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The disciplinary matrix of applied arts and artistic cultures

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Abstract

Applied arts and artistic cultures are taught in vocational high schools, in France, with the aim of developing civic and social skills in students, which are cross-cutting or generic. To achieve this, this design education revolves around the creation and conception of artefacts. This article explores epistemological issues relating to the role and nature of design education in vocational high schools. Following Kuhn, it proposes a disciplinary matrix of the subject, characterized by objects, knowledge (declarative and procedural) and a set of tasks. These different components make it possible to present a curricular analysis grid of design education in vocational high schools over the past 30 years. This reveals a curriculum development correlated to the evolution of design as an involved social practice. Additionally, the integration of Mitcham's technological manifestations framework enriches this analysis, offering a more comprehensive perspective on the role of technology in design education. This approach indeed clarifies what needs to be taught, fosters the evolution of teaching methods and incorporates new elements such as sustainable development, the environment, collaboration and information technologies. These adjustments reflect changes in professional practices and contribute to civic education in the context of sustainability and ethical challenges. This article makes a significant contribution to debates on the epistemological basis for design education, in France and beyond.

KEYWORDS
Applied Arts and Artistic Cultures, design education, disciplinary matrix, vocational high school

INTRODUCTION

In France, Applied Arts and Artistic Cultures (3AC) are taught 55 min per week to all vocational high school (VHS) classes. Students engage in this discipline in response to a teacher-designed specification to design an artefact (a model, an object and a visual). This is an introduction to design (MEN, 2019) that is related to the student's chosen profession and aims to develop social, cultural and professional skills. As research on the teaching of design and applied arts is scarce and pays little attention to secondary education (Tortochot & Moineau, 2020), this article presents an epistemological exploration, highlighting the specificities of design education in the VHS. To achieve this, the disciplinary matrix (Kuhn, 1970) of 3AC is updated through a curriculum analysis covering the last 30 years. The overarching research question asks: 'Does the study and analysis of prescriptive texts allow us to distinguish the reasons for the evolution of the content taught in this discipline at VHS?' To answer this question, the discipline of design and its epistemological foundations are described, as well as the design education provided in VHS, to explore its disciplinary matrix more fully.

Epistemology and didactics of design

The field of epistemology studies the discourse on scientific knowledge, methods and discoveries resulting from it. It is, therefore, not only necessary to define and circumscribe design as a practice, but also as a scientific discipline, which is still under debate as such. This is an essential prerequisite for, in a second step, being able to develop and study its teachings, their origins and the disciplines that have constituted them. However, the approach is not easy. Indeed, according to Petit (2023), design could be considered 'undisciplined', located in a midway between arts and technologies.

Design

Table 1 presents definitions of design from the Francophone (the French Designers Alliance) and Anglophone (Design Council) professional worlds, as well as an international perspective from the International Council for Design. While there is some contention around specific definitions, the three presented above share the sense of design as a human endeavour, engaging creatively and purposefully with the made environment.

The discipline of design belongs to the world of the artificial[1] (Simon, 1996), consisting of a corpus of general knowledge that encompasses design activities, artefacts, their properties and their mode of production (Cross, 2001; Mitcham, 1994). However, in the field of design education, the nature of knowledge can be thought of as somewhat controversial, as the subject borrows knowledges from other disciplines and puts it into action (McLain et al., 2019). Many researchers agree that a designer adopts a logic and way of thinking specific to design (Cross, 2001; Vial, 2014), which is polymorphic, complex and creative. Such 'logic' is based on four major categories of activities mediated by the notion of the project (Vial, 2014) and grouped by domains related to the problem or solution.[2] First, there is the *problem formulation*. It is central (Archer, 1979) and often considered difficult to emerge because it grapples with vague or contradictory information. The second activity aims to

TABLE 1 Definitions of design.

Organization	Definition
Alliance France Design (AFD)	… a creative, interdisciplinary, and humanistic intellectual process that aims to address and provide solutions to everyday problems, big and small, related to economic, social, and environmental issues. (AFD, 2022)
Design Council, United Kingdom	… what happens when people use creativity to solve problems. Computers and coffee cups, skyscrapers and socks. Everything not made by nature, has been designed. (Design Council, 2023)
International Council for Design (ICOD)	… a discipline of study and practice focused on the interaction between a person—a 'user'—and the man-made environment, taking into account aesthetic, functional, contextual, cultural and societal considerations. As a formalised discipline, design is a modern construct. (ICOD, 2023)

design an artefact in response to the defined design problem, passing through intermediate representation states of the artefact to be designed (plan, drawing, sketch, texts, models, etc.). In this activity, the designer interacts with the environment (Lebahar, 2007), translating a set of needs into a set of requirements and functions that will guide and mark the design. The third activity is the *realization*[3] *of the artefact*. It requires the mobilization of resources to make it concrete. This step is not necessarily carried out by the designer of the artefact (e.g. architecture or engineering). The last activity is the *evaluation of the artefact* and the result obtained. It is put in place when the final artefact is put into use, and has reached a level of maturity deemed adequate to fulfil the requirements. This modelling of designers' activity, resulting from research seeking to define, delimit or unify multiple practices, is nevertheless questioned. Thus, Petit (2017) discusses the 'indiscipline' of design, its 'resistance' to disciplinary normalization and emphasizes its 'constituent oscillation' between disciplines. According to Petit (2017, p. 20), research does not fully capture the nature of design when it approaches it too schematically in two ways:

> The first proposes universal project methodologies and seeks to naturalize or essentialize design, while the second presents an approach to design that does not require a definition of design, only a direction: the "in-between[4]" that would allow for an epistemology of the environment: between art and science, between producer and consumer, between social and human sciences and engineering sciences, between the actual and the virtual, etc. Design brings together arts, sciences, technologies, and those who study the artificial world.

