INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
8–9 SEPTEMBER 2022, LONDON SOUTH BANK UNIVERSITY, LONDON, UK

TIMES OF CODE RED - LEARNING SUSTAINABILITY BY SYSTEMIC DESIGN

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ABSTRACT
This paper describes master's students' experiences of working with systemic design techniques for sustainability and how this may produce feelings of self-efficacy. Systemic design can be described as a combination of systems theory and design practice. Systemic design was developed to offer designers the tools necessary to handle the complexity of the long-term goals, such as the UN set for in its latest Intergovernmental Panel on Climate Change calls for action 2022 [1]. The students participating in this study who work with systemic design methods, are also introduced to methods of co-creation and interdisciplinary and individual self-management. This is intended not only to enable them to perform systemic design for sustainability but also to stimulate feelings of mastery. That is, educational planning is designed to facilitate the emergence of self-confidence, even though the students operate in and design for a high degree of complexity. The underlying pedagogy is thus synthesized with the goal for students to understand the following: 1) "I will never be able to understand the entire system(s)"; however, 2) "I can relax because I will not design alone. Design for urgency and resilience must be done by many stakeholders in cooperation, and systemic design is conducted using many tools that make it possible for me as a student to handle and facilitate such interdisciplinary projects"; and this synthesis of methods suggests that 3) "I can look to new care models and tools that increase awareness of self-management and that can be used to facilitate co-processes and meetings with teams and networks."

Keywords: Systems theory, design for sustainability, disruptive values, transdisciplinary approaches, self-leadership

1 INTRODUCTION
Design for sustainability was implemented in industrial and engineering design education in the mid 90's. Technical, material and life cycle-oriented approaches, as well as future scenario methodology and conceptual design, were introduced to students in certain courses. Enthusiastic scientists and eco-philosophers opened students' mindsets and brought new understanding to designers' thinking and toolboxes. Systems thinking and theory were already a part of the syllabus in "eco-design," like Meadows, Meadows, Randers and Behrens III revealed the system dynamics of our industrial society to the world as early as 1972, with their first edition of *Limits to Growth* [2]. However, at this moment, there was still time for change reducing the climate gas emissions to a less critical level. Designers could imagine new designs and stories for the future, and engineers could explore technology in all dimensions. This was not seen as a time for urgent action. Most politicians and industries and the general population were occupied with their certain sectors and interests rather than the root causes leading to global ecological crisis. It was difficult to believe that Earth has limits concerning material consumption and emissions.
In 2021, the last of six reports from the UN Intergovernmental Panel on Climate Change (IPCC) was published, which coded red for humanity [1b]. This means that climate change is already here, and there is a need for a clear planned action reducing the amount of climate gases in the atmosphere. The global population is facing severe changes in climate that will cause permanent transformation of ecological systems and balances. The UN Paris Agreement is probably our best global tool so far, working towards a common goal. The UN Sustainability Development Goals (SDGs), too, present strategies for securing social, ecological and economic sustainability. The timeframe for a major change of direction is now set to 2030. Through the Paris agreement, global society has agreed on a common goal to reach net-zero climate gas emissions by 2050. Our global population is expected to increase to 9.75 billion by then.

Degrowth, slowing down the speed of human physical expansion and reducing our ecological footprint are therefore seen as unavoidable strategies for meeting this overarching goal [3].

2 THE NEED FOR NEW COMPETENCE AND WAYS OF LEARNING

Currently, students are expected to handle the challenges of the future. Their education should help establish their understanding of the situation and, at the same time, support their enthusiasm and eagerness to contribute to society and the problems it is facing [4]. The new report for action from IPCC (April 2022) encourages the global community to work in alignment with three time perspectives, short-, mid- and long-term, moving "from urgent to timely action", and "from climate risk to climate resilient development". More than any previous IPCC reports, this one pinpoints systemic design approaches and underlines the importance of understanding and recognizing the interdependence and interconnection of social, ecological and economical resources for the fight against climate change and for adaptation and future resilient development. The paradigm of sustainability should overtake industrialized society [5]. Because of system delays reducing, this transformation must be introduced for large-scale implementations by 2025 [1].

Thus, teaching design for sustainability in code red times is challenging, not least learning and absorbing this research and responding to calls for action. The traditional designer's role is not aligned with the uncertainty of the future and the clear need for a paradigm shift in industry and society. Students are entering the education arena as participants in a dialogue for change. The answers to their questions are found in the research and practice of the future, the field of climate research is continuously discovering new relations and behaviours on the planet. The skills taught in design education are therefore equally related to self-leadership, empathy, systems theory and thinking as they are to design in cooperation with many stakeholders for social and community needs rather than in response to growing market demands. Communication and relationship-building are of primary importance, as reflected in the UN SDG #17, Partnerships for the goals.

