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The Interplay of Engineering Skills, Aesthetic Creativity, and Ethical Judgement in the Creation of Sustainable Urban Transformations: Aristotelean Perspectives on PBL

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ABSTRACT

This paper examines a PBL project module "Sustainable Urban Transformation" in an Urban Design master's education. The module combines urban design and hydrology engineering. Within the module, students are supported by lectures and study circles on various dimensions of sustainability, especially vis-a-vis climate change. However, they are left with the freedom to choose how they balance between design and engineering approaches when they give a physical form for sustainability in the site transformation projects with which they work through the semester. This paper discusses the development of their skills building on three Aristotelean concepts: techne (engineering), poiesis (aesthetic form-giving), and phronesis (making of ethical judgments). The last two concepts, the paper argues, are especially important when at issue is design education. Based on an analysis of the student projects in Fall 2022, the paper examines whether and how the students manage to find a balance between engineering skills, on the one hand, and aesthetic creativity and ethical judgement, on the other hand, in their project work.

Keywords: Urban design, design pedagogy, sustainability, engineering, ethical judgement, problem-based learning

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INTRODUCTION

This paper examines a problem-based learning module "Sustainable Urban Transformation", which is part of the Urban Design master's program at Aalborg University. Each module in the program combines urban design with some specific branch of engineering science – in this case hydrology. The core of the module is a project where the students work in groups, each group being supervised by one urban designer and one hydrologist. The task given to the groups is to create a design for a sustainable transformation for a pre-selected urban site in the face of climate-change related challenges.

In this paper, the focus is on the theories behind the pedagogical solutions in the "Sustainable Urban Transformation" module. In the design of the module, the relation between knowledge – or forms of knowledge – and action is in a central position, as it typically is in problem-based learning. In approaching the knowledge-action relation, the paper builds on Aristotelean theories in pedagogics. The paper also illustrates and evaluates the pedagogical solutions and the theoretical ideas behind them, based on an analysis of the student projects carried out in the module in Fall 2022.

Given that all the authors of this paper are teachers in the module, and as such, responsible for the design and development of the module, the research approach could be classified as action research (Greenwood & Levin 2007). Action research is not based on any single methodology, but it can draw on various established research methods. In this paper, the research is based on philosophical theories of knowledge, design theory, pedagogical theories, and theory-guided analysis of students' projects.

In the existing research literature on sustainability-promoting design education, it has been often pointed out that sustainability should be advanced especially by integrating engineering approaches into design thinking (e.g. Altomonte et al. 2014) and that problem-based pedagogy and studio teaching should be used to support this integration (e.g. Moosavi & Bush 2021). Yet, given the differences between engineering and design traditions, integration can be difficult to achieve in practice. Engineering approach has traditionally emphasized universal scientific knowledge and formulas, which are derived from this knowledge, and which provide the basis for problem-solving (e.g. Schön 1983). Within this approach, it has been traditionally assumed that problems or tasks can be clearly defined, and that there are relatively clear criteria for judging whether the problems have been correctly solved (Rittel and Webber 1973). Within design approach, by contrast, knowledge often runs short, and creativity and imagination are needed so that the outcomes are not only well-functioning but also aesthetically appealing, innovative, and fitting their physical and social environment.

These two approaches – engineering and design approach – are discussed in this paper in light of neo-Aristotelean philosophy and pedagogics. Engineering approach is discussed in the framework provided by the Aristotelean notion on *techne*, referring to technical skills. Design approach is discussed in light of two different concepts: *poiesis*, referring to skills needed in creative arts and aesthetic aspects of design, and *phronesis*, referring to the capability for ethical judgment and practical wisdom. *Poiesis* has not thus far gained much attention in neo-Aristotelean pedagogical theories, perhaps because the concept of aesthetic creativity – or human creativity in general – was not yet matured in the ancient Greek, but began to gain attention from scholars only during the emergence of Renaissance humanism (Jauss & Shaw1982, 598–599). Nonetheless, as this paper argues, when at issue is design education, *poiesis* cannot be excluded from the typology of ways of knowing. *Phronesis*, in turn, has been a much-discussed concept in pedagogical literature (e.g. Lennartson & Sundin 2001; Gustavsson 2002; Birmingham 2004), and it is undoubtedly a central concept of design education where the students as future urban designers need to learn to take responsibility for the future generations and natural environments, on which the future of humans depends.

As regards the concept of sustainability, the pedagogical solutions of the course module are designed to leave the students with a freedom to define and concretize the meaning and scope of "sustainability", and to give it a physical form in their design projects. This is expected to support the development of their *phronetic* skills and creative design thinking. In this process, the students are supported by lectures, literature and reading circles where sustainability is discussed in relation to climate change and urban context. Urban planning and design have typically relied on two different types of responses to climate challenges: mitigation and adaptation (e.g. Davoudi et al. 2009; Howard 2009). Research has shown that climate change can be mitigated especially by densifying urban structure and thus reducing transport-related emissions. Adaptation to climate-change related threats such as extreme weather conditions can be advanced, for instance, by designing green structures that make the urban environment more resilient in the face of flooding. Mitigation can be integrated into adaptation solutions. Nonetheless, knowledge-based mitigation and adaptation do not always align. For instance, adding more green structures often decreases density that is needed for mitigation-related goals, and increasing density often consumes green structures needed for adaptation (cf. Larco 2016).

In addition to climate change mitigation and adaptation, global biodiversity loss has been an emerging theme in the discourse concerning sustainable urban transitions. Biodiversity loss has been argued to result from climate change (e.g. Bellard et al. 2012), but even though densification of urban structure might mitigate climate change globally, it often leads to local biodiversity losses.

Mitigation, adaptation, and prevention of biodiversity loss are types of action through which sustainability can be advanced in urban transformation, but there are also other possible ways of working for sustainability. For instance, the social and cultural aspects of sustainability need to be accounted for alongside the ecological aspects of sustainability. The tricky part of design work is that responses to one sustainability goal often create new problems in relation to some other aspect of sustainability. As such, designing for urban sustainability is a field saturated by "wicked problems" (cf. Rittel & Webber 1973; Lawson 2009). Wicked problems cannot be definitively formulated, but they keep on changing while they are being solved or re-solved. Wicked problems do not have one correct answer that could be derived from universal scientific knowledge and calculated by formulas coming from engineering sciences (Rittel & Webber 1973). Even though engineering approaches are helpful in indicating potential solution candidates for wicked problems, sustainable urban transitions require also creative design thinking – resulting as wild ideas – and skills for practical-ethical and aesthetic judgment through which ideas can be critically assessed.