This is also an issue addressed in the early days of design and technology education in England, and throughout its implementation in the curriculum (Kimbell et al., 1991, 1996; Ofsted, 1999, 2001, 2002), which challenges the singular notion of 'The' design process and proposes that designing involves iterative processes of thinking and acting in response to a problem, resulting in a solution, rather than a definable series of stages. The epistemological challenge of academic research in design is to apprehend this interdisciplinary or post-disciplinary discipline.

Alongside these epistemological concerns, design, as an activity and discipline, is regularly renewed by new practices and knowledge. The themes addressed in specialized francophone journals testify to these developments and the research that reveals them.[5] So, a key question at this point is: What influences do these changes and the research that reveals them have on design education? It is important to underscore that design education

is a rapidly evolving discipline, often influenced by technological advancements and shifts in the professional design world (Brosens et al., 2023; Hallström & Ankiewicz, 2023). For instance, the emergence of digital fabrication has created new opportunities and challenges for design educators (Seery et al., 2023).

When defining interdisciplinarity in design education, the distinction made by Repko (2012) between a multidisciplinary approach and a truly interdisciplinary endeavour is acknowledged. Interdisciplinarity is not merely the juxtaposition of two or more disciplines but necessitates their integration in the dissemination of disciplinary skills and knowledge as part of the student learning experience. In the context of design education, where interdisciplinary approaches are increasingly important due to the growing complexity of challenges faced by the design field (Norman & Klemmer, 2014), the definition of interdisciplinarity by Klein and Newell (1998) is positioned as ideal for interdisciplinary education in design: 'A process of addressing a question, solving a problem, or approaching a topic that is too broad or complex to be adequately handled by a single discipline or profession … and draws upon disciplinary perspectives and integrates their insights through the construction of a more comprehensive perspective' (Klein & Newell, 1998, pp. 393–394). The interdisciplinary nature of design means that it is often integrated into STEM (Science, Technology, Engineering, and Mathematics) curricula, requiring pedagogical reflection to align design with other technological subjects (Buckley et al., 2021; Hallström & Ankiewicz, 2023). Likewise, recognizing the importance of technological knowledge in design education is crucial for equipping students to be competent in this field (Buckley et al., 2019; de Vries, 2005; Norström, 2014). As pedagogical approaches like learning through design to learning design through play are being explored (Fleer, 2022), it is vital for researchers and educators to keep abreast of current trends and methodologies in the field (Gibson, 2008).

The teaching of industrial design and applied arts

The history of design education in France is heir to the history of applied arts to industry itself, stemming from the 'industrial arts' whose name distinguished them from visual arts, fine arts and architecture. In the second half of the nineteenth century, about 15 schools of applied arts opened in Paris with pedagogical objectives aimed at enriching the cultural background of designers (Laurent, 1999). By offering a historical overview of design education in France and Europe since the creation of the Bauhaus in 1919, Lebahar (2007) highlights 'forces that have shaped this education'. In this regard, the impact of the Bauhaus, founded in Germany in 1919 by Walter Gropius, on design education in France and globally is pivotal. Kentgens-Craig (1999) underscores that the Bauhaus established new paradigms in artistic education by merging various disciplines like visual arts, design and architecture. This interdisciplinary approach had significant repercussions on educational institutions in France, influencing both design pedagogy and practice in the country. The history of the applied arts curriculum is based on artistic and technological teaching inherited from historical debates (Laurent, 1999). From 1996, the term 'design' was introduced into certain curricula, added to or replacing 'applied arts, while paying off the dominant industrial implications and integrating the developments of the discipline (Roumy-Akue, 2019). Indeed, the term 'applied arts' is problematic, "it designates an artistic intention in an industrial application that can be manual or mechanized" (Laurent, 1999, p. 15). However, applied arts have long referred to 'decorative arts' and are still sometimes confused with 'fine arts'. By tracing the genealogy of the discipline (minor arts, mechanical arts, decorative arts, industrial arts, applied arts and finally design) (Laurent, 1999), we observe semantic developments that highlight these different aspects. More recently, the phrase 'crafts' ('métiers d'art' in French) has come to

complement the landscape of design education by asserting a duality that allows future professionals to 'orient themselves towards a sector that promotes ethical and sustainable values such as artisanal manufacturing' (IGEN-IGAENR, 2015, p. 12). Table 2 highlights this transition in the titles of diplomas awarded by the national education system in France. Conversely, the term craft has been viewed as problematic for the D&T curriculum in England, with connotations of looking backwards, towards more dogmatic and making focused activity.

The evolution of post-baccalaureate education[6] now grouped under the umbrella term 'design and crafts' marks a paradigm shift. There has been a transition from an artistic and then industrial conception of the discipline to a broader conception that also includes craftsmanship and new design practices outside of industrial production.

The school discipline 3AC (applied arts and artistic cultures) taught at VHS since 2002 was previously titled 'artistic education and applied arts' (between 1987 and 2002). The change in title did not seek to bring 'design' and 'crafts' closer together, like the post-baccalaureate programmes. The transition from Artistic Education and Applied Arts to 3AC does not seem to herald a real paradigm shift. However, from the point of view of teaching disciplines, it represents an attempt at clarification by the Ministry of Education. In fact, the expression 'artistic education' contributed to confusion with the teaching of visual arts, whereas 'artistic cultures' rather indicates a sensitization to artistic forms and expressions, including design practices.

