions, constraints, and objectives [7]. Once the material had been selected, the technical data sheet and the established processing methods were reported. The material was also analysed from a hedonic point of view using the mood board and sensory characteristics description. Finally, based on the technical data collected, a table was compiled to report the environmental impact of the material, including the most comprehensive values for CO2 emissions, energy and water usage, recyclability, and biodegradability. The third and fourth steps, and so on, repeated the analysis just described for the other project components. The penultimate step was to group the reflections on the product design strategy, as outlined in the theoretical lessons. Thus, students were able to exercise their critical thinking skills by seeking deeper justifications, reviewing and modifying their choices, and considering a way of thinking that took the product's life cycle into account. Finally, the last step consisted of a recap of the choices made for all components, accompanied by a statement on how the project was harmonious and

consistent, including the selection of a sustainable design strategy. For the disruptive phase, students were asked to complete the same template but implement the various design measures outlined above.

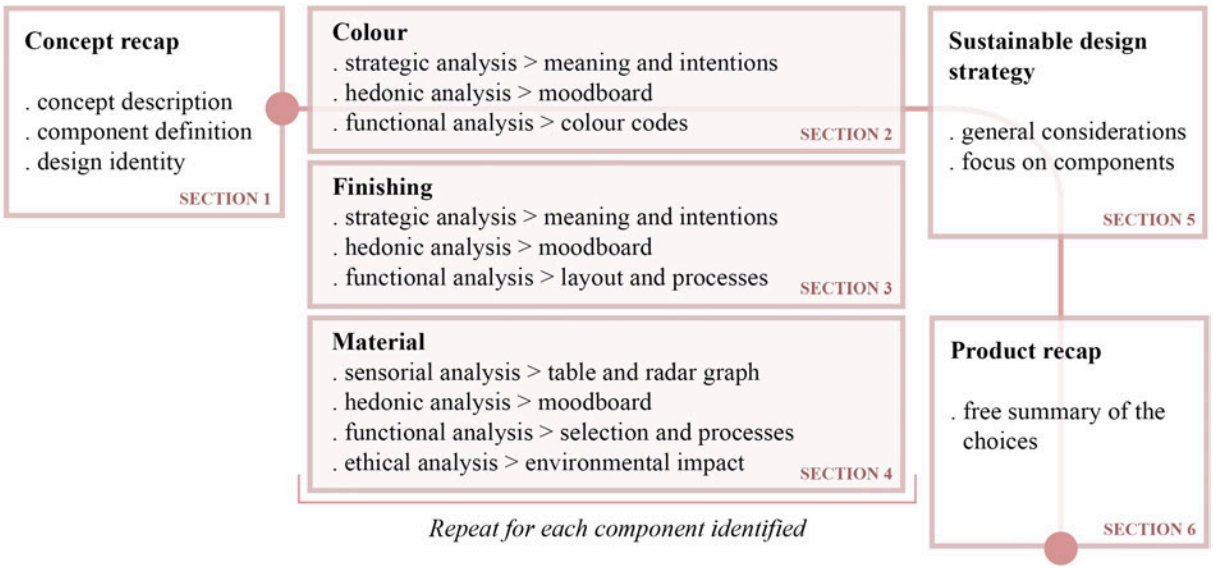

Figure 2: Template process. Image by the authors.

2.2 Assessment

Two anonymous surveys were conducted at the beginning and end of the activity to assess its impact on students' knowledge and skills. Both tests, structured in Forms, were carried out in the classroom and accessed by students via projected QR codes.

The first assessment survey took place during a break in the first kick-off lesson. The survey consisted of a mixture of short open and closed questions. The aim was to map the origin of the bachelor's degree to understand whether the topic had already been covered at other universities, on what occasions, and if they had ever been designed with CMF design tools.