In what follows, the theoretical background, the structure, and the expected learning outcomes of "Sustainable Urban Transformation" module are discussed drawing especially on the Aristotelean typology of skills or knowing in action. The research question is whether the course design of this module advances a balanced development of students' *technical*, *phronetic*, and *poietic* skills, or are some of the skills emphasized at the expense of others. More precisely, the aim of the paper is to find out whether the strong engineering orientation in this module reduces the space left for *poiesis* and *phronesis,* the ways of knowing and acting that seem to resist any simple "from problem to solution" or "from knowledge to action" structures. And vice versa, the question is also whether design education, where *poiesis* and *phronesis* have been traditionally important, turns out to be a problematic context for teaching systematic and knowledge-based problem solving typical for engineering sciences. These questions are answered by analyzing the Fall 2022 class's project reports, which showcase the actual learning outcomes of the project module. Finally, suggestions are made for the further development of the module, and for the development of PBL in general.

THEORETICAL BACKGROUND: ARISTOTELEAN VIEWS ON KNOWLEDGE AND ACTION

While scholars typically agree on the fact that students attend university education to acquire knowledge, there is typically no consensus over how the knowledge acquisition should ideally take place. This sub-section takes as its point of departure the interconnectedness of the questions concerning the appropriate methods of acquiring knowledge, on the one hand, and the questions concerning the academically relevant types of knowledge, on the other hand.

The proponents of problem-based learning argue that the traditionally popular methods in academic education such as attending lectures and reading books do not foster learning efficiently enough. Though these methods can support learning to a certain extent, the theorists of problem-based learning argue that to promote efficient learning, education should primarily take place through problem solving in groups of peers with the help of tutors or teachers, so that learning is student-initiated and there is sufficient time for self-study (Schmidt et al. 2019). When knowledge is acquired in the context of action, and turned into action through project work, the students learn to contextualize the knowledge in a meaningful way, assess the knowledge acquired against this context, and connect new knowledge to the knowledge that they already have (Moust et al. 2021). In this way, they are also typically more motivated to learn than they would be in traditional lecture-based courses or when reading books for exams (Rotgans & Schmidt 2019).

Traditional university education emphasizing learning through lectures and books has been concerned especially with propositional or theoretical knowledge – *episteme*, as it was called by Aristotle and other ancient Greeks. However, already Aristotle recognized that there are also other types of knowledge or knowing. Contemporary scholars in pedagogics have discussed alongside *episteme* the two Aristotelean forms of practical knowledge, *techne*, and *phronesis* (e.g. Lennartson & Sundin 2001; Gustavsson 2002; Birmingham 2004). These types of knowing have been seen as forming the core of such practice-oriented disciplines as urban planning and design (Davoudi 2015).

Modern engineering education has relied primarily on the tradition developed around the concept of *techne*, a concept that refers to technical knowledge where at issue is not primarily “knowing what” as it is with episteme, but “knowing how” (Davoudi 2015, 320). This type of knowing is needed for manufacturing products, and it is concerned with the means for achieving certain outcomes (Gustavsson 2002, 16). The notion of *techne* is the origin of the modern concept of technology, but also of the Latin word *ars*, which originally referred to art as craft, but which has also become to mean high arts in the modern world (Schatzberg 2018, 16).

Even though Aristotle differentiated between *techne* and *episteme*, the concept of *techne* was not disconnected from knowledge altogether. *Techne* did not refer primarily to embodied, non-conceptualizable skills such as the skill of riding a bike, but it was grounded in propositional knowledge and included “specifiable principles toward a definite end” (Ford 2015, 144; see also Schatzberg 2018, 21). As such, *techne* can be argued to anticipate modern understanding of technology as a science-based activity. The conception of *techne* as a skill based on specifiable principles aligns with the traditional conception of problem solving in engineering, where the problem, or the end, is known beforehand, where solutions can be justified with explicit principles based on universalizable knowledge, and where it is thus relatively easy to judge whether the problem has been adequately solved.

The concept of *phronesis* brings us closer to the tradition of design education where the existence and status of specifiable principles of production can be contested because of the wickedness of design problems. Whereas in the case of *techne* at issue is the production of an external object, in *phronesis* – often translated as practical wisdom – the goal is not an external object but the political and ethical action, that is *praxis*, in itself (Gustavsson 2002, 16). *Phronetically* skilled planners and designers are capable of making practical judgements based on their personal experience, which means that "phronesis goes beyond analytical (episteme) and technical (techne) knowledge" (Davoudi 2015, 321).

While *techne* and *phronesis* have already gained attention in neo-Aristotelean pedagogical literature, this paper – being focused on design education and on the production of aesthetically good-quality urban environment – adds to the discussion the concept of *poiesis*, which is used in this paper to refer to the art of "producing beautiful artefacts" (Volanen 2007, 79). In this case, this means aesthetically appealing urban design. The fact that the Ancient Greeks' concept of *poiesis* has not been much discussed in the theories of education is probably due to the dual nature of this concept. On the one hand, Aristotle used the concept of *poiesis* to refer merely to one specific stage of techne, the "making" of the object, without discussing the specific poetic or aesthetic dimensions of such making in the modern meaning of aesthetics (e.g. Dewar 2016, 27); on the other hand, *poiesis* is a concept in which the word poetry is rooted, and as such, it seemed to refer already in the Ancient Greek to the specific artistic dimensions of action and knowledge, dimensions dealing not only with *what* the poets said but *how* they expressed their messages (Murray 2015, 159). At issue was not the production of just any objects of use, but such pieces of work that had specific experiential qualities and that were meant to impress the audience by "enchanting their souls" (Ford 2015, 145–146).