It is, therefore, necessary to observe and analyse activity in these different forms of practices to understand the objectives of design and try to identify the relevant knowledge to be taught.

THE 3AC, GENERAL DISCIPLINE AT THE VHS

In France, vocational education in VHS alternates between internships in professional settings and classes in educational institutions. The training of these students is organized into two areas: the professional education area and the general education area common to all 'families of professions' within which the 3AC academic subject is included. After obtaining a vocational baccalaureate (the equivalent of the Business and Technology Education Council, or BTEC, in the United Kingdom), or a vocational certificate (CAP), the student can either enter the workforce or continue their studies. When the professional baccalaureate was established in 1985, general subjects held a relatively limited place in students' curricula. Vocational education emphasized the development of technical and professional skills specific to each trade, often relegating general subjects to a secondary role. Students

TABLE 2 Evolution of designations of degrees in Design and Applied Arts.

Level	Former titles	Titles used in 2022
Technological baccalaureate	Applied Arts Industrial Sciences and Techniques	Sciences and Technologies of Design and Applied Arts (STD2A) since 2011
Short higher education	Higher Technician Certificate (HTC) applied arts Upgrade in applied arts Diploma in crafts	National Diploma of Crafts and Design (NDCD) since 2021
Long higher education	Higher diploma of applied arts industrial creation (HD2A)	Higher diploma in applied arts, design specialty (HD2A) since 2011

attended classes in French, mathematics and science, but these disciplines were often disconnected from their future jobs. At that time, the primary goal was to train qualified workers for specific positions, with general skills considered complementary.

However, with the introduction of the professional baccalaureate in 1985, the situation began to change. General subjects, including applied arts, gained importance in students' curricula, although they were still perceived as complementary to professional skills. Programmes now included courses in French, mathematics, science, as well as history-geography, civic education, foreign languages and applied arts (MEN, 1987). The objective was to provide students with a more balanced education, recognizing the importance of general skills for their personal and professional development.

The 2009 reform (MEN, 2009) marked a significant turning point by further strengthening the role of general subjects. Reducing the duration of professional training from 4 to 3 years was accompanied by an increase in hours dedicated to general subjects. The goal was to better prepare students for diverse careers by providing a solid foundation in general skills while preserving the nurturing of their professional expertise.

The 2018 reform (MEN, 2019) continued this trend by placing even greater emphasis on general subjects. Students gained more flexibility to choose modules in general subjects based on their needs and professional aspirations. This individualized approach allowed students to focus on relevant general disciplines, enhancing their preparation for diverse careers.

Since 1987, and with the pace of vocational baccalaureate reforms, the teaching standards for applied arts have evolved in response to changes in design practices. The objectives have broadened and go beyond the framework of learning creation-conception to address the acquisition of associated skills. While the development of creativity and awareness of artistic expression are part of the goals of the 1987 (MEN, 1987, p. 126) and 2009 (MEN, 2009) programmes, the objectives of the 2019 programme are more specifically geared towards acquiring work methods and building the 'professional culture' of the prepared professional baccalaureate (MEN, 2019, p. 2). Table 3 presents the changes in applied arts programmes in VHS through the inventory of occurrences related to design. Thus, the term 'design' is used 46 times in the latest standard (MEN, 2019), while the 1987 programme (MEN, 1987) only refers once to 'designers' (p. 121) and once to 'product design' (p. 128) (alongside the term 'industrial aesthetics'). This multiplication of the term is representative of the transformation of design professional practices. Crafts and handicrafts have a more significant presence, while the reference to industrial production is less important. In other words, the teaching of 3AC is gradually freeing itself from its industrial heritage in favour of design, handicrafts and crafts. Moreover, it also frees itself from the plastic and aesthetic dimensions associated with it until 2009 to almost detach itself completely from plastic arts in 2019. Finally, the digital aspect is gradually affecting 3AC teaching. Indeed, the standards now recommend a strong digital grounding (MEN, 2019, p. 3) oriented towards the profession prepared by the

TABLE 3 Correspondence Between Kuhn's disciplinary matrix elements, Mitcham's modes of technological manifestation, and study categories.

Elements of the disciplinary matrix (Kuhn, 1970)	Modes of technological manifestation (Mitcham, 1994)	Categories
Symbolic generalizations	Technology as an object	Objects
Paradigms	Technology as knowledge	Declarative knowledge
Values	Technology as activity	Activities—tasks
Exemplars	Technology as volition	Procedural knowledge

student. The understanding of the different design domains aims to enrich the professional culture of students who will not have a professional design practice.

In 3AC, the programme components revolve around permeable disciplinary fields related to design and art history in their practical and cultural dimensions (MEN, 2019, p. 7).

The 3AC curriculum is organized around four areas, two of which claim a cultural dimension related to the following areas of knowledge:

- Design and culture applied to the profession;
- Artistic, cultural and civic openness;

The other two areas, which use an action verb in their name, are related to skills and have a dimension that can be described as *practical*:

- Communicate one's analysis or intentions;
- Appropriate a design process;

It is within this last area, in sustained interaction with the other three, that the practice of creation and design is situated.

