

The role of aesthetics in design education

Leverage of creativity through concrete and abstract form exploration

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Design education has undergone transformations over time, although less emphasis has been placed on developing core areas such as form and aesthetics. Learning processes in design education are creative and comprehensive, but to an extent, learning has become a mission with a large focus on relevance and societal benefits. The designer's role has become somewhat more instrumental, and designers' function more often as facilitators than creators. Nevertheless, form and aesthetics are important competences that enable students to work creatively with both processes and results. As creators, design students need to develop their personal comprehension of forms and aesthetic expressions. This article demonstrates how aesthetics are activated through assignments and exercises that leverage awareness and experiences of concrete forms and abstractions. The assignments and exercises were given to bachelor's degree and master's degree students in Product Design at Oslo Metropolitan University, Norway, and to students from all levels (bachelor's, master's and PhD) at UNESP, Bauru in Brazil. Aesthetic awareness relates to perception and abstract form principles demonstrated through assignments and exercises, including various dramaturgies, results, and reflections. Examples demonstrate how haptic experiences change the way students perceive forms and spaces, particularly when the visual senses are muted or removed. Based on the students' reflections and the results of the exercises, knowledge achieved through their explorations is equally valuable beyond the actual properties of forms and the engagement of personal affect from the creative processes.

Keywords: aesthetic awareness, abstraction, comprehension of form, creativity, design education

Introduction Aesthetic awareness – multi-perception and an open attitude

Design as a discipline has traditionally occupied a position between art and crafts, where comprehension of form and aesthetics are considered core knowledge; however, over the past 60 years, design education has changed. 'Design for the real world', an expression launched by Viktor Papanek (2019), is used in many contexts in the development of design to something else, more than design as a form giver. Many new fields of design have been established. Education related to the new, broader design fields is essential because the world is becoming increasingly complex, and there are many new areas in society for which designers are sought, such as areas within UX design, particularly service design. Design education is overcoming new challenges by introducing new fields into the design curriculum subjects, such as ethnography, culture, and psychological approaches, which involve knowledge about human behaviour and interactions. In a complex world, information has become more available. Design students often deal with collecting large amounts of data, and there is not always time to digest and work exploratively in the next phases to create original and novel design products. Students should be challenged on a personal level and have time and frames so that they can explore and charge their personal register as creators. This involves an awareness of surroundings and interactions with forms and people. As a design field, service design has emphasised fields other than aesthetics to overcome challenges in a complex world. Service designer Marc Stickdorn mentions aesthetics only when describing what service design is not: "it is not simply aesthetics or putting lipstick on a pig" (Stickdorn et al., 2018, p. 24). Design is not, and will never be, only about human behaviour. We are all part of a *material culture*, and design should always involve competence in form, aesthetics, and crafting skills.

I propose that design should maintain its position as a *making discipline*, and that aesthetics should not be reduced to a cosmetic factor of design.

In this article, perspectives on aesthetics in design education are grounded on awareness and knowledge from our senses, abstract form theories, and engagement through materialized processes (material agency). Two assignments and short exercises were used to demonstrate the role of aesthetics in design education. Abstract knowledge is based on theories; however, the examples in this article show how abstraction is experienced and becomes embodied. The comprehension of form in art and design is based on three types of knowledge: propositional knowledge (theoretical knowledge), practical knowledge (skill or procedural knowledge), and confident knowledge (Jarvis, 2002; Nordenstam, 1983). Embodied knowledge is another term for confidential knowledge, which means that knowledge from theory and practice merge. An important pedagogical goal of this article is to demonstrate how materialized, explorative processes, and personal engagement in the making can enhance creativity in design education. There are many layers of creative choices that take place during the *making* processes, and which develop the students' comprehension of form as both abstract and embodied knowledge.

I am a ceramic artist, teacher, and researcher. In my work, and comprehension of form, the three forms of knowledge are activated. I use elements and principles for formal relations from form theory to describe the forms I experience. I perceive a form's proportions, structure, directions, and movements because I am familiar with the theoretical principles and have acquired the skills to handle forms professionally with confidence. Thus, my experience of forms is both embodied and theoretical. According to Rolf (2017), the connection between propositional knowledge and experienced knowledge (practice) is 'intimate', and experienced and theoretical knowledge often have a "common ground" (p. 66). Therefore, an important part of research, and as a learning outcome for design students, is to find "the underlying knowledge" as a starting point for integrating practice and theory (2017, p. 72). One way to leverage embodied knowledge beyond the personal is to communicate experiences from practice visually and to use abstract principles from theory as "common ground" and part of the framework and criteria for explorations and analyses. The examples in this article shed light on Sawyer's (2018) ethnographic study on pedagogical practices used to guide art and design students in learning how to create and develop their creativity. Creativity is a skill and a core element of professional practice. Creativity has many definitions. According to Sawyer (2018), the central concept of teaching and learning within art and design is three themes for creative processes: "learning outcomes associated with the creative process, project assignments that scaffold mastery of the creative process, and classroom practices that guide students through the creative process" (p. 138). A central learning outcome in this study is defined as comprehension of form – concrete and abstract. The assignments and exercises used a few aesthetic tools to contribute to the students' concentration in order to experience mastery. The examples do not directly show how the students are guided in the classroom. Nevertheless, my experiences from taking part in the student's creative processes affect how the process, their reflections, and results are communicated.