While Aristotle held that the production of these responses could be knowledge-based and follow at least some technical principles, many other Greek philosophers – Plato being the most famous of them – held almost the opposite view in arguing that in such production, technical principles are interrupted by a divine intervention that sets the poet "out of his mind" (Murray 2015, 159). Modern aesthetics has largely departed from the company of Aristotle as it has emphasized the autonomy of aesthetics, that is, the disconnect of aesthetics both from knowledge and ethical or moral considerations. Nonetheless, while the modern idea of autonomy of aesthetics may function in the context of high art, it does not work in the domain of design where aesthetic dimensions of the creation and experience cannot be dissociated from the technical and ethical-practical concerns. This being the case, Aristotle's concept of *poiesis* – with its connections to *techne* and *phronesis* – may provide a more fruitful point of departure for discussing the aesthetic dimension of urban design than does modern aesthetics conceived of as philosophy of art.

An interesting aspect in the Greek concept of *poiesis* is that unlike *techne* that is oriented towards the object produced, *poiesis* captures the process of making or "leading things into being", resembling in this sense *praxis* rather than *techne* (Whitehead 2003). *Poiesis* therefore can account for the changing nature of objects, which in turn seems to be necessary when at issue is the environment, instead of the traditionally static and fixed works of visual arts. Following Heidegger, who has influenced greatly the 20th century aesthetics of architecture and environmental design, Whitehead (2003, n.p) concludes his description of the procedural nature of *poiesis* in the following manner: "working with the raw materials of the imagination (ideas, concepts, schemata) and those of the material order (paint, clay, or stone), constitutes a means of renegotiating our sense of 'place' with a renewed and placeful place of poietic and non-exploitative encounter."

In our view, design education should promote the idea of aesthetics as *poiesis* in the meaning encapsulated in Whitehead's description. Aesthetic aspects in design should involve creativity where knowledge can be left behind, and room is made for radical experimentation, but it should also include such negotiation of radical ideas where at issue is their appropriateness in relation to their social and cultural context as well as to their natural environment. When compared to the ways in which aesthetics of visual arts are conceptualized in contemporary philosophy of art, the Aristotle-inspired concept of *poiesis* has the advantage that it can accommodate the temporal aspects of landscapes and townscapes, the constantly changing experiences of the users of the environment, and the narratives related to the human and non-human origins of the environmental change. Here, the concept of *poiesis* can bring added value for instance to landscape aesthetics, a discipline that has typically drawn on the tradition of landscape painting, and as such, it has had difficulties in conceptualizing change in the environment (e.g. Waldheim 2016). However, the problem with educating students to work with temporality is that design practice cannot ignore such traditions that build on non-temporal, "frozen" images of environments, given that design needs to be represented through fixed visualizations. This is one of the central problems or dilemmas to which the pedagogical solutions of "Sustainable Urban Transformation" wished to provide answers.

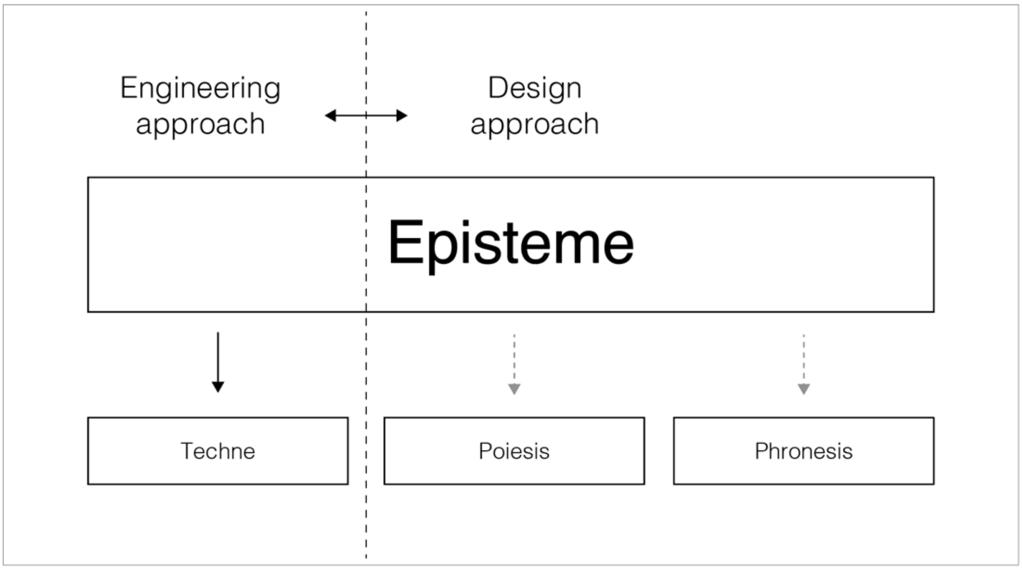

Figure 1. The relation between engineering and design approaches portrayed in terms of episteme, techne, poiesis and phronesis.

THE STRUCTURE AND THE EXPECTED LEARNING OUTCOMES OF THE PROJECT MODULE

The theme of the first semester of the master's program in Urban Design is urban transformation: the constant re-making of the urban environment, where sites change their function and character, adapting for instance to the changing society, culture and climate. The semester consists of two course modules (5 ECTS each), which are followed by a project module (20 ECTS). The first course module is an introduction to urban design, and the second is about the basics of hydrology.

Urban design and hydrology are then combined in the project module "Sustainable Urban Transformation". The assignment in the project module is to create a design proposal for a site in need of transformation. In fall 2022, the site was an urban waterfront area in Aalborg, Denmark. The site is characterized by a diverse maritime life, including a leisure boat marina and green recreational structures. The topography of the site is low, making it vulnerable to flooding due to rising sea levels. In addition to the sea level rise, the students are expected to respond to challenges such as storm surges, changing ground water levels, and cloudbursts.

The learning goals of the project module include both knowledge (*episteme*) and skills (related to *techne*, *poiesis*, and *phronesis*). Firstly, the students must gain knowledge about sustainability in the context of urban planning and design, especially knowledge concerning climate-change mitigation, local climate-change adaptation, and the prevention of biodiversity loss. Secondly, the students must learn about the dynamics of climate in the Danish context to understand the implications of climate change on hydrology in the local scale and to target their climate adaptation strategies to specific periods. In Denmark, we expect more frequent and extreme weather events of precipitation and storm surge, along with rising groundwater and sea water levels (DMI n.d.). Whereas a storm surge and extreme precipitation have a short time horizon, sea water level rises slowly over centuries. There are climate projections available in relation to different return periods. Hence, the students need to reflect critically on which climate scenario/scenarios they use as background material for their design proposals.