THE 3AC DISCIPLINARY MATRIX

The objective of this section is to develop the disciplinary matrix of 3AC to open didactic pathways for teaching design in vocational education. Kuhn (1970) defines the disciplinary matrix of academic disciplines as the juxtaposition of several complementary sets. The *first* set consists of symbolic generalizations, which refer to the theoretical content of the discipline such as its laws (logically formalizable). The *second* set constitutes the metaphysical part of paradigms, which consists of collective adherence to certain beliefs and models, providing researchers with metaphors or analogies to understand the discipline. The *third* set consists of 'values' used to judge theories, refuting the idea that 'truth' is the ultimate epistemic value, according to which theories are accepted or rejected. These values must address the accuracy, consistency, scope, simplicity and fruitfulness of a theory. The fourth (and final) element is the paradigm of representative examples. Examples are illustrations of symbolic generalizations, linking them to problems.

Mitcham proposes four manifestations of technology: technology as an *object*, as *knowledge*, as *activity* and as *volition* (Figure 1).

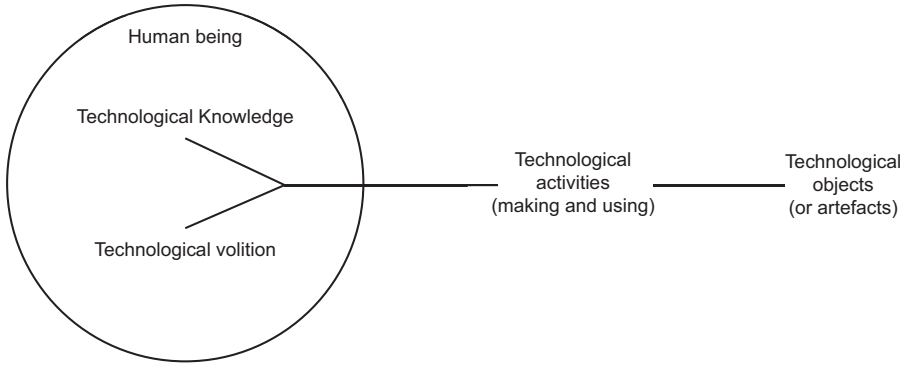

FIGURE 1 Mitcham's (1994) modes of the manifestation of technology.

Several studies interested in describing an epistemology of Technology Education (including D&T) use this approach (e.g. Ankiewicz, 2019; McLain et al., 2019; Svenningsson, 2020). Although not taught in the same education phases,[7] D&T and 3AC are close disciplines. Both offer an interdisciplinary approach and integrate knowledge and skills from different domains such as art, science, technology and humanities. They promote a holistic and cross-cutting approach to learning, contribute to the development of a common culture among students and recognize the importance of digital technologies in the fields of design and applied arts. They also emphasize learning through practice and the realization of concrete projects, encouraging students to develop skills by working on real-life situations and collaborating with others.

Even though there are also differences between the two programmes, using Mitcham's theoretical framework to contribute to the development of the disciplinary matrix appears to be relevant for this study. 'Technology as an Object', corresponds to Kuhn's concept of 'Symbolic Generalizations'. In this context, technological objects become tangible manifestations of the theoretical content within the discipline. These objects represent the practical application of theoretical knowledge.

'Technology as Knowledge' (Mitcham, 1994), can be linked to Kuhn's notion of 'Paradigms'. Kuhn's paradigms encompass collective beliefs and models of thinking within a discipline, which align with the theoretical and conceptual knowledge associated with technology. These domains of technological knowledge are influenced by shared beliefs and models of thinking within the technological field.

The part of Kuhn's disciplinary matrix that pertains to 'Values' and judgements on theories can be associated with 'Technology as Activity' (Mitcham, 1994). Activities related to technology reflect the values and practices underpinning a discipline. For example, values such as efficiency, safety and sustainability impact technological practices.

Kuhn's concept of 'representative examples' (1970) can be linked to Mitcham's idea of 'technology as volition' in his model (1994). However, it is important to note that these concepts stem from different theoretical frameworks, which can complicate their direct relationship. Kuhn's 'representative examples' typically refer to specific cases supporting symbolic generalizations within a discipline, while Mitcham's 'technology as volition' focuses on the ethical and societal aspects of technology. Although there may be potential connections, there is limited empirical evidence to substantiate this relationship, and these concepts are generally discussed independently in academic literature. An interdisciplinary exploration could help clarify any possible connection, but it would likely reveal a nuanced relationship.

The combined use of Kuhn and Mitcham's theoretical frameworks to develop the disciplinary matrix of the 3AC offers a comprehensive and balanced approach. While Kuhn focuses on the academic aspects and the evolution of paradigms within disciplines, Mitcham provides a more detailed perspective on technology as an object, knowledge, activity and volition, as well as the values and ethics associated with technology. This complementarity allows for a deep exploration of the specifics of design education, taking into account both academic and practical aspects. Furthermore, Mitcham's interdisciplinary approach enriches the study by allowing the examination of design from various angles, while considering the ethical and social implications of technology in this educational context.

Following Kuhn, adopting a didactic point of view, Develay transposes the disciplinary matrix to establish an 'epistemology of school knowledge' (1993, p. 53). As shown in Figure 2, objects, tasks, declarative knowledge and procedural knowledge allow for the identification of a disciplinary matrix.

These four elements are quite common in French educational programmes; therefore, these categories are retained for the development of the disciplinary matrix of 3AC. The exploration of potential correspondences between the elements of the disciplinary matrix proposed by Kuhn (1970) and the modes of technological manifestation by Mitcham (1994) is depicted in Table 3.