2.1 Moving from fragmented goals to interconnection and system dynamics

The theme of sustainability has been slowly fragmented and adapted to our sectoral silo thinking. The municipalities of Norway approach the 17 UN SDGs willingly, but their plans clearly show their traditional analytical procedure of choosing the most "relevant" goals and defining new, more detailed goals for every SDG, ending with a daunting number of goals to bring into action [7]. Consequently, municipalities and private companies find it difficult to implement strategies for sustainability [7]. The sustainability paradigm [5] applies an opposing approach. This approach connects as example, the SDG goals and oneself to the work of development with a holistic understanding by exploring the relations between details and primary goals, guided by systemic thinking and the principles of ecology [8]. This approach must be combined with an understanding of unsustainable practices [9] [10] and system traps [6], pinpointing today's unsustainable practices. Systemic design promotes a holistic approach based on analyses and awareness of feedback loops and system dynamics over time. Nature, as the base for knowledge, is central, and the relationships and interdependencies of elements such as species and local demography with resources of all kinds define the foundations of eco-literacy and sustainability. What hinders these relations from existing in a resilient, regenerative state is defined as sustainability principles [9] [10]. **Error! Reference source not found.** shows the components of knowledge and competence used to build the courses and workshops used to teach sustainable design approaches at OsloMet 2021.

In a redefined Master's curriculum named Design in Complexity (OsloMet, 2019), design students are trained in these processes and in understanding the difference between scientific knowledge and political goals for sustainability, such as the fact that the UN SDGs are a global democratically adopted strategy. As an example, it not defined as a part of the SDG goals to reach for a new economic model for sustainability in the SDG goal #8. Decent work and economic growth, although researchers in this field pinpoint the need for such. The students are provided with a general design methodology that may also be used by teams of non-designers. This methodology draws on system thinking and practical approaches to mapping and analysing systems. The importance of introducing students to specific ecological and social sustainability principles is that concrete strategies may guide the search for and lead to leverage points in systems, as well as new concepts for interventions [6]. As a profession and way of thinking, design embraces the development and implementation of non-material interventions, as well as how material solutions perform and are anchored in or integrated for use in certain contexts.

Students are introduced to the four levels of design: 1.0 traditional design, 2.0 product service systems, 3.0 organizational transition design and 4.0 transition for social change [11]. This makes them aware of the interrelations between all levels, regardless of the point at which the design process is entered. Connecting the generation of ideas and their influence on behaviour, services, physical elements and infrastructure, to all four levels, may increase system influence (i.e., reaching more and higher leverage points) and thus result in greater impact on sustainability. The constant movement and changes in systems are the result of time and system dynamics [2] [6]. Systemic understanding and awareness therefore requires the personal ability to remain in uncertainty. The students are thus introduced to leadership both of oneself and of a team.

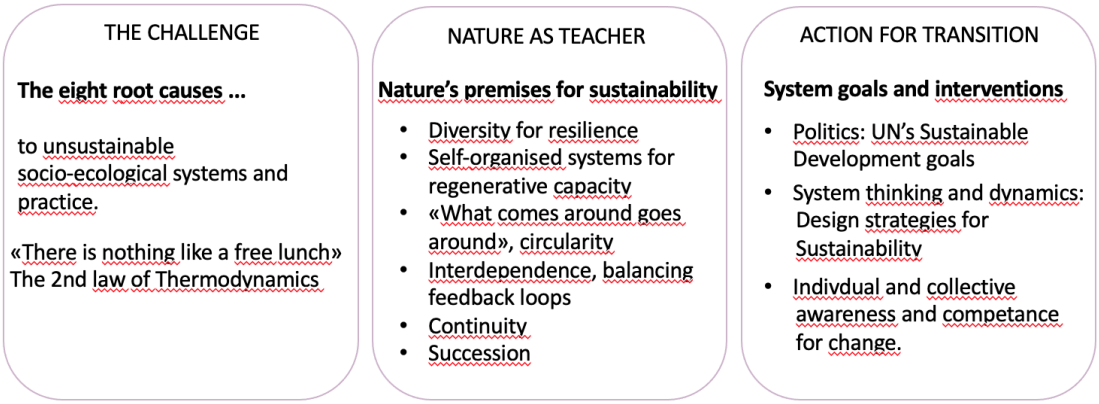

Figure 1. The key elements of teaching sustainable design approaches: root causes of the unsustainable status quo, how nature creates resilience and regenerative systems, and actions humans may take for transition of practice

3 METHODOLOGY

3.1 Learning to identify and develop interventions with high leverage

The UN SDGs underline the importance of "including all" in aiming to achieve the goals [1b]. Designers and design students may take the role of catalysts in their practice, connecting stakeholders through a visual and systemic language that brings understanding of new relations and intersectoral interventions. The students are exposed to a diversity of stakeholders, which are brought into play through a set of pedagogical and systemic approaches. In the time of code red, workshops and other pedagogical experiences should cause the proliferation of activities and actions for change. New mental models that develop courage and lead to inspiration for new collaborations are critical for enabling innovation and the inclusion of all. Table 1 presents practical approaches for students and stakeholders to experience systemic and ecological literacy, as well as self-efficacy.