Project work can be additionally backed up with scenarios concerning other themes than climate-change, such as social, cultural, or economic changes, even though climate change is typically considered to be the most crucial factor when the future of the earth is at issue, being also a factor that might have major social and economic consequences. To support the students' understanding of future changes in the environment and in society, and the implications that these changes have for urban planning and design, they were given a workshop on scenario planning (e.g. Goodspeed 2020). Scenario planning literature typically discusses three types of scenarios. First, there are evidence-based scenarios, which indicate how the world will be likely to look like at a certain point of time if there are no interventions that change the current line of development (e.g. Ravetz & Miles 2016). Climate scenarios are typically an example of this. However, the future is always characterized by uncertainty, and some scenario planning scholars have suggested that there might be some unlikely but possible trajectories that we might want to consider when planning and designing our environment. To form "exploratory scenarios" charting out these unlikely changes, both knowledge and imagination are needed (Avin & Goodspeed 2020). Finally, scenario planning includes normative scenarios, visions of an ideal future state of affairs. These scenarios form the core of urban planning and design, because planning and design are disciplines that are purported to make the world a better place, and to halt those trajectories that lead to undesirable scenarios. However, if we want to avoid the creation of utopian urban designs that cannot be implemented in practice, normative scenarios should be conditioned at least to some extent by evidence-based scenarios, and perhaps also by explorative scenarios.

In addition to scenario building, scenario planning literature discusses the method of backcasting, where the steps required for the attainment of desirable future visions are determined (Robinson 1990, 822–823). The students were encouraged to produce phased designs, reflecting on what would be the phases that are strategically important for the attainment of their design goals and when those phases should be carried out.

Temporality is an aspect that is important not only for strategic planning, but also for the physical design on the site. Students need to understand the landscape, its topography, and the movement of water on the site over time. The designs must perform under different conditions such as rising sea level, extreme weather events, and dry periods.

Yet, the designs are not only purported to support sustainability conceived of in terms of climate-resilient physical structures, but they should also advance social and cultural sustainability. While these aspects of sustainability can also be supported by knowledge – for instance, social-scientific knowledge or local knowledge obtained from the users of the site – the final judgments concerning the needs and preferences of future local communities require *phronetic* skills from the students. Furthermore, when the students design environments that are vulnerable to flooding, knowledge about climate dynamics in relation to hydrology and practical-ethical judgments concerning the needs of future citizens need to be combined with imaginative creation of new waterscapes, landscapes, and townscapes. Hereby, *techne* and *phronesis* become integrated with *poiesis*.

Finally, the students are expected to learn to communicate their professional knowledge and skills via their project report and scale models. In this article, the focus is on visual representations such as diagrams, maps, technical drawings, sections, and renderings, all these instruments being useful not only in representing the final design and its justifications but also in testing the initial design ideas during the design process. Many of these instruments also facilitate the integration of technical knowledge into design narratives containing both *phronetic* and *poietic* elements, enabling designers to effectively communicate these narratives visually to the public.

ANALYSIS OF THE STUDENTS' PROJECTS

The method and the theoretical framework

In what follows, three out of the total five design project reports from the Fall 2022 project module are analyzed, including the final design proposals, illustrations and texts. The three projects were selected because they represent three quite different approaches on advancing sustainability and climate-change resilience.

The analysis utilized the framework consisting of knowledge or *episteme*, on one hand, and generic skills related to *techne*, *phronesis* and *poiesis*, on the other hand. More precisely, this framework of knowledge and *generic skills* formed a lens for looking at the ways in which the students had practiced in their projects the following *specific skills* needed in sustainable design vis-a-vis climate change, skills that we have defined to be the key learning outcomes of the course module "Sustainable Urban Transformation": 1) the ability to understand, define and give a physical form to sustainability, 2) the ability to understand, work with, and influence different temporalities related to climate and the environments, and 3) the ability to develop and present the design proposal by the means of visual representation and communication. The aim of our study was to find out whether the students are able to practice the generic skills related to *techne*, *phronesis* and *poiesis* in a balanced manner within our course design, or would the balanced development of these skills require an update of the course design including the pre-defined learning outcomes of the course.

The analysis was conducted in three steps. First, each of the three members of the research team went through all three project reports by analyzing the contents in the framework described above. Secondly, the individual analyses were followed by a discussion between the team members to find out whether the interpretations made in the content analyses were commensurable and whether the conclusions drawn by the team members aligned. Thirdly, given that each team member had acted as a supervisor for one of the groups, and all researchers had taken part in the interim reviews, the researchers complemented the analysis with such pieces of knowledge about student groups' design processes that were not directly traceable from their project reports.

Approaches on sustainability

When discussing sustainability, the first thing to ask is what needs to be sustained (Larco 2016). Is it for instance human culture, man-made environment, or ecosystems? The project by Group One introduced a nature-centric solution to climate change adaptation as an alternative to the prevailing human-centric solutions. The primary aim of this design proposal was to sustain and improve the aquatic habitat in the Limfjord that faces the project site.

Group One had an ethically oriented mindset right from the beginning of the project. Rather than creating a feasible and developer-friendly proposal, the group aimed to spark "conversation about life in the fjord and future climate change" with their project (Høgild et al. 2022, 42). This could be interpreted as a *poietic* move where the design has a story to tell for its users. Nonetheless, in the beginning of the process, this group relied heavily on natural-scientific knowledge. The more they studied marine ecology, the more difficult it became for them to propose any design interventions, because these interventions seemed likely to disturb natural processes. *Episteme* thus did not turn into *techne* easily for this group.

In the end, Group One decided to create one "classic" masterplan of the on-ground design and another masterplan of the seabed, the designed habitat for the non-human life in the fjord (Figure 2). The group aimed to foster interaction between the two "zones" by making the fjord more accessible for the users for instance through sea gardens and promenades raised above the sea. In so doing, the group wished to provide for the local community opportunities for recreation and learning about marine ecology, thus encouraging the community to act for the restoration of the balance of the aquatic ecology in the fjord.