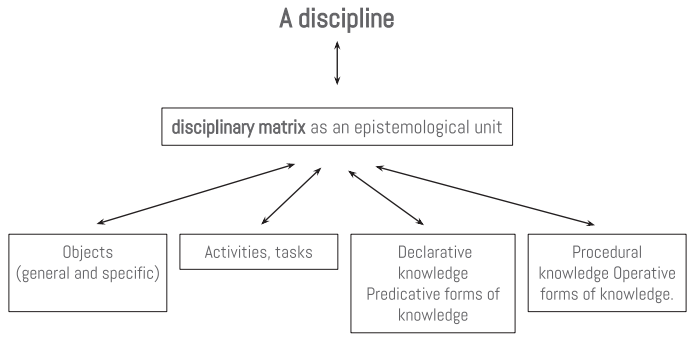

FIGURE 2 The Foundational Elements of a Discipline (Develay, 1992).

The creation of the 3AC disciplinary matrix in the context of vocational design education is essential for several interconnected reasons. In an era where design is constantly evolving, influenced by rapid technological advancements and cultural shifts (Brosens et al., 2023; Hallström & Ankiewicz, 2023), education in this field must be adaptive and aligned with current labour market needs (Herrington & Reeves, 2022). This becomes even more significant as design is increasingly seen as an interdisciplinary discipline integrating elements from the arts, technology, psychology and social sciences (Klein et al., 2001; Klein & Newell, 1998). An established disciplinary matrix can help standardize and harmonize diverse educational approaches, while serving as a foundation for rigorous pedagogical assessments (Wiggins & McTighe, 2011). It also encourages critical reflection on the epistemological and methodological aspects of art and design education, which is crucial for the academic evolution of the discipline (Findeli, 2001; Meyer & Norman, 2020; Orr & Shreeve, 2017). Moreover, by creating the disciplinary matrix, contemporary subjects such as sustainability and design ethics can be more adequately addressed, thus addressing emerging issues in design practice (Manzini, 2015). This emphasizes that an authentic epistemology of design cannot be considered as being static or timeless, but dynamic in that it evolves alongside developments in technology and society. Therefore, attempts to define it must be regularly subject to review and revision. The objective here is, on the one hand, to determine the foundations of the disciplinary matrix of 3AC and, on the other hand, to describe its evolution over the last 30 years. To do so, in the following sections, the objects, activities and tasks, as well as declarative and procedural knowledge, are extracted from the 3AC programme (2019a). They are then compared to previous prescriptive texts, the 1987 and 2009 programmes. However, it also has significance for education policymakers in other countries for how design education curriculum reform is approached, when compared to more definable disciplines, such as science or mathematics.

Objects

According to Mitcham (1994), one of the four manifestations of technology refers to material objects created and used by humans.

Regarding vocational training in VHS, the applied arts programmes do not mention the use of objects that would be specific to the teaching of 3AC, but prescribe the use of physical and digital tools for design, realization and communication. The objects appearing in the 3AC teaching programmes since 2019 have been divided into five categories (Table 3).

The *first* category includes everyday objects. These are common objects (equipment, tools, instruments, clothing, vehicles, furniture, accessories, etc. [MEN, 2019, p. 4]),

communication media (graphic design) and built space (workshops, offices, public and private spaces, etc.). The *second* category of objects includes traditional and general digital tools, explicitly made up of pens and markers and simple digital tools (presentation, layout). The *third* category is that of design objects and tools, such as the specifications, model and certain image editing and 2D and 3D drawing software. The *fourth* category of objects concerns 'art objects' (iconography, works of art and art history texts). The *fifth*, and final, category includes scaffolding objects and school objects (method sheets, tutorials, videos, templates, overlays, mind maps and slideshows).

It is not easy to discriminate between the common or specific aspect of some of these objects. On the one hand, because the names used by the programmes are quite generic.[8] On the other hand, because one of the challenges of 3AC is to move some of these objects from the specific to the general status, cultural objects, for example (iconography, works of art in general, etc.). The evolution of a discipline is correlated with the evolution of the objects it uses (Develay, 1993, p. 38). This correlation between the discipline and objects is clearly visible in the changes made to the curriculum over the years. An analysis of the 1987, 2009 and 2019 curricula reveals a significant transformation in how objects are approached in education.

In the 1987 curriculum, the objects taught primarily focused on everyday objects such as furniture, equipment and clothing. Communication media, such as advertising images, signage, TV spots and jingles, as well as visual media like video, also played a significant role. At that time, traditional analogue tools were predominant in students' creative processes. Specific objects, such as photocopies, brushes, paint, clay and terracotta, were essential for artistic and design practices.

In 2009, the curricula evolved to accommodate the emergence of digital technologies. Everyday objects and common objects remained at the core of education, but communication media were specified to include graphic, editorial, advertising and multimedia communication. The built and non-built environment was introduced, emphasizing the relationship between design and space. Traditional tools were complemented by digital tools, such as word processing software and the Internet, reflecting technological advancements of the time. Specific objects were expanded to include design objects, artworks, craft objects and propaganda images, reflecting a diversification of the areas covered.

In 2019, the applied arts programmes further evolved to consider technological advancements and the current needs of design education. Everyday objects, communication media, the built environment, as well as traditional and digital tools, are now grouped into specific categories. Emphasis is placed on the importance of digital tools, with explicit mention of layout, image editing and 2D and 3D drawing software. Moreover, traditional and digital means and techniques of expression are highlighted, emphasizing the importance of creativity and technology in the field of design. Specific objects are more varied, encompassing art tools, artworks, educational support objects such as tutorials and videos, as well as models and mind maps to stimulate creativity.