According to Sawyer (2018), creativity research presents four different conceptions of creativity: as a personality trait, as self-expression, as a moment of insight, and as a process of working. Any one of these might be found in art and design schools, and each of the four conceptions has different implications for teaching and learning (Sawyer, 2018, p. 138). As indicated about merging knowledge from practice and theory, it is not easy to distinguish creativity in design education as a moment of insight from the process of working. Much creativity research is connected to *design thinking* (divergent thinking). However, materialized processes in art and design are "nonlinear in which ideas and images emerge from the process of working with materials" (Sawyer, 2018, p. 142).

An important pedagogical goal of this article is to demonstrate how materialised, explorative processes and personal engagement enhance creativity in design education. Creative processes include both

intuitive and systematic methods that apply to exploration, interpretation, and communication. Boris Müller (2017), a professor of interaction design, described intuition as a skill: “Generally speaking, intuition is the ability to reach conclusions and make decisions without conscious reasoning” (2017, p. 2). Theories about the value of intuition would help students enter and stay in fuzzy zones when working exploratively with design. However, mastery of creative processes also involves skills in, for example, registration and *seeing with the hands*, and skills and to articulate these. Registration refers to an analytical approach to seeing, based on criteria such as structure and rhythm. Seeing with your hands means expanding sensory experiences by limiting visual perception. It is also a well-known approach to creating beyond what you see based on what you think you know (symbolic appearance) (Edwards, 1979). An overarching aspect of the explorative process is the concept of *aesthetic awareness*, defined as “an open attitude and sensitivity to interaction between the form and body through the material” (Heimer, 2022, p. 6).

The two research questions guided this study: (I) How can aesthetic awareness leverage creativity in educational settings? (II) Given that the comprehension of form is concrete and abstract, how can abstraction enhance concrete experiences of form? In art and design, the theoretical and methodological foundations overlap, as the theory referred to also contains methodological elements. To effectively discuss the issues raised, we need theories and methods that shed light on the central concepts, which can generate links between aesthetic practice and theory in new ways. This part is divided into two sections: Aesthetic awareness – Multi-perception and an open attitude, and Comprehension of form – Concrete and abstract.

Aesthetic awareness – multi-perception and an open attitude

The definition of aesthetics is broad, and like many other concepts, it can be described as a travelling concept affected by time and place, as well as by culture, society, and language (Blok Johansen, 2018, p. 9). The concept ‘aesthetic awareness’ is used in this article to emphasize that aesthetics involves perception, attitudes, and conscious actions (Saito, 2014). The concept of aesthetic awareness is used in parallel with aesthetic experience—knowledge and competence—to underline the connection between theory and practice as a methodological dimension in design education. Jørgensen (2018) emphasised that aesthetic experiences are a matter of cognition. They are a matter of sensory experiences and logical cognition. Aesthetic experiences are “a special form of cognition carried by emotions, sensations and hunches” (Jørgensen, 2018). As a craftsperson, my aesthetic knowledge is aesthetic through the use of the several senses (Baumgarten, 2008), being pragmatic (Dewey, 2005), utilising the ‘living line’—a concept that relates to aesthetic attitude and the interpretation of forms as energies, which correspond to the body’s movements (Munsterberg, referred in Veder, 2015, p. 2)—and applying concepts based on formal aesthetics (Akner Koler, 2007; Critchlow, 2011; 1969; Hannah, 2002; Wong, 1993).

To develop and utilize aesthetic competence in design, it is of great value for students to activate their perceptions. They must expose themselves to sensory experiences using different modalities of the senses. Psychologically, visual perception has been and is the most dominant of all our perceptions; however, in the making disciplines, synesthetic (in the sense of multisensory) experiences are an enrichment because our perceptions are activated in several ways, which creates stronger and richer experiences. To stimulate students to have an open attitude and sensitivity to interaction between the form and body through the material would expand their experiences and enable them to reach the core of phenomena. Learning outcomes should open up concrete and abstract expressions, which are perceived through our senses and feelings. Further, the students need aesthetic tools and vocabulary to analyse and communicate these experiences. Figure 1 shows a photo representing my aesthetic experience of modelling. The photo is from my doctoral thesis, *Grip, to get a grip of form. Concrete and abstract comprehension of form* [Published only in Norwegian: *Å gripe for å begripe form. Konkret og abstrakt formforståelse*] (Heimer, 2020, p. 66). Through frames and criteria for modelling based on

haptic perception, my experience became focused. The photo combined with the quote below gives a nuanced picture of how I became more aware of the hand as form, structure, and movements. Through the study of my modelling hands, I saw the potential of the hands as an aesthetic tool, which enhanced my possibilities to work creatively.



Figure 1. Modelling hands. From a series of photographs showing characteristic positions and movements when I model forms in clay (Heimer, 2020. p. 66). Photo: Geir Foshaug, 2014.