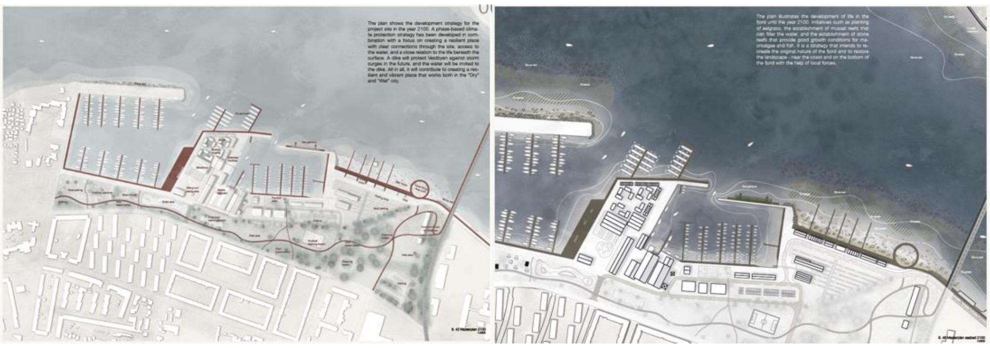

Figure 2. A classic masterplan of the dry-land side and a masterplan of the seabed by Group One (Høgild et al. 2022).

Ethical orientation was present also in the project of Group Two, but this group did not aim at nature-centric development, as did Group One; for them, *phronesis* was primarily about balancing the needs of nature and humans and about adding value to the site by enhancing the connections between nature, local communities, their daily practices and facilities and the existing built heritage (Figure 3).

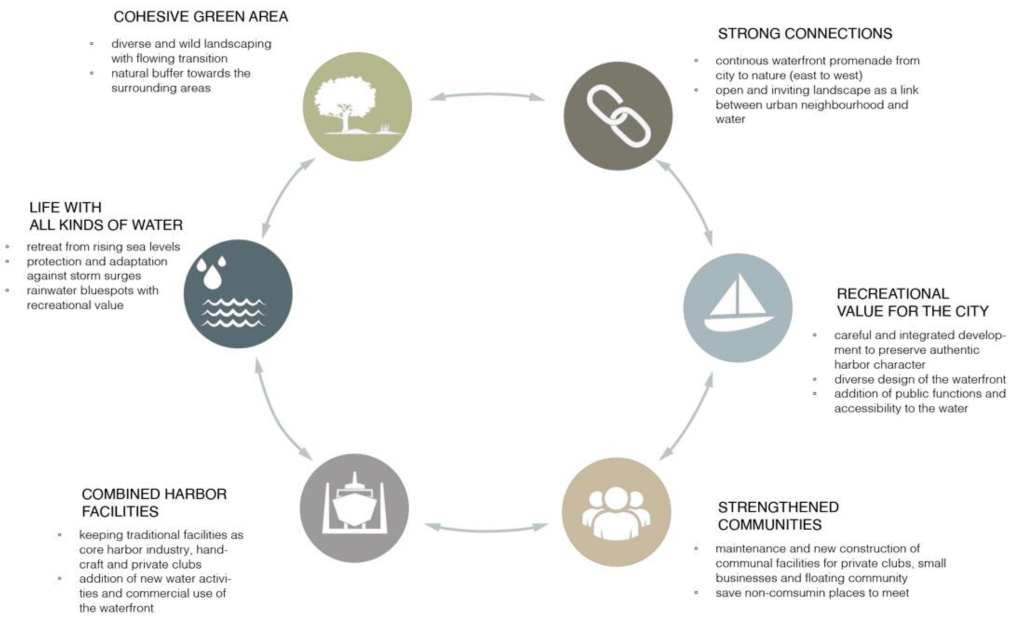

Figure 3: A graph by Group Two demonstrating how they balance between various objectives contributing to the sustainability of the site design (Fisker & al. 2022).

By leaning mostly on *techne*, the group combined three types of climate adaptation solutions: they invited water into the designed built environment in a controlled manner (adaptation), they kept the water out of the urban area by using hard engineering structures such as dikes and sluices (protection), and they moved some flood-prone urban structures away from water (retreat) (Figures 4 and 5). Nonetheless, *phronesis* was also represented in the design process as the group wanted for instance to secure the continuation of social processes of the city dwellers when enhancing the resilience of the site in the face of the “behavior” of the water. Furthermore, *phronesis* was combined with *poiesis* when the group balanced the preservation of architectural heritage and the replacement of old buildings with new ones to serve the local communities’ new and emerging needs.

Group Three’s design proposal reflects an approach on sustainability that is more human-centric than the other two proposals. It embraces nature as an aesthetic and recreational component, as it increases the room given for water elements to be used for recreational purposes and for introducing housing on water (Figure 6). Thus, it concretizes sustainability in terms of new ways of living by making room for the water instead of protecting existing urban areas by keeping the water out. However, the implementation of this design proposal would demand radical human interventions and hard engineering solutions, as the project works against the existing terrain, making notable excavation of soil necessary.

This project also relies to some extent to the strategy of climate change mitigation through the densification of urban structure, unlike the other two projects. All in all, the *phronetic* considerations of this group are quite anthropocentric. The aesthetic aspects of the project, in turn, highlight the aesthetic value of human-designed structures. Given that the group does not wish to design with nature, but rather wants to maintain the authorship strictly in their hands, this group does not conceive the aesthetic aspects of urban design in the same dynamic sense that we understand them through the concept of *poiesis*.

Figure 4. Plan showing different protection levels by Group 2 (Fisker et al. 2022).