Table 1. Teaching sustainability in different arenas for practical involvement and collective understanding of systems

Learning context	**Pedagogical approaches**	**Goals and procedures**
System play	Student group is challenged by different games, such as the triangle game or the more advanced beer game, experience the complexity imposed by simple rules. The students experiment collectively with the structure and behaviour of systems.	Building system-literacy: the students experiment collectively, practically (with their own body) and mentally the structure and behaviour of systems. The students intervene in the play by suggesting new rules, and dialogue between sessions reveals individual and collective experiences of the system.
Workday at an organic community-supported farm	Students have bodily experience of ecological systems, life cycles and interdependencies.	Building eco-literacy and increased understanding of food production, bio economy and strategies for social sustainability: discussions after completing work in the fields link physical work and ecological life cycles to the

		understanding of economic systems, efficiency and production of quantitative and qualitative values in a system.
Public system and service design	Students engage in "real-life" communication and organizational and social systems analyses.	Public institutions are forced to implement strategies and action plans to reach the UN's SDGs. The students experience the hindrance or promotion of social sustainability.
Product service systems for businesses and start-ups	Students practice empathy for difficulties and possibilities in "real-life" business development.	The students come in direct contact with stakeholders with influential power. The students experience how a systemic perspective exposes new possibilities, as well as traps, and the difficulty of intervening to remove obstacles to ecological sustainability. .
One-day workshop of drawing exercises revealing the internal process of theory U [12]	Students explore a deeper level of concentration and contact with personal qualities and obstacles in letting go, remaining with uncertainty and be confident in decision-making.	Strengthening the feeling of self-efficacy: the students receive training in understanding inner processes and "changes in gear" for decision-making. [5]
Creating a common meal experience	The international student group is challenged to create a meal with a dish from their own countries, sharing their skills in preparing and cooking.	Experiencing diversity in culture, communication, and teamwork: the students engage in social sustainability practice, relational capacity building and understanding the role of food on a personal level in daily life as well as in an international context.

3.2 Pedagogics for systems thinking and understanding

A dilemma in learning sustainable design approaches is the need for some degree of systems understanding to actually perform interventions on a level sufficient to produce transformation and change. However, a method of training students in "systems literacy" is engaging in systems play (Table 1). The experience of being physically part of a system communicates the concept of systems knowledge to the participants in only a few minutes. In addition, inviting the students to engage in farm work to improve their understanding of ecological and social sustainability, resilience and regenerative systems gave direct feedback of involvement and enthusiasm for learning. Figure 2 below indicates how eco literacy is the primary goal of the course and emerges in pedagogy through systems literacy and is brought into play through communication and creativity.

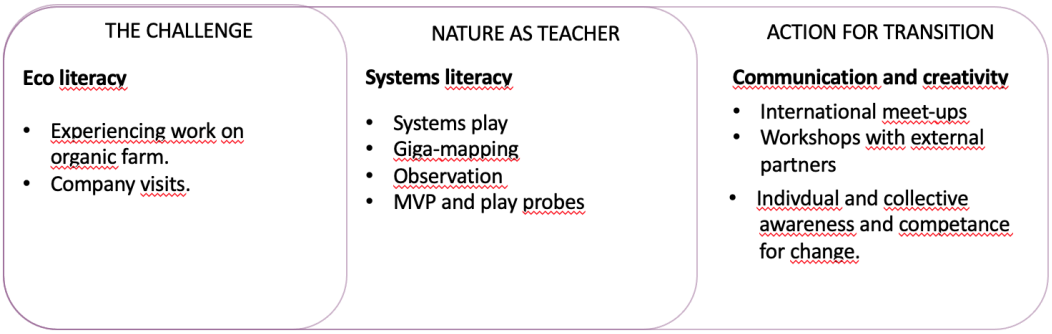

Figure 2. Teaching for a new paradigm requires tools engaging the head, hand and heart in holistic understanding and approaches