The second survey, on the other hand, aimed to gather opinions and criticism on the proposed template. Compared to the first survey, the questions in the second survey were more structured, employing various methods. The first question, presented as a 5-step Likert scale, asked respondents how they found the methodology in terms of both the CMF process and its connection with sustainable design strategies. The second, more specific, question asks about the sections where difficulties were encountered. This was followed by a query regarding the design process and the sequence of steps. Finally, the students were asked to use a Likert scale to share their impressions of the two outcomes. With the same question structure, general assessments were requested on the usefulness of the CMF approach in designing sustainability strategies and on the usefulness of prior knowledge. Moreover, the authors investigated: how much background students thought they needed to explore; if they felt they would have been able to complete the task without the workshop; what they learned; and whether they would use this approach in the future.

3 RESULTS

All 22 student groups completed the template, providing the teaching staff with a copy that outlined both the project concept and the disruptive parts. Overall, the activity yielded positive results. Several students commented, informally and during reviews, on the usefulness of the process. In many cases, forcing the whole class to undertake such a structured, in-depth study also allowed those who were behind to catch up and reach the same level of project definition as the more advanced groups. Students who completed the activity could describe colours, materials, and finishes in detail. With support to guide them in their reasoning, students could balance functionality and aesthetics.

Assessment surveys provided precise results on the progress of activities. The kick-off survey revealed that 77% of students had studied at Politecnico di Milano, and 94% were familiar with CMF design, although few had actually tried it. Two students had heard about CMF at work and online, while most had learned about it

at university. Only 32% had used CMF tools, such as mood boards, radar diagrams, material libraries and samples, and graphs to describe materials. Most were aware of CMF but had never tried it.

The workshop closing survey, on the other hand, provided a clear picture of the situation. More than half of the students (29) reported being satisfied or very satisfied with the CMF process. This result shifts towards a neutral opinion of the CMF process when combined with reflections on sustainable strategies. In the selection process, the most challenging part is the materials selection, followed by defining sustainability strategies and finishing. The survey also investigated how students approached their designs and found most started with colour, then material, and finish, or material + finish. In many cases, strategy was third or fourth in the order of choices. As for the disruptive project, most students focused on changing the context, followed by a shift in material, branding, and a specific aspect of the project. In general, most students (around 70%) reported being satisfied or very satisfied with both the CMF framework for the concept and the disruptive aspect.

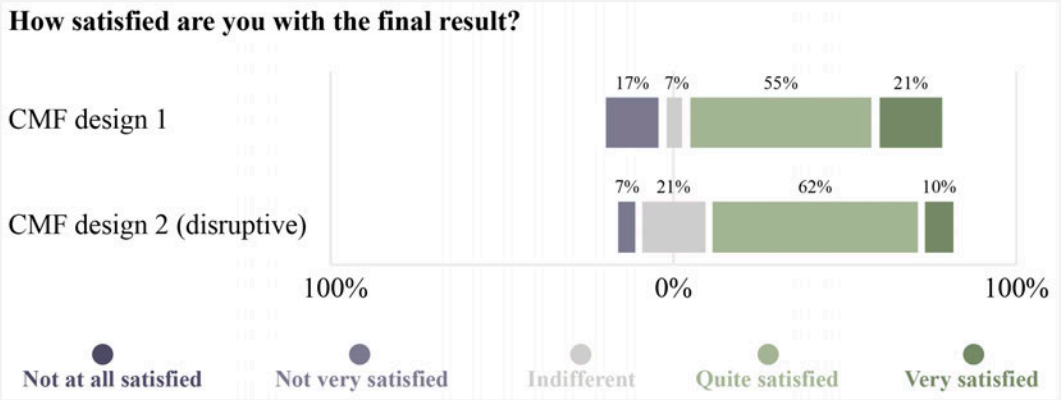

Figure 3: Assessment of satisfaction levels with CMF and disruptive CMF analysis processes. Image by the authors

The same result was obtained concerning opinions on the usefulness of the approach for designing with sustainability strategies and prior knowledge. From the open-ended questions, positive and negative views on the usefulness of the methods are equal. The negative opinions suggest that the definition is still made, albeit in a less in-depth and redundant manner. The positive opinions, however, indicate that this method enabled students to focus on sometimes overlooked aspects and the choice of material in a more structured manner. Finally, 79% expressed a positive opinion on their intention to reuse this approach, 18% said maybe, and 4% expressed a negative opinion.