The evolution of objects taught in the field of applied arts reflects the curriculum's adaptability to the changing needs of design education. It acknowledges the growing importance of digital tools while retaining the value of traditional tools in students' creative processes. This curriculum evolution ensures that students are well prepared for the current realities of the discipline, maintaining a balance between tradition and innovation in art and design education.

Declarative knowledge and in 3AC

Table 4 lists the declarative knowledge and skills within the teaching standards for applied arts in VHS since 1987. The three 'original' domains of design are addressed according to their status, their relationships with the user, their plastic and technical properties and their

TABLE 4 Declarative knowledge and skills of the disciplinary matrix for teaching applied arts in VHS (programmes from 1987, 2009 and 2019).

2019 curriculum (MEN, 2019)	2009 curriculum (MEN, 2009)	1987 curriculum (MEN, 1987)
Object Design • The status of industrial and artisanal objects. • The relationship to usage and the user. • The technical and plastic properties of main materials. • The relationships between plastic and technical characteristics. • Digital technology in object design.	Product design • The appearance, quality and attractiveness of the product. • The relationship with the user. • The technical characteristics and properties, and its integration with sustainable development. • The plastic relationships between volumes, shapes, structures, materials and colours of objects.	Products • Form (dominant line, ratios and proportions, hierarchy, distribution of shapes, values, colours, materials, organization and rhythm). • Relations to context (social, artistic and commercial). • Visual phenomena (light, chromatics and perspective), changes in appearance. • Aesthetic and technical relationships.

(Continues)

TABLE 4 (Continued)

2019 curriculum (MEN, 2019)	2009 curriculum (MEN, 2009)	1987 curriculum (MEN, 1987)
Graphic design • The nature and status of printed and digital media. • The relationship with the recipient. • The plastic and technical properties of printed and digital media. • The plastic characteristics. • The digital aspect in graphic design.	Graphic design • The image, sign and communication. • Relations to the recipient. • Composition and layout. • Plastic relationships. • Plastic and aesthetic components of still and animated images.	Visual communication • Fundamentals, signifier and signified, denotation and connotation, monosemy and polysemy. • The structuring of visual messages. • The relationships between narrative and plastic components, between image and text, and the basic figures of visual 'rhetoric' • Formal analysis (dominant line, relationships and proportions, hierarchy, distribution of shapes, values, colours, materials, organization and rhythm) • Analysis of visual phenomena (light, colour and perspective), changes in appearance • Analysis of intentional use of form, colour, light and space.

TABLE 4 (Continued)

2019 curriculum (MEN, 2019)	2009 curriculum (MEN, 2009)	1987 curriculum (MEN, 1987)
Space design • The typology and status of space. • The relationships to usage and users. • The technical and plastic properties of major materials. • The plastic and technical relationships. • The digital in space design.	Space design • The typology of spaces and modes of organization of built and non-built environments. • Relations to the user. • The typology of housing, inscription in HQE (High Environmental Quality). • Plastic relationships.	Living environment • The form (dominant line, proportions, hierarchy, distribution of shapes, values, colours and materials, organization and rhythm). • Relations to the context (social, artistic and commercial). • Visual phenomena (light, colour and perspective), changes in appearance. • Aesthetic and technical relationships.
Craftsmanship • The status of the artisanal object. • The plastic and technical relationships.		

(Continues)

TABLE 4 (Continued)

2019 curriculum (MEN, 2019)	2009 curriculum (MEN, 2009)	1987 curriculum (MEN, 1987)
The main concepts of design and art • Works, authors and movements belonging to heritage and contemporary creation. • Impact of the evolution of society, technical and technological advancements on design and artisanal creation. • Contexts of production, exchange or creation. • Major challenges of creation in the twenty-first century.	The main concepts of design and art • Works, authors and movements belonging to heritage and contemporary creation. • Impact of societal, technical and technological developments on design and artisanal creation. • Contexts of production, exchange or creation. • Major issues in creation in the twenty-first century. • Key moments and reference works (chronological markers of major fields of creation, evolution of means of production, industrial revolution, major innovations and ruptures). • Evolution in various fields of creation (trends, eco-design and prospective). • Events that have facilitated exchanges between cultures. • Multicultural societies • Sound arts (aesthetics, means of expression, discovery of practices, relationship to sound materials and the environment, role of the public and creator). • Visual arts (techniques and means, materials appropriation, role of image and digital, hybrid practices, interactive devices and role of the spectator) • Heritage. • Performing arts (reference works, identifying works over time, current events, principles of composing a work, technological and technical evolution, specific vocabulary and artistic practices)	The main concepts of design and art • Artistic productions that are most contemporary in applied arts, craft and industrial design, environmental design, visual and audio-visual communication. • Lineage and connections with productions from previous periods. • The various functions of art and forms of artistic expression. • Influence of technological and scientific advances on forms and modes of artistic creation. • Relationships between the arts and society.
		Visual arts • Fundamental theoretical notions: • Composition. • Colour. • Three-dimensional organization and research in volume.

link with digital technology. Part of the declarative knowledge and skills is related to art history.