The multi-perspective of the hands. The perceptions of the hands that are triggered by touch and movement, give me a different and more holistic spatial understanding of the form compared to when I only see it. I perceive proportions, structure, directions and movements in the form in a way that enriches what I see (Heimer, 2020)

Comprehension of form – Concrete and abstract

Abstraction is a crucial factor in the comprehension of form, as it functions as an aesthetic tool and structure in a way similar to how grammar functions for language. It provides an understanding of how we perceive and create forms. There are other factors that influence our experiences as well—that is, earlier experiences, knowledge, and fantasies. According to Steinø (2012, p. 147), “form-making involves the capacity to understand, conceive, and create form. This capacity is at the same time a cognitive, linguistic, and bodily capacity, which therefore requires a careful pedagogical setup in order to be taught successfully”.

A common term for form theories is ‘basic design’. Basic design functions as an analytical tool and structure for new forms and constructions. According to Denman W. Ross (1853-1935) and Arthur W. Dow (1857-1922), both prominent educators in design and art, abstract principles were originally established to “provide grounds for experimentation and exploration of possibilities [...] reasoning does not necessarily depend on a finite, universal vocabulary. Rather, it develops with definitions that are continuously changing” (Özkar, 2017, p. 143). Principles related to formal relationships must be understood dynamically and require the individual performer to reflect on their aesthetic choices during the design processes to create greater room for creativity. Basic design involves abstract theories for the comprehension of form based on geometry and ‘geo-organic vision’ (Akner-Koler, 2007; Critchlow, 2011, 1969; Hannah, 2002; Wong, 1993).

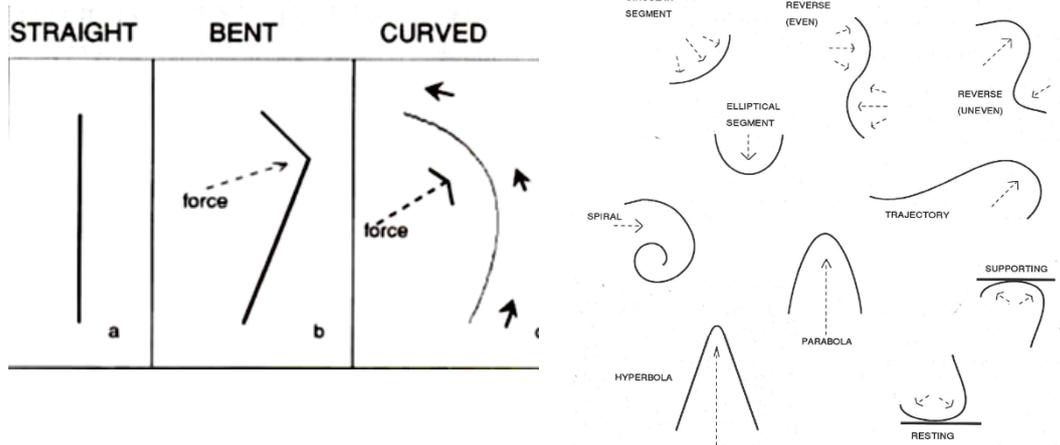


Figure 2 and 3. 'Straight, Bent, Curved', and 'Curve chart'. Two visual analyzes for different activities in lines and curves. In *Form & Formlessness. Questioning aesthetic abstractions through art projects, cross-disciplinary studies, and product design education* (Akner-Koler 2007, p. 117–118).

Geometry belongs to mathematics, a science that can provide real knowledge about the world without justifying it through experience (Godfrey-Smith, 2003, pp. 20-21). Geometry was originally created to obtain two-dimensional constructions to *explain* the world based on abstract principles for spatial form and concepts for 'number in space' (Critchlow, 2011, p. 41). This reminds us that we ourselves are part of geometry and that understanding concepts involves calculated numbers, geometric structures, and how we perceive forms. The basic concepts of geometry are point and line. A point in geometry constitutes the smallest unit. A point in motion creates a line. Surfaces and volumes are created when the line unfolds into two and three dimensions, respectively. Examples of formal relations of form theory are proportion, position, and direction. Akner-Koler (2007) described the concept of a geo-organic vision as "a fusion between geometric abstractions and organic principles of growth and tension in forms" (p. 18). Figure xx shows some of Akner-Kolers' (2007) visual analyses of various lines and their inherent forces and movements.

The examples of assignments and exercises below—*Lines in space*, *Haptic exercise*, and *Registration and exploration of form – Structure and rhythm*—are chosen to demonstrate how the students develop their aesthetic awareness of forms and boost divergent thinking through their working processes. The examples also shed light on different perspectives on conceptions of creativity, which Sawyer (2018) described as moments of insight, self-expression, and processes of working.

Lines in space – Single line drawings

An abstract assignment that I often use is based on Rowena Reed Kostellow's abstract assignment 'Lines in space', which is volumes made from a metal rod (Figure 4). 'Lines in space' is a form exercise constructed as a continuous, spatial line and based on the form principle 'Dominant, subdominant, and subordinate', a form of asymmetry introduced by Kostellow (Hannah, 2002, pp. 50–53). Single-line drawing is well known within art and design, and is used to increase flow in two- or three-dimensional forms. Kostellow used this exercise to develop an understanding of dynamics in spatial asymmetric forms. The criterion for the assignment 'Lines in space' is that the volume should be made of six lines (straight or curved). An important criterion for this assignment is that for each new line, the metal wire is bent and changes direction. In this way, the form is activated in six different planes in different directions in space, hence the term 'multidimensional'. The volume form was made from a 100 cm welding metal rod. The form has a distinct, clear expression and is well activated in space.



