Frontier education for a sustainable future - speculative design in architecture as a transdisciplinary experiment

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ABSTRACT: In this article, the authors propose the term *frontier education* referring to the well-established notion of *frontier research* - one, that through opening unexpected transdisciplinary perspectives, may offer new insights and create a fertile ground for new discoveries and ground-breaking concepts. In answer to the question of how to get rid of normative thinking and extend architectural experimentations, a speculative design architectural studio was proposed to students of Gdańsk University of Technology (Gdańsk Tech), Gdańsk, Poland, in collaboration with a non-academic foresight institution. In this article, the authors discuss the effects of introducing the speculative design methodology as a transdisciplinary and frontier education experiment. They reflect on how this kind of experimentation contributed to enriching the student's understanding of the constant process of adaptation of architecture to environmental challenges, social trends and technological innovations.

Keywords: Educational strategies, sustainability, city, speculative design, architectural design, future

INTRODUCTION

In the time of climate crisis, globalisation and the development of a knowledge-driven economy, providing a quality engineering education becomes an utmost desired objective. All universities strive to develop solid and comprehensive programmes and propose innovative design approaches that enable graduates to understand and creatively respond to the challenges ahead. In times of technological breakthroughs, environmental concerns and progressive societal changes, there is a growing surge toward enriching existing educational strategies. Many academic courses are designed to span bridges between disciplines [1-3]. Employed methodologies include active learning, learning by challenge, gamification and experimentation with new tools for modelling, virtual reality and hybrid spaces [4-6]. All these strategies aim to extend the knowledge of students, facilitate understanding and boost creativity. The question appears, however, as to how to involve students in truly ground-breaking creative investigations and pioneering pathfinding work.

In pursuit of the new innovative paths in educational strategies, it is worthwhile to refer to the notion of *frontier research* - the most innovative genre of research that is depicted as a foundation for a new discovery [7]. According to the European Research Council (ERC), frontier research is related to ground-breaking, high-risk projects that aim to stimulate scientific excellence and boost creativity. It is not limited to particular topics, nor subject to geographical, environmental and cultural boundaries. The essence of frontier research is the pursuit of new discoveries. The ERC documents and guidelines for evaluators stress the difference between research that may lead solely to the extension of knowledge and frontier research - one, that, through opening the unexpected transdisciplinary perspectives, may offer new insights and create a fertile ground for new discoveries and ground-breaking concepts [7]. In this context, it seems justified to propose the term *frontier education* referring to educational approaches that enable students to cross the boundaries, re-define presuppositions and create a fertile ground for providing original answers to current problems and challenges ahead.

The aspiration of crossing the boundaries, so intrinsic to frontier research, seems to be particularly challenging in engineering education, which is often considered as being focused on providing practical solutions for existing problems. Engineering disciplines are deeply associated with the ancient notion of *technê* (skills, crafts), which is often contrasted with *epistêmê* (knowledge). This mode of thinking led to long-lasting oppositions, such as theory and practice that even today is often perceived as conflicting. However, as Parry argues, despite the fundamental opposition, there has always been a close relationship between *epistêmê* and *technê*. While *technê is associated with knowing how to do certain activities, epistêmê sometimes indicates a theoretical component of technê*, in the root sense of theôria - looking [8].

At this point, the question appears, of *how* to involve students in the process of integrating skills and crafts with creative looking around, questioning existing presuppositions and setting new ways of thinking. An even more fundamental question is *why* direct students into high-risk experimentation. Moreover, which are the most challenging issues that demand contesting existing initial assumptions and developing new ways of thinking?

The topics that require transgressional thinking would be different for each engineering discipline. In architecture and urban planning issues related to sustainability, the future of cities, adaptation to climate change and reactions to environmental changes are considered as most emerging. Following the publication of strategic documents, such as the 2030 Agenda for Sustainable Development and Paris Agreement that guide choices towards building the resilience of cities *by climate-resilient development pathways* [9], many educational guiding documents were adjusted. The requirement to re-think architectural education from the perspective of the sustainable development framework appeared for the first time in 2013, with the publication of the Amendment to the European Directive 2005/36/EC on the recognition of professional qualifications [10]. As one of the eleven specified requirements, concerning skills, knowledge and competencies that the education shall guarantee in the pursuit of the profession of architect, the amended Directive indicates:

> *…adequate knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against the climate, in the framework of sustainable development* [10].

Accordingly, the issues related to sustainability, sustainable development and environmental concerns underpin the majority of architectural and urban planning courses. The recent advancements in technology, development of new materials and modelling techniques are triggering new genres of architectural investigations focused on a sustainable future [11]. Students are involved in developing fast prototyping installations for greening the cities [12], motivated to delve into the topic of intelligent buildings [13] or encouraged to integrate media and interactive technologies into the building skins [14].