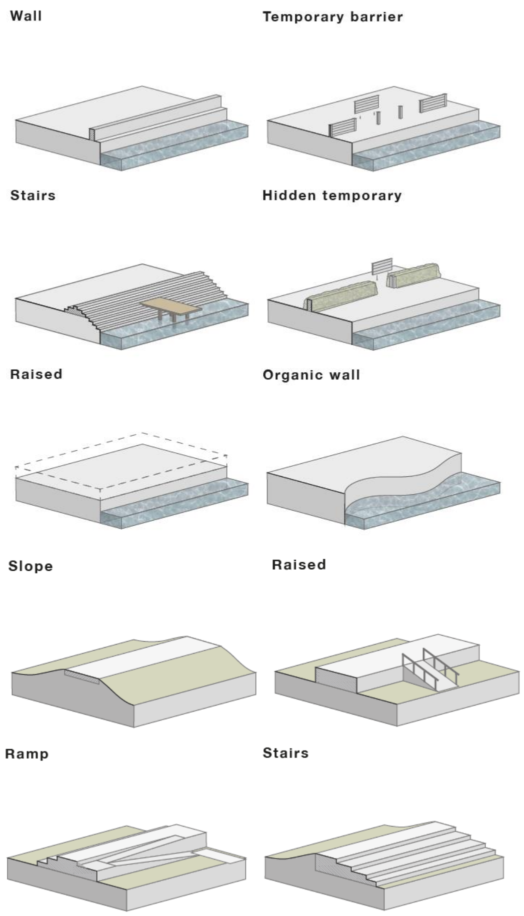

Figure 5. Various designs of coastal barriers and dikes by Group 2 (Fisker et al. 2022).

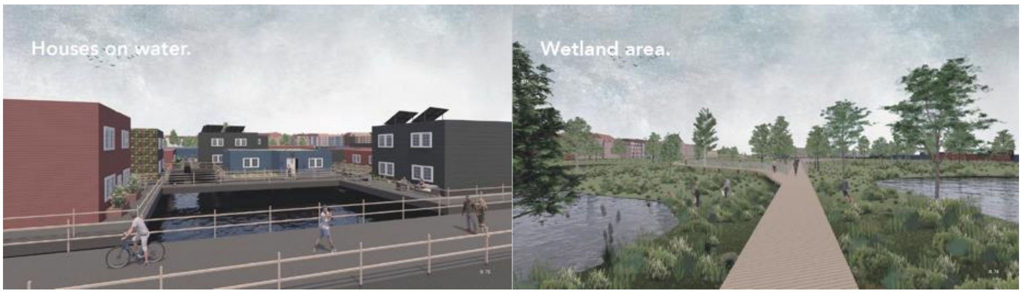

Figure 6. Renders by Group Three showing how water is an active element in the future's recreational environments and housing solutions (Krøis et al. 2022).

Working with temporality in relation to climate change dynamics

The three projects represent two ways of working with temporality in design. The first way is the integration of design and different climate scenarios. When using climate scenarios to support design work, the functioning of the design must be assessed under different hydrological conditions. The design must function under different sea levels and extreme events that might occur over time, and it should not be developed primarily for such conditions that would for instance appear once in every hundred years.

Another way of working with temporal aspects is by phasing of the design proposal. Large-scale urban development takes place over several years or even decades, which makes it important to sequence the development. In this sequencing, backcasting might prove useful, as through this method it is easier to see what phases are needed and when they are needed if we wish to achieve the desired end-state on the site. Phasing also allows designers to adjust their designs to future uncertainties regarding climate change by leaving certain decisions open until more precise knowledge is obtained.

An example of the first way to work with temporal aspects can be found in Group One's project that presents three renders of a final design area (Figure 7). It illustrates how the area is affected by three different water conditions. The first one shows how it would appear in the near future, the second shows how it would appear in the year 2100 where the sea level has raised 50 cm, and the third shows how it would appear under a 100-year storm surge event in year 2100 with a sea level of about 240 cm (from left to right). Here knowledge of hydrological dynamics and climate scenarios is used to develop designs that function under different sea levels and extreme events, ensuring long-term design value.

Another example is the technical diagram presented by Group Two (Figure 8). The diagram folds together technical knowledge of sea level rise, storm surge scenarios, and the site's topography. It becomes a design-guiding diagram, opening the discussion concerning the level of protection needed for the designed structures and the required types of protection solutions. The group decided to use one scenario for 2050 (RCP 4.5) and another, more extreme scenario for 2100 (RCP 8.5). This manifests the concern about the increase in the uncertainty of climate projections the further ahead we look in time. Furthermore, the diagram communicates technical aspects of climate change affecting the local context. Both examples show how technical knowledge of climate change becomes a key factor in the design process, where the design must find its form in a changing waterscape.

Figure 7. Renders showing a design proposal affected by different climate scenarios by Group One (Høgild et al. 2022).

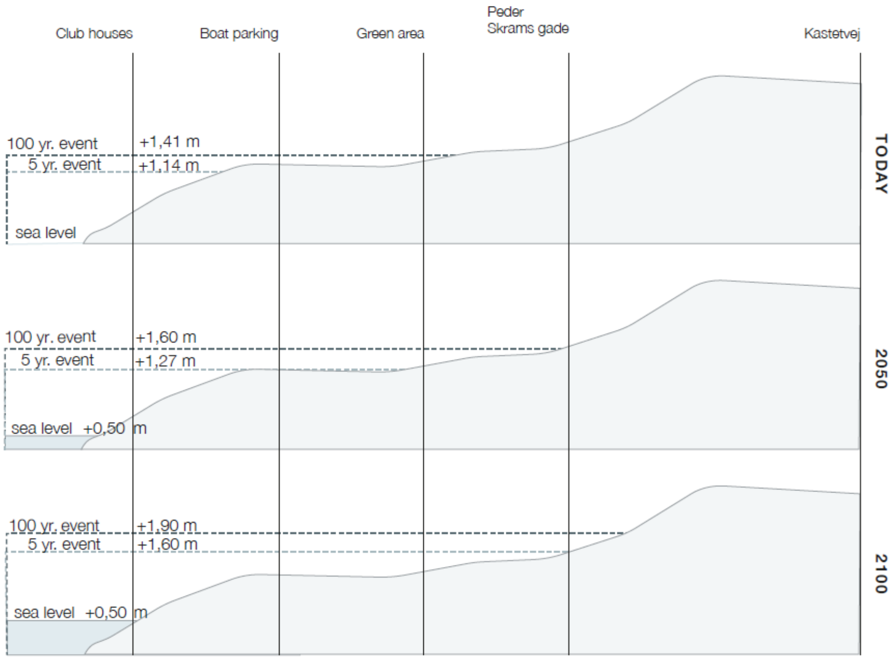

Figure 8. Diagram of sea level rise and storm surge affecting the site and its immediate surroundings by Group Two (Fisker et al. 2022).