Figure 4. “Lines in Space”. Volume form based on the asymmetric form principle, “Dominant, subdominant and subordinate” (Hannah, 2002). Photo: Martin P. Knudsen 2020.

Of the six lines, two should be straight lines, while the other four should be curved. Other criteria used in this assignment are form principles applied to formal relations, such as proportions and the shapes of lines (straight, various curves), to promote activities as movement and forces in the volume. The two straight lines in the composition act as neutral contrasts to the curves. This means that the straight lines contribute to and emphasise the activity in each of the curves and in the relationship between parts and wholeness in the form. Through this assignment, the abstract knowledge of lines is experienced concretely. Akner Koler’s visual analyses in Figure 2 and 3 (2007, p. 117–118) are based on Kostellow’s theories (Hannah, 2002).

Based on my teaching experiences, I see how criteria from “Lines in space” combined with the visual analyses of lines work well in guiding the students in their exploration of lines. Another important factor is the use of a metal rod. The metal wire provides *positive resistance* in the creative process. It is obvious that experiences with the materialised lines had an impact on the students’ comprehension of forms as activities. Terms such as ‘inherent forces’ and ‘movements’, which are central in the ‘geo-organic-vision’, become clear both as concrete and abstract forms. Single-line drawing is connected to the concept of a ‘living line’, that is about aesthetic attitude, and the interpretation of forms as energies—which correspond to the body’s movements (Munsterberg, in Veder, 2015, p. 2). The line explored as a multidimensional, single-line drawing is an effective tool and approach for spatial sketching processes and for articulating forms representing actions and interactions. In my teaching, I have used this approach for various short exercises. Examples include the use of single line-drawing to articulate the form of a sound and to register and analyse interactions with products and/or people. When introduced to this exercise, the students were reminded that all our movements have a form; for example, there are differences in forms, such as the way we grip a cup for coffee or a pint of beer. Representing the movement for bringing the drinking vessel from the table to the mouth is most likely also different if it is a tiny, delicate porcelain cup compared to a large glass of beer. It is interesting to observe how students enhance their embodied knowledge and express their experiences both concretely and abstractly. Figure

What is obvious is that proportions are perceived differently when visual perceptions are limited or removed (Heimer, 2020). This perspective on haptic perception has also been discussed by other researchers, such as Akner-Koler (2007, and personal conversation) and Hesselgren (1954). Visual perception is closely connected to our pre-understandings of forms. To create a form based on a familiar motive/form, there is a risk that the form will become a representation of what we know about the form—not the potential of how we experience the form (here and now).

The photo in Figure 6 depicts the results of a haptic exercise for second-year bachelor's degree Product Design students at OsloMet. This haptic exercise was inspired by Johannes Itten (1975), based on the way he taught aesthetics for the foundation course at Bauhaus. The material chosen was clay. The students worked blindfolded to enhance their haptic experiences and to avoid being distracted by what they thought they knew. This exercise was conducted in two parts of 20 minutes each: (1) The students sat around tables and were told to cover their eyes with a textile ribbon. They received a spheric, hand-sized piece of plastic clay, followed by a fresh fruit familiar to them. The next step was to model the form of the vegetable or fruit. The students had to work in silence throughout the session to remain focused. As an observer, I recognised that the concentration for registering and giving shape to the clay increased during the 20 minutes. (2) For part two (still blindfolded and silent), the students received a new, spheric, hand-sized piece of plastic clay, followed by the same fruit but cut in half. The version of the fruit cut in half changed the experience and gave the students a completely new sensation of the form. The students were then asked to model their experiences with the fruit once more. The only documentation from this exercise included photos and reflections during oral presentations. Based on the dialogue with the students, it was clear that the clay was experienced very differently. Some students had a hard time gripping the plastic clay, which they found difficult to form and define. Other students became engaged and highly focused. What was obvious was that proportions were perceived differently when visual perceptions were limited or removed. The modelled forms were often similar to caricatures—exaggerated. Caricatures highlight the essence of forms and give us a new, more distinct version of reality. The results of this exercise can be compared with similar assignments that I have given during my long teaching experience.



Figure 6. Modelled pomegranate. Results from the Haptic exercise – with students blindfolded. (Photo: Student 2 BA, 2020).

One student working blindfolded in a freer explorative form exercise described the process as *conscious–unconscious*. I like this expression because it represents a kind of twilight stage, meaning an ambivalent, creative stage and letting go of control. Another reflection on working blindfolded is from a first-year master's degree student. As she worked blindfolded, making modelled hollow clay forms,

she became more aware of her perceptions, and that limiting visual perception could possibly strengthen her observation skills. Her reflections, described in the quote below, are from the article ‘The value of crafting in design’ (Heimer, Andreassen et al., 2016):

She experienced a calmness and rhythm of work that enhanced her focus and strengthened her other senses once the visual sense was removed. She claimed that this may have affected her further work with system design in a health context. She exemplified the use of blindfolds when making observations of space and activities in places such as hospital sites in terms of better recognition of sounds, smells, and other impressions.