> *Living in an era of smart technologies and innovations means there are now many more concepts and projects around the world by which to reverse the negative impact that humans have had on the environment* [15].

However, the question appears, of how to get rid of normative thinking and extend architectural experimentations toward adopting technologies that are currently hardly visible - only at the stage of emerging application in research laboratories. According to Auger:

> *…the products of tomorrow will be shaped and controlled by the emerging technologies of today (…). The journey of technology from the laboratory to the home is long and arduous but ultimately happens in quite predictable ways* [16].

How will the application of these new technologies change the line of products developed by engineers, and specifically - how will the buildings look like and what kind of functionalities would they provide? How would these new functionalities resonate with social and cultural trends, and how would they influence the relationship between the building and the environment? Another group of questions is related to educational methodologies, such as how to involve students, and by what kind of educational strategies, in a creative search toward re-thinking the role of architecture in charting new paths toward a sustainable future. Ultimately, how to teach critical thinking about the future, having insights only into current knowledge and experience [17].

In response to these questions, a speculative design course has been offered to students of the Faculty of Architecture, at Gdańsk University of Technology (Gdańsk Tech), Gdańsk, Poland. To provide students with state-of-the-art expertise on the speculative design process a collaboration between Gdańsk Tech and the foresight company - InFuture Hatalska Foresight Institute - was initiated. The speculative design course, as a research-by-design architectural studio was introduced in 2018 and continued in later years with different topics, such as the future of office buildings, office interiors, the future of educational spaces, the future of waterfronts and the future of skyscrapers. This joint academic and non-academic architectural studio was designed with the following objectives:

- to acquaint students with the scenario model construction as a mode of critical thinking;
- to encourage students to study emerging technologies and experiment on the effects they may bring, while applied in concept development for sustainable buildings;
- to encourage students to enter into a dialogue with the identified social trends;
- to discuss the role of experimentation in architectural education.

In this article, the authors discuss the effects of introducing the speculative design methodology as a transdisciplinary and frontier educational experiment. They reflect on how this kind of experimentation contributes to enriching the student's understanding of the constant process of adaptation of architecture to environmental challenges, social trends and technological innovations. Another aim of this article is to present how students were encouraged and guided through the speculative design process that enabled the whole group to free themselves of the presuppositions and invent

original and critical architectural proposals for future cities. Additionally, the authors reflect on how speculative design studios may contribute to experimentation on the integration of emergent technologies into engineering thinking and facilitate the understanding of the correlation between today's choices and their future consequences.

SPECULATIVE DESIGN AND FUTURE STUDIES - A THEORETICAL FRAMEWORK

Futures studies is an interdisciplinary field of research that appeared in the mid-sixties. Contrary to appearances, it does not rely on predicting or guessing the future. This is forward-looking thinking, which deserves more to be called an exercise in strategic planning and preparing alternative, possible, probable, preferred or desirable scenarios. One of the basic paradigms of thinking about the future is the use of the plural because there are many alternative futures [18]. How can we guide our design decisions to achieve desirable goals? Van Notten defines the scenarios as *coherent descriptions of alternative, hypothetical futures that reflect different perspectives of past, present and future events that can form the basis for action* [19]. Speculative design has always been identified as a genre of critical design. Dunne and Raby who coined the term write:

> *Let's call it critical design, that questions the cultural, social and ethical implications of emerging technologies (…). [Speculative design] thrives on imagination and aims to open up new perspectives on what are sometimes called wicked problems, to create spaces for discussion and debate about alternative ways of being, and to inspire and encourage people's imaginations to flow freely* [20].

As Mitrović explains, from a modern perspective, design is directed into a *problem-solving practice* that is conceptualised around the question of how to design things that would better serve the needs of people. Contrary to this everyday approach, speculative design is more a discursive and critical practice, and as such, it originates from the radical architecture of the 1960s, and refers *partially to the critical practice of avant-garde and neo-avant-garde art* [21]. Despite this highly theoretical component, the speculative design method is commonly used in the design of products and services. It is also a growing academic field, as it offers tools for the conceptualisation of scenarios for the future in relation to changes taking place today in the real world [22-24]. This approach demands a shift from traditional normative thinking towards more flexible approaches that encourage experimentation on alternative perspectives and foster innovations. Analysis of trends, forecasts and emerging technologies, along with their critical interpretation allows for a design decision to be taken and an appropriate scenario to be developed.

METHODS

In the first stage of the course, the Foresight InFuture Hatalska Institute shared with students the methodology of creating alternative scenarios. As a non-academic partner involved in the implementation of research tasks commissioned by market agencies and institutions, the company revealed the methods of data gathering. The data was systemised in three groups: 1) environmental scanning; 2) signals-based forecasting; and 3) in-depth expert interviews. In the next step of the process, the identified change factors were analysed by students according to the multi-criteria analysis: sociological/cultural, technological and environmental. In the following stage, students were selecting particular technology or group of new materials and technologies, and critically discussed how they could be used in future buildings and how such buildings might relate to the environment and respond to social and cultural trends (Figure 1).