Group Three builds on future climate scenarios just as Group One and Group Two, but Group Three's main concern with regard to temporality is the phasing of their radical and comprehensive site transformation. In sequencing the transformation of the site, they look both at the requirements stemming from construction engineering and at the possibilities to sustain the functions on-site through the transformation process. Group Two has also programmed the phasing of their design based on the time needed for distinct stages of the construction project and the possibilities of maintaining the functions on the site while the construction goes on. Group One, however, has chosen an alternative strategy: they reflect when it is relevant to start to adapt the site to climate change, while the other groups implement climate adaptation from the start, whether or not there is an urgent need to do so. Group One prioritizes the establishment of recreational functions and the improvement of marine ecosystems as the most urgent interventions, and only after these interventions would they start the construction of the structures needed for climate adaptation.

An approach that is missing from all groups is the development of climate adaptation designs that would accommodate changing climate predictions by incorporating flexibility in design. By allowing the designs to flexibly change as we become more certain about the future predictions, the groups could have avoided the construction of potentially “oversized” or “undersized” climate adaptation solutions. The lack of flexibility in the designs shows that working with dynamics and change is a new and difficult topic within urban design, a discipline that has traditionally focused on fixing the details of the physical forms of the city, whereas the discipline of planning has been concerned with strategic flexibility already for decades (e.g. Taylor 1998). However, as we have argued, designs could be usefully seen rather as narratives than as fixed pictures of the desired end-state, especially when at issue is environmental design. The environment, after all, is always in flux.

Visual representations integrating technical and design approaches

Visual representations provide one way of integrating engineering approaches (*techne*) into design approaches (*phronesis* and *poiesis*). Visualizations such as diagrams, mappings, sketches, and drawings are all tools for design thinking (Nijhuis et al. 2017). Through different types of visualizations, designers gain knowledge about spatial patterns, structures, conditions, potentials and problems of a site. However, visualizations are also tools for constructing and testing new design ideas and for communicating design ideas to the public (Schön 1983; Lawson 2008).

In Group One’s project, scientific and technical knowledge of marine life is translated into a design narrative of the coexistence of marine ecosystem and the local community. Figure 9 communicates – in addition to the changing sea levels – knowledge of what a healthy seabed consists of compared to an unhealthy one. It also demonstrates *phronetic* thinking as it makes an ethical statement concerning the urgent need to promote the health of marine ecosystems, attracting attention to this statement with an aesthetically appealing, *poietic* visualization. The knowledge comprised in this visualization is used in the final design where a salt marsh is created underneath footbridges, which make the area accessible (Figure 10).

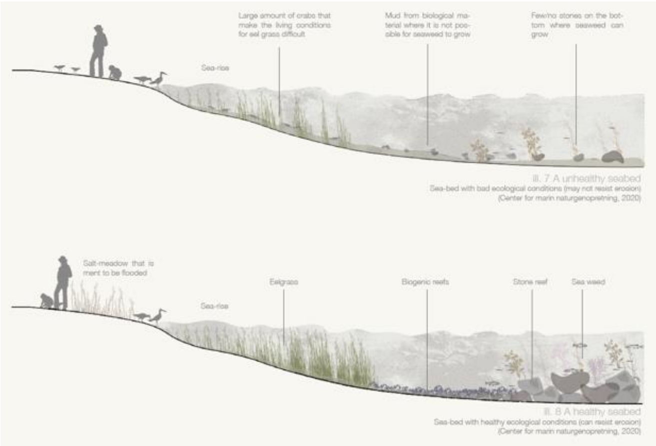

Figure 9. Section by Group One communicating principles of building a healthy seabed to improve marine life (Høgild et al. 2022).

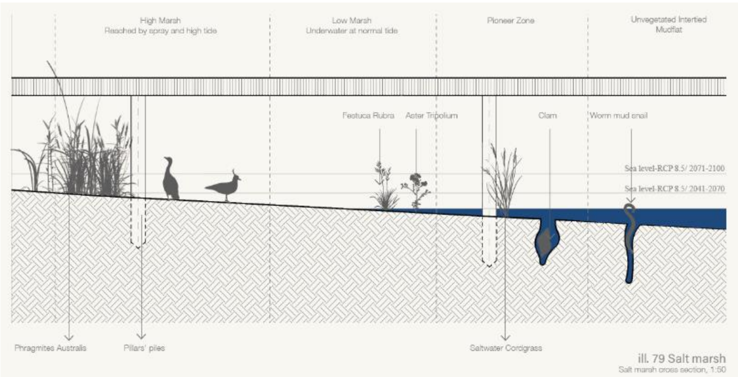

Figure 10. Technical section of a salt marsh by Group One (Høgild et al. 2022).

In Group Two's project, the section in Figure 11 shows how technical calculations of pond size in relation to water amounts (*techne*) are incorporated into the visualization of the user's environmental experience represented by the human walking in between the ponds (*poiesis*). The additional plan shows the user's alternative paths and experiences, representing also technical considerations concerning water flows from pond to pond. Likewise, in Figure 12 three sections communicate technical knowledge of the dimensions of ponds and dikes as well as experiential qualities of the interaction between the users and the water elements. When the ponds are not filled with water, they can be used for recreational purposes. This is indicative of Group One's *phronetic* considerations concerning the balancing of different kinds of needs in the design proposal.

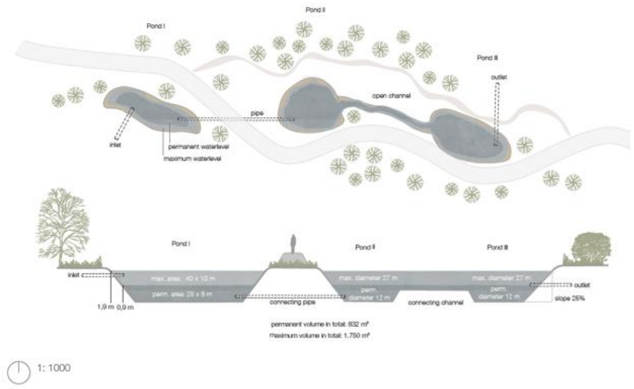

Figure 11. Plan and section of a rainwater management system by Group Two (Fisker et al. 2022).