These examples from the haptic exercises demonstrate the role of perception in design. Limiting visual perception works as a *positive restraint* in the exploration of form, which opens up new experiences that affect the comprehension of form. The frame for the process contributed to the students’ creativity and guided them to avoid symbolic expressions based on what they thought they knew. The last example is related to enhancing observation skills, which shows that haptic exercises have an effect on students’ learning beyond forms.

Registration and exploration of form - Structure & rhythm

In brief, ‘Registration and exploration of form – Structure and rhythm’ is an assignment during which the students explored two-dimensional and spatial (3D) forms through various media and techniques and different perspectives. The only materials and tools used were pens, photos, paper, and glue to join multiple volume forms. The examples shown in this article are from first-year bachelor’s degree product design students at OsloMet. The assignment was divided into three parts, in which the students worked with sketches, abstract volumes, and compound forms. The point of departure for this exercise was the roof of the Opera House in Oslo. Barcode, which at the time was a new distinctive skyline seen from the Opera House, became the most popular view for the students. The criteria for Part 1 were as follows: Work with sketches as media for the registration of forms in an Oslo urban space. Emphasise structure and rhythm. Use different sketching techniques and drawing tools to develop rich visual vocabulary. For this part, the students worked individually. Structure and rhythm worked well as keywords for the sketches (Figures 7 and 8 left).

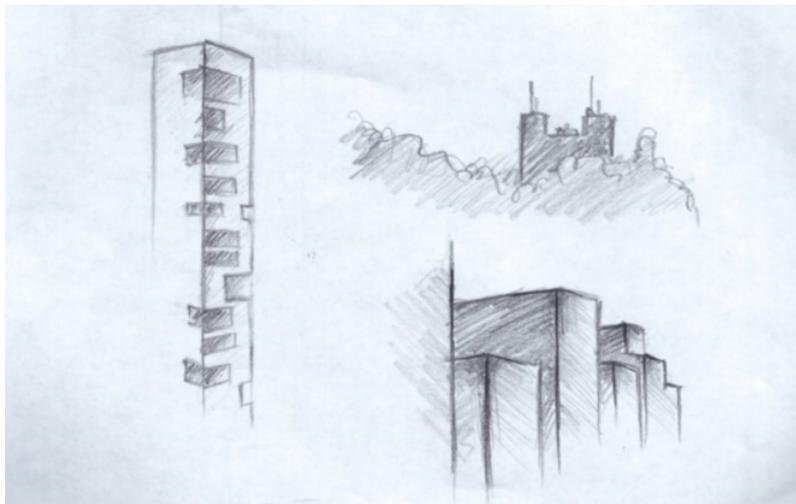


Figure 7. Sketches. Results from the assignment, ‘Registration and exploration of form – structure and rhythm’ – Part 1. (Students IBA, 2015).

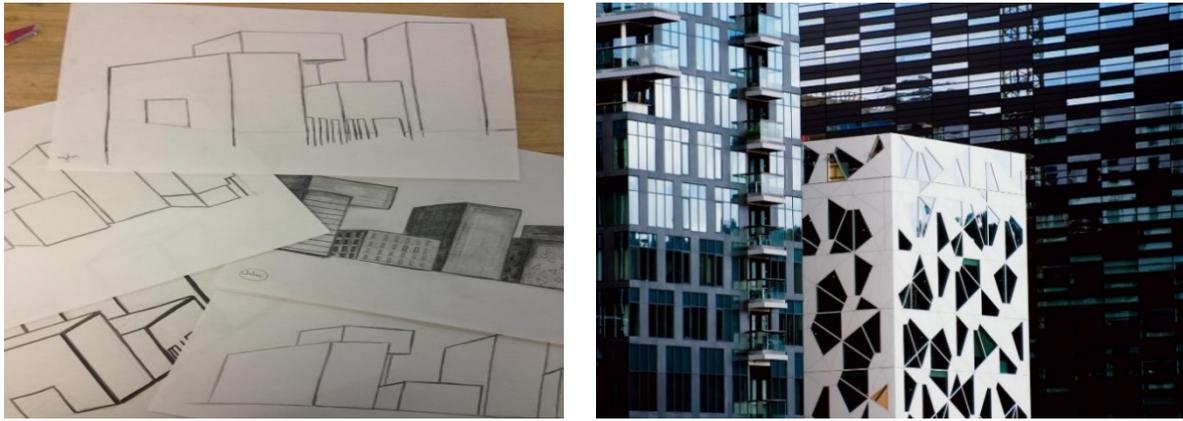


Figure 8 and 9. Sketches. Results from the assignment ‘Registration and exploration of form – structure and rhythm’ – Part 1 (left) (Students 1, BA, 2015). Photo of Barcode, Oslo (right) (Photos: Student 1 BA, 2015)

On the second day, the next part of the assignment was presented to the students. The criteria for Part 2 were as follows: Explore abstract volumes through folding techniques (A4 paper). Make 100 identical volumes and create a large compound form. Figure 8 shows variations in forms and materiality (use of geometry and sharp edges, symmetric neutral curves, and textured crunched paper).