These areas of declarative knowledge have hardly evolved over the past 30 years; however, issues related to sustainable development and the environment, as well as digital technology, emerged as early as 2009 (MEN, 2009). In the 2009 and 1987 curricula, arts and crafts are associated with object design, where it is only compared to industrial design, but it has a more prominent place in the 2019 curriculum. The readjustment of declarative knowledge in the 2019 design education programmes reflects an increased focus on the role of the user in design. This trend can be seen as a response to the evolution of consumer society, where the needs and desires of consumers increasingly play a central role. User-centred design has become a predominant design philosophy that aims to create products that meet the specific needs of end users. This evolution has been widely documented in academic and professional literature, notably in the work of Norman (2013), who wrote about the importance of human-centred design in the context of increasingly complex consumer products. Similarly, cultural changes have also left their imprint on design education programmes. The rise of social justice movements and the growing awareness of issues related to inclusion, diversity and equity have likely contributed to more pluralistic approaches and the inclusion of modules such as 'relations to the context (social, artistic, and commercial)'. These cultural movements have stimulated critical reflection on the role that design can play in perpetuating or challenging existing social and cultural norms. They also encourage considering design not only as a technical discipline but also as an intrinsically cultural and social activity that can have extensive implications. Thus, taking into account cultural and social dynamics in design education reflects an evolution towards a more holistic and contextualized understanding of the discipline.

Procedural knowledge in 3AC

Procedural knowledge concerns the concrete realization of an action. It is about procedures to follow, methods to implement or techniques to apply. In the case of 3AC, in 2019 (MEN, 2019), eight aspects of procedural knowledge are associated with the practice of tools and techniques. They not only allow the student to investigate, express intentions, design and produce artefacts, but also to present and share a realization (Table 5).

Overall, procedural knowledge has not fundamentally changed in the successive curricula. However, mastery of cavalier (oblique) and axonometric perspectives is no longer explicitly mentioned. On the other hand, the design of mind maps, slideshows and infographics are new procedural knowledge. In addition, the oral communication of intentions has appeared since the 2009 curriculum. In the 1987 programme, procedural knowledge focused on functional and plastic organization, as well as mastery of graphic and chromatic expression means. In 2009, the emphasis shifted towards the application of a project methodology, initiation to various forms of artistic expression and the communication of observations and intentions. Finally, the 2019 programme expanded procedural knowledge by including research, analysis of products and works of art, justification and argumentation, as well as structuring graphic, written and oral communications. This evolution reflects a more comprehensive and multidisciplinary approach to design, emphasizing research, creativity, communication and critical thinking.

TABLE 5 Procedural knowledge in the disciplinary matrix of teaching of applied arts in VHS (programmes of 1987, 2009 and 2019).

2019 curriculum (MEN, 2019)	2009 curriculum (MEN, 2009)	1987 curriculum (MEN, 1987)
Investigate • Search, identify and collect documentary resources. • Select, classify and sort different information. • Analyse, compare products and works of art.	Investigate • Apply a project methodology. • Identify. • Question oneself.	Investigate • Identify and exploit sources of information. • Gather and/or assemble information elements. • Choose, classify and organize information. • Compare.
Experiment • Select appropriate tools for communication.	Experiment • Initiate oneself to different forms of artistic expressions within the framework of an artistic and cultural partnership -Choose.	Experiment • Arrange plastic elements. • Conduct plastic research. • Organize forms, colour relationships and materials. • Relate functional and plastic organization.
Realize • Respect a request and implement a specifications document. • Engage in a creation-design activity.	Realize • Produce	Realize • Propose several solutions to the problem posed using appropriate graphic, volumetric and chromatic means of expression.
Present and share a creation • Justify and argue. • Structure and present a graphic, written and/or oral communication.	Communicate • Communicate an observation, an intention, a project and an approach. • Present research orally and in writing.	Communicate • Communicate information. • Implement an argumentation justifying an approach, an opinion and a choice.
Represent	Represent • Develop expressive gestures for representation.	Represent • Acquire a know-how in plastic expression (sketch, quick sketch, modelling and mock-up) and conventional representation (geometric views, cavalier and axonometric perspectives)

Activities and tasks

According to Mitcham, one of the four manifestations of technology refers to activity, focusing on human actions and encompassing activities involved in the creation, use and management of technological objects. This can include activities such as design, invention, manufacturing, work, operation and maintenance. Technological activities can take place at different levels, whether they are individual actions, group practices or institutional activities. Mitcham emphasizes that technological activities are deeply rooted in social, political and economic contexts and have a complex and contested nature.

The task is part of a situation, but these should not be confused. From a design perspective, the definition of the task corresponds to the construction of a model for realizing an artefact (Lebahar, 2007, p. 40). However, some distinctions must be made between what is prescribed (the task) and what is performed (the activity). The formulation of a creation-conception task constitutes an indication of the teacher's pedagogical intentions and the targeted competences. For the teaching and learning of 3AC (MEN, 2019), activities and tasks can be grouped into five categories. *First*, investigative activities allow the student to carry out research and analysis,[9] which have been present in programmes since 1987. *Second*, experimentation activities allow the student to manipulate objects, produce graphical elements following analysis or demonstrating a point of view, and transfer and adapt concepts identified in references selected by the teacher, also present since 1987. *Third*, activities that can be described as 'methodological' are related to the specifications and instructions. They will require the student to respect constraints and to evaluate and select a proposal within their production based on its degree of relevance to the specifications. They will also call for group, collaborative and participatory work. These methodological activities are now strongly anchored in professional design practices, whereas in the 1987 programmes, they were more focused on visual arts. In addition, the collective only appears in the 2009 programme, and collaborative and participatory activities in those of 2019. *Fourth*, during realization activities, the student will be able to specify and consolidate a proposal, enrich the realization of the 'masterpiece' and explore avenues in relation to a specification. Again, the realization activity develops and asserts itself in the various programmes, almost non-existent in that of 1987, it finds an important place in 2009 and becomes a major transdisciplinary test in the latest reform of the professional baccalaureate. *Fifth*, and finally, communication activities allow the student to use specific vocabulary, construct and deliver an oral presentation and choose tools adapted to communication. These activities had a minor place in the 1987 programme, while they are grouped in a large cluster in that of 2019.