As the opening survey for the workshop revealed, the students who participated were familiar with the CMF design, but not with using the tools or the steps involved. The theoretical input and review sessions helped them engage with a new approach. The reviews revealed that some students can express concepts less through images (e.g., calm, quiet, with an image of red dirt on a racetrack).

One element that gave rise to most reflections was the evaluation of the CMF process in connection with sustainability strategies. Furthermore, strategies were almost always the last choice in the students' logical process. This created some difficulties in completing the template itself. For this reason, with a view to future developments, the authors intend to adopt a more guided approach to support students in developing their strategic sustainability line.

Considering the question relating to selection, the element that generates the most difficulty remains the material. This difficulty also arises in a context outside the workshop and is perhaps linked to the challenges in the actual selection process, specifically in translating constraints and requirements. Related to this aspect are the comments of students who stated that they had to independently explore the more specific technical aspects of the project in greater depth.

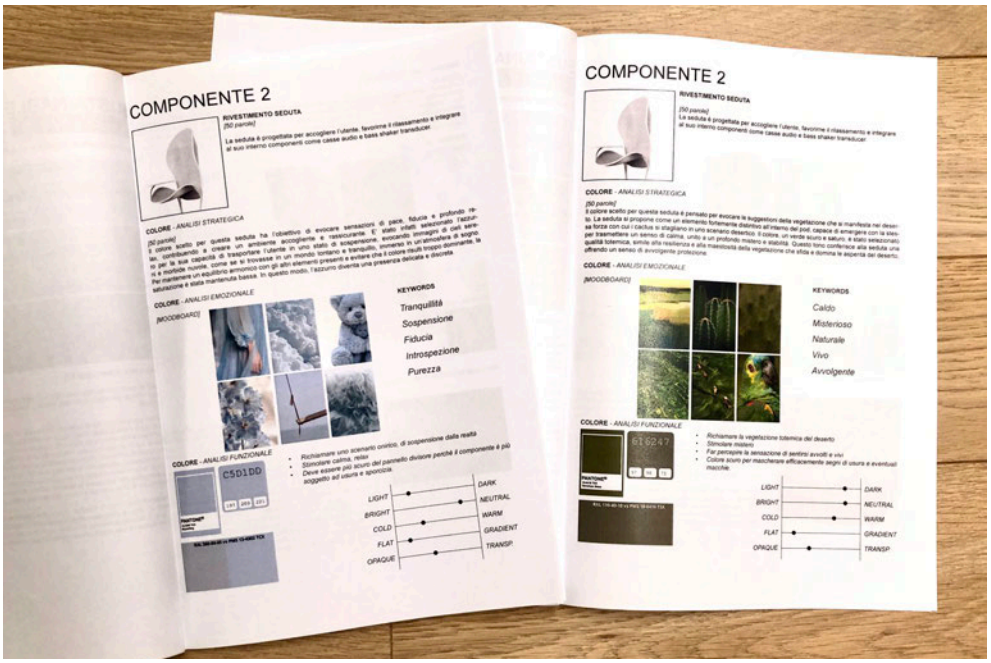

Figure 4: The boards of a component in the standard and disruptive CMF versions. A project of Giulia Grimaz.

From a practical point of view, some comments focused on the redundancy of the template in certain sections, such as the continuous repetition of mood boards. Although these steps were deliberately structured redundantly to allow for thorough exploration of each aspect, the authors reserve the right to review the structure and limit this redundancy.

In conclusion, the experience can be positive, demonstrating that the template may have been structured in the right direction.