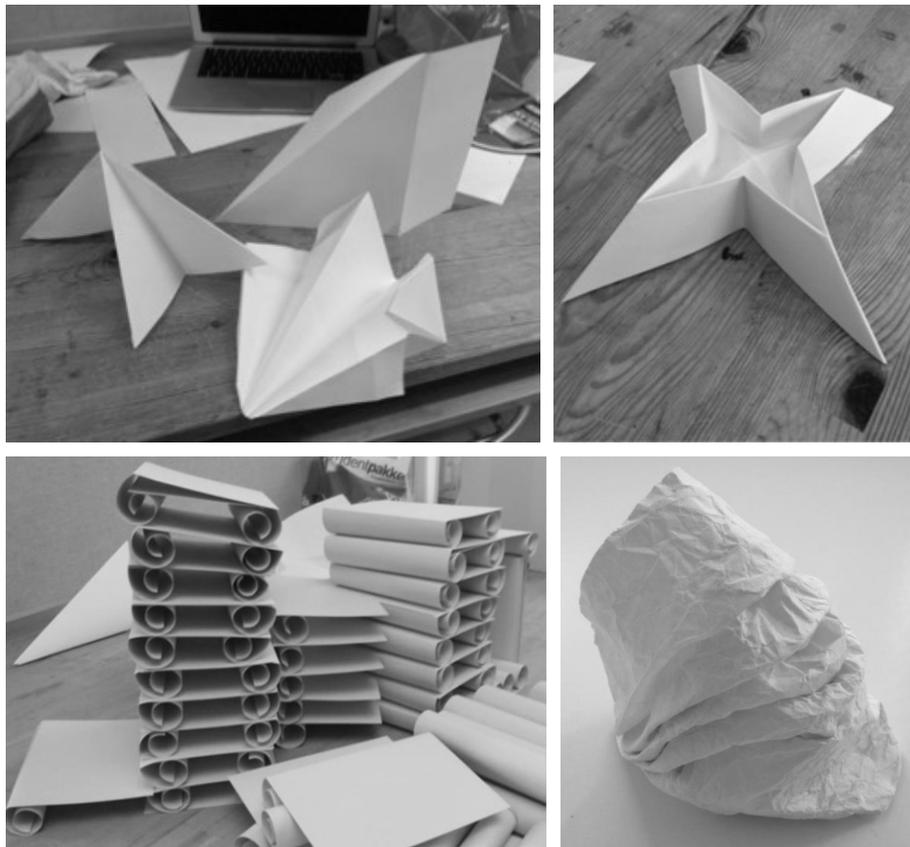


Figure 10, 11, 12 and 13. Various volume forms made by folding techniques (A4 paper). (Photo: Students 1 BA. 2015)

In the third part, the students continued working in teams. At the beginning of Part 3, all materials (sketches and volumes) were collected and analysed. Each team selected one sketch to represent structure and rhythm and one abstract, folded volume (duplicated, 100 copies) that could work well as a module in compound form. The different parts of the assignments were presented separately, and the students did not know from the beginning that the different parts were to be combined in the last session. The purpose was to give the students the freedom to explore volumes. If the students knew all three

steps, there would have been a risk of limiting themselves to a more linear process. The three steps were set up to avoid the students purposely planning their exploration to create *the* optimal volume as a module for a compound form.

Figure 14 and 15 shows a sketch of the windows on one of the blocks in Barcode and a compound form (detail) made of abstract folded forms inspired by the structure and rhythm seen in the sketch. One of the groups took inspiration from a sketch based on a study of windows as various triangles in one of the blocks of the Barcode. In the sketch in Figure 14, the lines create an exciting structure and rhythm that almost resembles a small alphabet. These lines were then transferred to the geometric volume forms to generate a rhythmic ornamental pattern.