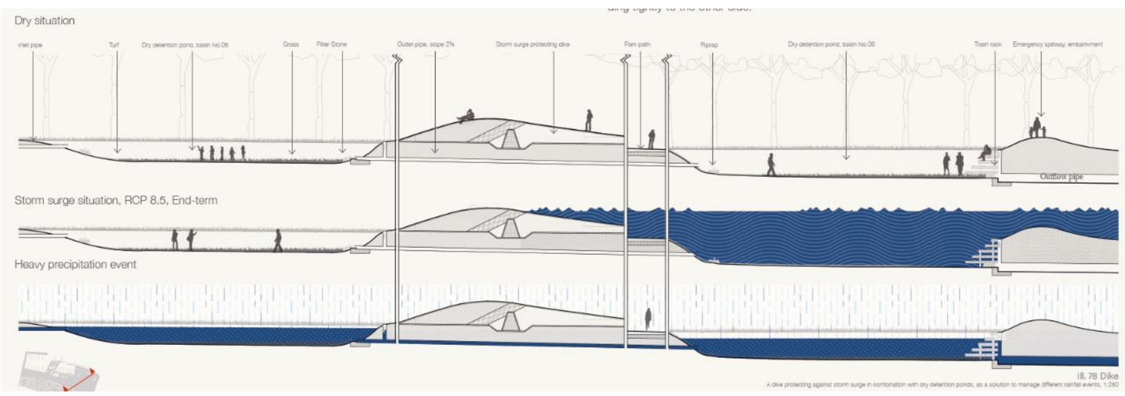

Figure 12. Sections of ponds and dikes affected by different climate scenarios by Group One (Høgild et al. 2022).

Group One and Group Two have used multiple sections in their projects to communicate the integration of technical knowledge and design. When working with climate adaptation in urban design, the topography of the urban landscape is a key to understanding hydrological principles. Contour lines on the map indicate how high or low the terrain is in relation to the average normal sea level. Thus, the topography and its contour lines inform the designer of how the water flows, what areas are vulnerable to flooding, and to what level of climate adaptation is needed. Therefore, sections as design instruments have the potential to communicate design narratives alongside the technical aspects of design.

DISCUSSION AND CONCLUSIONS

"Sustainable Urban Transformation" module has been designed to develop the students' technical skills in hydrology engineering, on the one hand, and design skills, on the other hand. As teachers of the module, we initially thought that the students end up prioritizing technical skills in their design work, since the technical knowledge and natural-scientific perspectives occupied central positions in the course description, and since at least some students expressed their concerns that this might narrow down the possibilities to be creative in the design work. In the end, however, all groups succeeded in practicing *techne*, *phronesis* and *poiesis* in quite harmonious ways.

Group One focused in the beginning mostly on *episteme* to be able to recognize and respect natural processes with which they were working rather than to control these processes technically. In the end, knowledge did not paralyze the group, though, but they managed to *phronetically* balance between the needs of nature and the needs of the users of the site in their design proposal. For Group Two and Group Three, by contrast, it was clear from the beginning that knowledge alone is not going to provide a sufficient basis for the design process and that they would need to take the responsibility of making design choices based on *phronesis* as well as on knowledge.

The aesthetic or – in terms of this study – *poietic* form-giving skills were important for all groups, which was not surprising given that many students had a background in architectural design. In this module, students' design skills were expected to develop mainly through sketching and building models. These ways of working helped the students to understand, evaluate and enhance the experiential qualities of their designs.

The understanding of *poiesis* introduced in this paper departs from the traditional understanding of visual arts especially as it accommodates the temporal dynamics of the environment. All the analyzed projects dealt with temporality in some ways, though not always in relation to *poiesis*: for instance, the groups explored the future of the site through different knowledge-based scenarios vis-à-vis climate change, or they worked with technical phasing of the site transformation reflecting the technique of backcasting. What was missing was the flexibility of design proposals, flexibility that could have made it possible for the design to adapt to changing conditions at some later point of time when there is less uncertainty about the future, for instance, about the sea level rise. This lack may be indicative of the strong impact that visual arts with their inbuilt ideas of static images have had on design education. However, flexibility was present when the students tested and concretized their ideas through sketching during the design process. The takeaway from this observation is that the students should be constantly reminded of the fact that their designs are hardly ever final, but that works in environmental design change over time, even after their implementation. Designs, we have argued, could be usefully viewed as *poietic* narratives rather than static pictures or sculptures.

Even though our contribution to Aristotelean pedagogics has been in this article the concept of *poiesis*, we are fully aware that there are risks involved in emphasising the *poietic* aspects of design expertise. Already the Ancient Greeks discussed critically the fact that *poiesis* includes a possibility to communicate in an appealing and persuasive way things that are not true or ethically right. In the class of 2022, all groups had solid technical knowledge and *phronetic* thinking behind their designs and visual communication. Especially Group One utilised very consciously the aesthetic appeal of their plan to communicate scientific knowledge and ethical care and concern for the natural environment to the users of the site. Nonetheless, it is also common that appealing storylines and visualisations are used to support urban designs that only appear as ecologically or socially sustainable, while in reality, their primary guiding values may be economic ones. For this reason, the takeaway of our study for related disciplines such as civil or environmental engineering is that the *poietic* dimensions of design should be assessed within problem-based learning also in those disciplines that are not directly educating professionals who produce aesthetic artifacts. After all, also technical professionals need to be able to critically read and evaluate visual communication of information and ideas. In addition, technical professionals might benefit from skills of visualizing the knowledge that they produce, skills that they should use in an ethically responsible way, though the lack of ethical responsibility in engineering practice should not be a major problem today, given that *phronesis*, unlike *poiesis*, has already made its way to engineering education in many countries (e.g. Lennartson & Sundin 2001; Kim et al. 2019; Frigo et al. 2021).

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