The design process is known to include a "chaos-phase," the phase between analyses and the generation of new concepts for interventions and choices regarding final direction. In systemic design for sustainability, this phase may seem overwhelming. The complexity of defining the boundaries, values and goals of systems in relation to typical design thinking, which details user needs and wants, may cause the stagnation of decision-making and progress in student projects. In an educational context, these feelings of stagnation and overwhelming experiences are valuable for creating awareness of the

necessity for care. Care is defined here as seeing and acting in a way that nourishes the relations between oneself and the distinct surrounding layers of people, society and nature [14]. Johan Rockstrôm and his colleagues [15] point to the need for a closer human connection to the biosphere and understanding of planetary boundaries to protect them. A healthy planet is the main goal to support all goals of SDG; however, strategies for reaching this goal must include caring, seeing and acting in ways that embrace the whole, oneself as an individual and the collective as all, and relation to nature. Reaching for inner sources of creativity, as well as the ability to switch between relaxation and point of action, strengthens self-management and self-care. Through nine-minute line drawing exercises and other simple physical approaches to drawing, the students start their practice and make contact with their inner compass for direction in overwhelming moments of systems mapping and the notion of "chaos" in the design process, and concentration in contact with creative thinking and new perspectives emerging[12].

3.3 Communication as intervention and process management

The search for designers' contribution in times of code red clearly shows that design is a tool for joint problem solving, inviting interdisciplinary cooperation and practice. Concepts for continuous learning courses and workshops are also developed through international cooperation (so far, between three universities at OsloMet [2020–2022]). The students are exposed to cultures from around the world and other disciplines that may contribute to the central knowledge of the systems being mapped. The field of systemic design evolves in these contexts, and its methods become more resilient, enabling non-designers to enter the scene of development and innovation. The key to this emergence of resilience is communication as a theoretical concept and as a practice. Bringing a rich set of communication tools and theories to the table and becoming aware of the complex mix of mental models and perspectives represented in an interdisciplinary group is crucial to the development and process of implentation. The participants (here, students) learn to be humble in expression and aware of the layers of communication present in both systems and individuals [16].

4 EXPERIENCES, ANALYSES AND EVALUATION

Students' evaluations so far show that they are motivated by practical workshops, inspiring lectures, mastering specific tools and group work. Systems theory and new knowledge of sustainability, as well as methods of designing for sustainable behaviour, are mentioned as eye-openers that strengthen the students' belief that their profession as designers can make a difference.

In terms of further development of the pedagogical tools and context of learning, on the one hand, the systemic approach is demanding, and most participants in the student course express that there was too little time for in-depth study concerning sustainability, as systems theory dominates. On the other hand, the students find it a relief to understand that it is impossible to know an open system in its entirety and its behaviour. Understanding the given limits to own understanding of "the whole," is as important as understanding the possibilities of influence.

When student teams function well, individual learning is high. However, students also evaluate time for individual reflection highly, as well as time for reading and exploring the material on their own and working in groups. The learning environment should nourish individual inner capacity and concentration, as well as inspiration from the outer world's input and relational building. The students point to a wish to emphasize the practical use of tools and the understanding of systemic design, sustainability, and self-management.

5 CONCLUSION

This paper concludes that teaching systemic design in relation to design for sustainability reveals to students at least three important competences that strengthen their self-confidence as designers in times of code red: 1) "I will never be able to understand entire systems"; however, 2) "I can relax because I will not design alone. Design for urgency and resilience must be done by many stakeholders in cooperation, and systemic design is conducted using many tools that make it possible for me as a student to handle and facilitate such interdisciplinary projects"; and this synthesis of methods suggests that 3) "I can look to new care models and tools that increase awareness of self-management and that can be used to facilitate co-processes and meetings with teams and networks."

6 FURTHER DEVELOPMENT

At some point, the disciplines of importance introduced to design students must be limited. Rather than gaining their own knowledge in all fields, students can be supported by a network that includes other experts on their teams. The students' experiences so far, however, indicate the need for deeper skills in communication, understanding social complexity and social interventions [16]. The inner development of self-efficacy is a previous blind spot within the subject design for sustainability and requires attention and concrete tools for students and practitioners working in the complexity of times of code red. *The inner development goals* are an international initiative [17] addressing five inner goals that are promoted as fundamental in the work towards the SDGs. This initiative may be one of many that explores and supports the diversity of personalities and motivations supporting the vision of including all in the transition to sustainable futures.

ACKNOWLEDGEMENT

Prof. Tore Gulden and colleagues at OsloMet Department of Product Design, Siv Helene Stangeland who is co-founder of Helen & Hard Architecture, Ninni Sødahl from Vækstcenteret, and colleagues at L'ecole de design Nantes Atlantique and systemic design at HTW-Berlin.

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