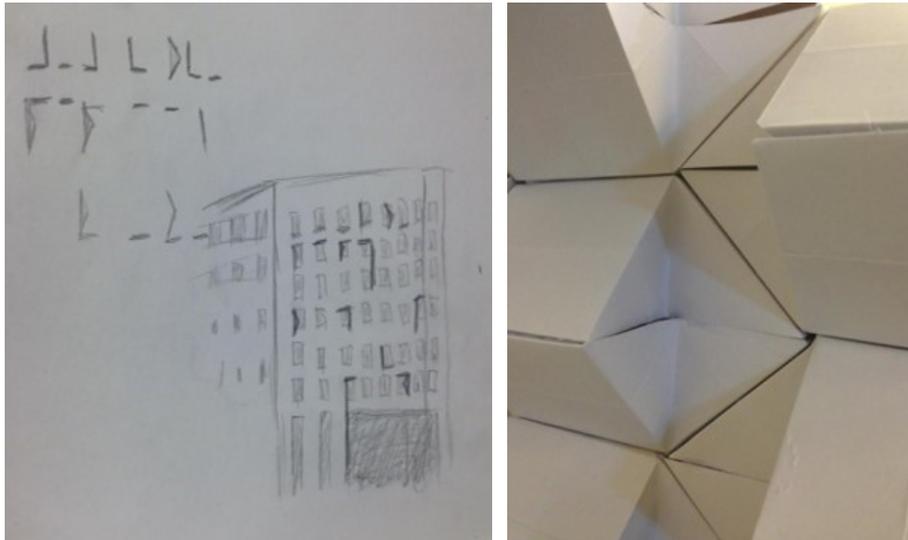


Figure 14 and 15. Sketch of a building from Barcode, Oslo. Structure and rhythm are keywords for exploration of form (left). Compound form (detail) of volumes made by folding techniques (paper A4). The photo represents an exploration of ornamental structures (right). (Photos: Students 1 BA, 2015).

One of the groups chose a star-shaped volume. This form has good material strength and construction principles and functions well as a module in a compound form. The star-shaped module is also flexible, which allows the exploration of the compound form in different ways. The two photos shown in Figure 16 and 17 depict two versions of the compound form. The students explored how they could use various compositions to create a new interpretation of Barcode as rhythm, depth, a positive to negative form, and a reflection of the buildings in the surroundings and towards the water (Oslofjord).

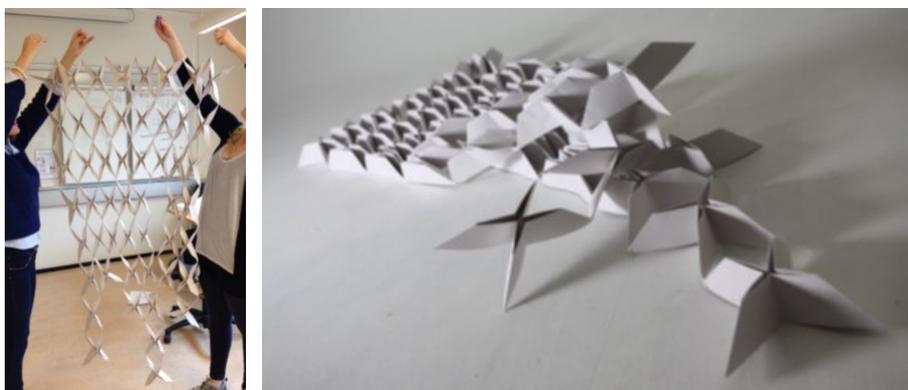


Figure 16 and 17. Compound form made by 100 identical star-shaped volume forms (module) (paper A4) (left). Version of the compound form as shown to the left (right). (Photos: Students 1 BA, 2015).

The quote from one of the students' reflections demonstrates that the combination of concrete and abstract approaches to form exploration gave the students important perspectives on how to perceive concrete forms:

What I liked about this assignment was first and foremost that we had to invert our thinking and get very abstract angles on our ideas. We had to learn to look at buildings in a whole new way and see them not as buildings but as a feeling. I think I will benefit greatly from being able to think this way in future design assignments as well.

Some of the students wanted more information about the requirements of the task in advance and stated that there was too much 'guesswork' during the making, analysing, and communication of the work. There were also questions about sketching: What does a *rich visual vocabulary* mean? Nevertheless, the students seemed to manage their apprehensions, and according to one student, *this assignment requires openness, which involves an element of doubt and is a natural part of exploration and quests*. This quote is in line with creative theories that involve intuition. Referred to in the section above, intuition

is a skill and "ability to reach conclusions and make decisions without conscious reasoning" (Müller, 2017, p. 2). Students need to enter and stay in fuzzy zones to reach new experiences and creative results in design.

The next example demonstrates how the creative process of working with shaping abstract volumes can influence the concrete development of design products. The example is also from the course, 'The creative space, form, perception originality, novelty in design education' at UNESP, Brazil. As part of the introduction to Part 2 of the Registration and exploration of form – Structure and rhythm' assignment, abstract volumes through folding techniques (A4 paper) were introduced. A PhD student who participated in the course was conducting research on a medical vaginal speculum. This course served as a break from her PhD studies; however, the abstract explorative work was stimulating for her PhD project. Figure 11 shows how the students explored the geometry of forms through analogue and digital media.



Exploration av form - Origami

"I believe that the results were quite enlightening on the question of the limits of shape morphology."

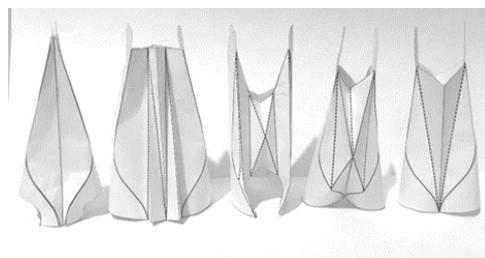
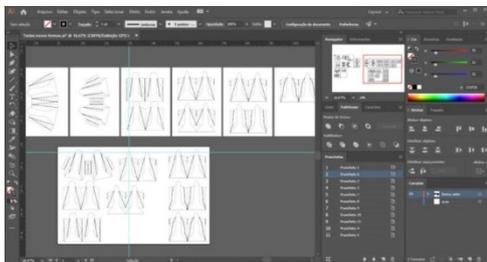


Figure 17, 18 and 19. Medical vaginal speculum (upper left). Volume forms – digital experimentation (bottom left) Volume forms – paper (bottom right). (Photos: PhD candidate, 2019).