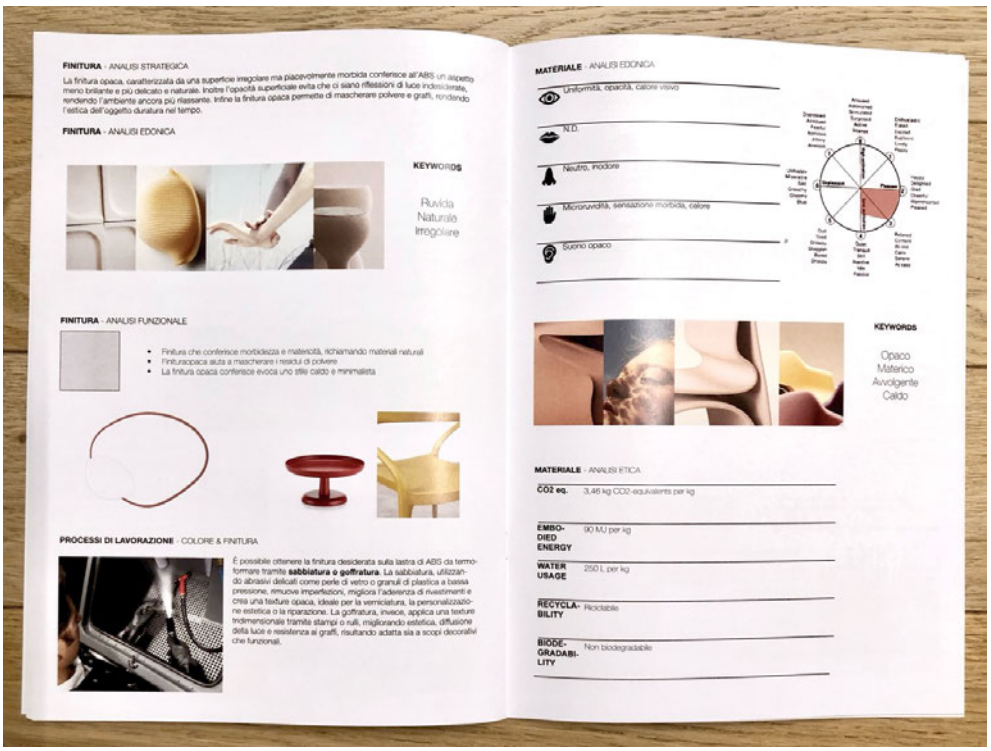

Figure 5: Final sections of the template related to sustainability and a summary of the choices made. A project of Paola Novelli and Bianca Reale.

4 CONCLUSIONS

The CMF design workshop demonstrated significant educational value, enabling all 22 student groups to complete the structured template and articulate detailed project concepts, including disruptive innovations. Pre- and post-activity surveys confirmed a notable progression: while 94% of students were familiar with CMF concepts beforehand, only 32% had prior hands-on experience with relevant tools. Post-workshop, over 70% expressed satisfaction or high satisfaction with both the CMF framework and its application to sustainable strategies, with 79% indicating intent to reuse the approach in future projects.

The experience presented demonstrates how CMF design can also be a valid approach for training new designers, enriching the creative process. Including the selection of colours, materials, and finishes from the earliest stages of design does not mean dwelling on aesthetic details; rather, it recognises their strategic role in defining the identity of an artefact. This also includes its functional and sustainable consistency. The workshop results highlight how, despite starting with only a superficial knowledge of the subject, students could use the framework to explore their choices in greater depth, developing a deeper critical awareness and analytical skills.

However, the difficulties encountered – particularly in selecting materials and integrating sustainability strategies – show that more targeted teaching tools are needed. Environmental strategies were often placed as a final step, rather than as the guiding premise of the process, confirming the need to strengthen the link between CMF and sustainability. The perception of redundancy in the template also indicates the need to review certain steps, striking a balance between methodological rigour and operational agility.

Despite these limitations, most students expressed a positive opinion, recognising the approach's usefulness in clarifying their design choices and developing greater confidence in balancing aesthetics and functionality. This confirms that CMF should not be understood solely as a set of operational tools, but as a design language capable of mediating between technical, cultural, and emotional dimensions.

Overall, the activity bridged theoretical knowledge with practical skills, fostering a balanced consideration of functionality, aesthetics, and sustainability. It particularly benefited less advanced groups, levelling the class's project maturity. Future iterations will incorporate a more scaffolded structure for sustainability integration and streamlined template sections to maximise accessibility. This CMF-centred methodology proves a robust pedagogical tool for cultivating innovative, sustainable design thinking in industrial design education.

Finally, the consolidation of CMF in academic courses and its theoretical formalisation could further strengthen its dissemination, preparing designers to tackle contemporary complexity with a more conscious, critical, and sustainability-oriented approach.

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