Thus, some activities (investigation, communication and realization in certain cases) could be described as transversal because they are not specific to the 3AC domains. Their specificity lies more particularly in the link that they establish with the future professional practices of the students. The broadening of design professional practices[10] (Moineau et al., 2022) is driving the mutations of certain activities, particularly methodological activities, while activities related to plastic practices and visual arts are gradually fading. This evolution can be compared to the progressive disappearance of certain objects specific to 3AC presented in Table 3.

CONCLUSION

The modelling of a disciplinary matrix contributes to a better understanding of the evolution of design education in VHS. Thus, the formalization of disciplinary matrices for the teaching of 3AC since 2002 and previously for Artistic Education and Applied Arts (between 1987

and 2002) has made it possible to describe the objects, tasks and activities as well as the declarative and procedural knowledge that underlies (or underlay) these teachings.

This descriptive effort helps clarify what needs to be taught to overcome beliefs, habits and routines. And this approach promotes the transition from design teaching methods belonging either to an industrial creation paradigm or strongly linked to visual arts, to teaching methods where design-conception activity, dematerialization, collaboration and craftsmanship find a significant place.

The discipline of applied arts/design in VHS, to use Kuhn's terminology, has not fundamentally changed, but it has undergone regular adjustments in response to technological and societal change. New design practices are also part of this evolution. Sustainable development, the environment, collaborative and participatory work thus contribute to the disciplinary matrix of 3AC. New objects have also been integrated into this matrix, and almost all of them relate to information and communication technologies. Moreover, the distance from visual arts is highlighted by the disappearance of specific objects related to artistic and design practices (clay, pochade) in favour of tools that could be described as transversal (computers) that students will use in their future profession, whatever it may be (auto mechanic, personal care, etc.). The study of programmes, considering the elements that underpin the disciplinary matrix, testifies to the evolution that this education has undergone since 1987. These curricular evolutions are shaped by changes in design professional practices and related fields (arts, technology, etc.). The evolution of programmes also testifies to the evolution of a transposition of design practices for 'social and cultural' purposes to contribute to the active training of future citizens facing issues of sustainability or ethical challenges.

The notion of objects (general or specific) highlights one of the challenges of 3AC, which is to move, from the students' point of view, 'works of art' from the status of specific objects to that of everyday objects. This example shows that the different components of the disciplinary matrix (objects, knowledge, declarative knowledge, procedural knowledge and a set of tasks) constitute fruitful research avenues for the teaching and learning of design in VHS and more generally to contribute to the development of a design didactics. This article make a significant contribution to the complex nature of design education's epistemology as dynamic (changing and evolving) and interdisciplinary or indeed post-disciplinary (cross-cutting and transversal), when compared to more relatively static epistemologies of disciplines such as science and mathematics.

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ETHICS STATEMENT

In the context of our study, we wish to clarify that the analysis and use of documents are conducted in strict adherence to copyright laws and applicable legal standards, ensuring the integrity of the resources reviewed. The curricula analyzed are systematically cited, and any excerpts used are done so faithfully, without alteration. The presentation of our data and conclusions is carried out with integrity, in respect of ethical principles.

GEOLOCATION INFORMATION

This article focuses on the teaching of design and applied arts in French vocational high schools, with reference to other national curricula including England.

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ENDNOTES

[1] In contrast to the natural world, design encompasses the activities of artefact design in response to needs and goals.

[2] However, the 'solutionist' dimension of design practices is also being questioned (Morozov, 2014; Winner, 2002).

[3] The term 'realization' can also be referred to as production, construction, implementation or elaboration.

[4] 'in-between' is the translation of the French term 'milieu' which designates (1) the middle or centre and its surroundings; (2) the 'in-between two places' (mi-lieu); (3) the ambient atmosphere; and (4) the medium (middle-term, intermediate or mediator) (Petit & Guillaume, 2018, p. 88). So, it would not be a 'third culture' (Snow, 2012), but rather the included third, the one that cannot be precisely substantiated, and yet it defines design: neither one nor the other, but both at the same time.

[5] The thematic dossiers of the journal *Sciences du Design*, for example, focus on topics such as the Anthropocene, sustainable development, health and public innovation, while those of the journal *Design Arts Médias* address topics such as the design of scarcity and the Anthropocene.

[6] A French student enrols in higher education after obtaining the baccalaureate (around the age of 18 years).

[7] Design and Technology (D&T) is part of the national curriculum to the age of 14 years and taught up to General Certificate of Education (GCE) Advanced (A) Level to the age of 18 years in schools in England, while 3AC is taught to vocational track students aged between 15 and 18 years old.

[8] For example, markers or coloured pencils are 'general objects' that all students know, whereas high-quality coloured pencils and markers used in the fields of visual arts and design are 'specific objects'.

[9] It involves identifying materials, describing shapes, identifying functions, recognizing analogies and differences, identifying the characteristics of study objects, putting them in relation and situating them in a context, establishing principles and concepts to extract meaning or symbolism, and finally, making a list to initiate analysis and research.

[10] Service, participatory, social innovation through design, etc.

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