The abstract volume forms were versions of flexible forms with an open and close function that was far more dynamic than the original function of the instruments she had seen or had imagined. She reflected:

Exploration of form – origami. I believe that the results were quite enlightening on the question of the limits of shape morphology. It is obvious that the hands-on exercises contributed to creativity and originality in forms. The folded forms turned out to be totally new semantics.

This quote connects to Haverkamp's (2012) description of aspects of aesthetics and the use of the senses in design education. He proposed combining the functional with aesthetics and sensuality:

The synesthetic orientation of product design also requires abandoning the separation of functional engineering and design as the field of aesthetics and sensuality [...] The task of design consists of more than addressing the technical aspect – moreover, the sensually tangible must be organically deduced from the functional. (p. 413)

The abstract approaches expanded the students' experiences and perspectives on the *concrete* world—surroundings and existing designs. The examples in this section demonstrate the role of abstraction in design, and how it works as an aesthetic tool for explorations and analyses that contributes to the creative processes.

Concluding remarks

Aesthetic exercises are not just playful activities as an introduction to design before learning to design for the real world. Students must challenge themselves in the design processes to overcome their preconceptions about forms and to expand their creative space. Design has become a strong user-centred discipline, in which product development is often based on user surveys rather than personal, explorative processes. During complex design processes with a wealth of information and experiences, students sometimes forget to use their own voices. Aesthetics is certainly not only cosmetics for design but also involves knowledge, attitudes, and embodied experiences. Working with aesthetics in design involves intuitive and systematic phases, and it is crucial to maintain curiosity and encourage explorative processes. Aesthetics not only involves beauty and harmonious forms but also involves developing knowledge and an awareness to find 'the underlying knowledge' for how we perceive forms. Of importance in that sense is to integrate practice and theory, and to communicate personal experience (Rolf, 2017, p. 72). In a complex world, where information has become more available, it is important for design students to digest collected data and new experiences. Students should be challenged on a personal level and develop aesthetic tools for exploring and charging their professional register as creators. This involves an awareness of surroundings and interactions with forms and people. Design is part of the making disciplines, and it is time for recalibration to contribute to students' confident knowledge and to reduce the polarisation between design thinking and design making in design education. The examples in this article demonstrate that when connected to embodied learning, aesthetics contribute to students' experiences of the material world and to interactions with people. Aesthetic perspectives in design education challenge students to perceive reality in multiple ways. The examples also demonstrate how aesthetic awareness can expand the capacity for divergent thinking and promote creativity.

The aesthetic assignments and exercises discussed herein demonstrate how abstraction and creative processes that involve working with various media enhance students' consciousness of and engagement with form. Abstraction is a theoretical foundation, as well as a methodological strategy to uncover new forms and expressions for interactions. Abstract knowledge enhances our comprehension of form as concrete, materialized forms, and immaterial forms as forces and movements. This means that design making not only results in products but also contributes to students' comprehension of the world from an embodied aesthetic point of view. Through the assignments, the students in this study also learned how experiences with form through making can have an impact on how we perceive our surroundings, including people. The real world can be experienced more clearly through abstractions, as shown in the examples above; that is, the exploration of abstract forms based on sound can contribute to new understandings of patients' 'joys, sorrows, feelings, and pains', as illustrated by the exercise 'Form representing a sound' (single line drawing). The example 'Haptic exercise' demonstrates how haptic experiences of forms and form processes can change students' mindsets when visual perception is limited. Positive restraint in creative processes had an effect on students' comprehension of form. It also opened up explorative processes in which the students made forms beyond symbolic expressions based

on what they thought they knew. The last example of haptic exercise is related to observation skills and shows that haptic exercises can affect students' learning beyond aesthetic expressions and forms. Transformation of form between sketches based on concrete experiences to abstract expression, as demonstrated through the assignment 'Registration and exploration of form - Structure & rhythm', sharpened the students' perceptions in multiple ways. There were few criteria for each of the steps that helped the students to concentrate and deepen their creative processes. Nevertheless, comments from the students clearly indicate that the formulation of criteria and learning outcomes should be clear. The expression rich visual vocabulary could easily be replaced with great variations of form expression.

Aesthetic awareness and abstractions are crucial for creative processes and enable students to develop original and novel products for the future. Aesthetic experimental assignments are often given early in bachelor's degree study programmes in design education. Nevertheless, form, aesthetic awareness, and a multisensory approach to creative processes need to be taught at all levels. The PhD student who worked with folding techniques and achieved new semantics for a medical vaginal speculum is an example of how abstractions contribute to creativity and originality.

Among Sawyers' four criteria for creativity (2018) – personal trait, self-expression, moment of insight and process, and the creative process – are often put forward in today's design education. By guiding the students towards a greater aesthetic awareness, they can reach a level of subconscious and discover and express their inner voice (self-expression) as new forms. To challenge the students' perspectives using abstraction has the potential to reconstruct their minds and experience moments of insight.

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