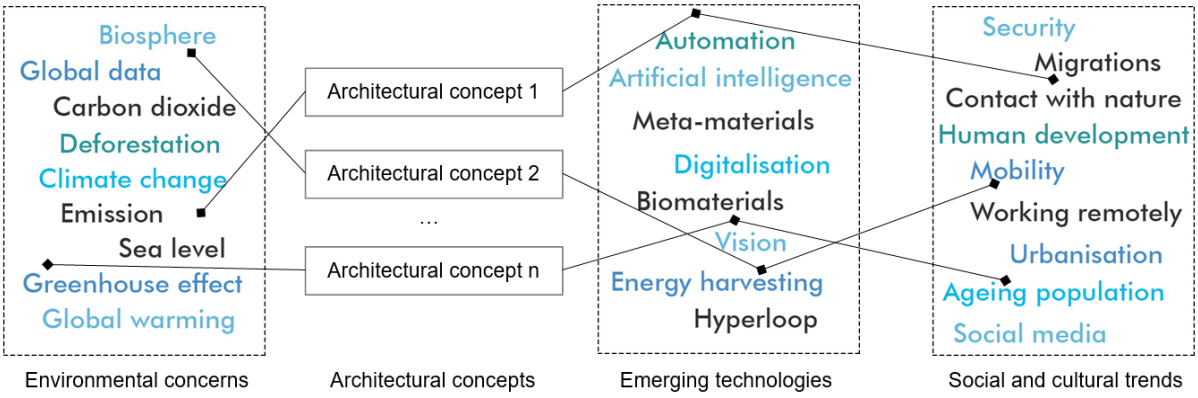

Figure 1: Applied methodology - a scheme of the architectural concepts' formation.

In the final stage of the process, the architectural concepts were developed. This phase was of crucial value both for students and the foresight company. Usually, foresight companies present findings as verbalised descriptions of scenarios written in the form of reports that give insights into the characteristics of possible alternative futures. In addition to this usual scenario construction process, students developed their visions using architectural design as a language of expression. In effect, the descriptive concepts were furtherly developed and refined in the process of architectural research by design experimentations - partly intellectual, and partly emotional and intuitive. The final results were thoroughly discussed and evaluated. Control questions were asked in the form of a survey conducted at the beginning and the end of the design studio.

RESULTS

In the creative process of experimentation, students developed concepts for future buildings linking the chosen environmental scenario with a response to social and cultural trends and basing them on the selection of innovative technologies or materials. This approach led to the presentation of interesting concepts for architectural objects and interior spaces. The projects for the architecture of the future developed by students could be divided into the following distinctive groups:

1. return to nature (invisible buildings dissolved in the environment and green architecture);
2. autonomy in architecture and self-sufficient constructions (buildings providing the production of oxygen, drinking water and food, as well as sewage treatment);
3. bio-architecture and biophilic design (organic materials, adaptability, flexibility).

The surge toward a return to nature, blurring the boundaries between the architectural object and the environment, between the built and the organic appeared as the most explored path toward the architecture of the future. To develop such scenarios students planned for the new means of transportation, such as transportation drones or a hyperloop (high-speed transportation), used materials with a negative angle of reflection making the surfaces invisible, materials that change colours to provide energy benefits or organic materials, such as algae for the production of biomass (Figure 2 and Figure 3). Instead of increasing carbon emissions - buildings were designed as microclimate installations that bring benefits to the environment. Green buildings were presented as covered with layers of vegetation and equipped with vertical living walls inspected by automated horticulture robots. Floating objects were conceptualised as growing structures fabricated from filaments made of micro plastic extracted from oceans by controlled strains of bacteria.

Figure 2: *Flying Tomorrow*. Created by: Jakub Sokólski and Łukasz Staniewski, Faculty of Architecture, Gdańsk Tech.

Interestingly self-sufficient constructions were developed by students for two opposite scenarios. In the first one, buildings were embedded in a post-apocalyptic environment or in inaccessible regions and designed as capable of providing oxygen and producing food, sometimes equipped with separate mobile elements (Figure 4). In the other one, they were encrusted in dense urban structures as independent constructions with rotating elements adjusting to the quality of light and wind conditions. Buildings resembling natural formations were equipped with architectural meta-seeds, in the form of mobile modules that may travel to even distant places. This speculation on unrooted architecture took also the form of living compartments floating on the water or transported by drones to changing locations.

Figure 3: *Invisible Architecture*. Created by: Anna Jeziorska and Paulina Gudzińska, Faculty of Architecture, Gdańsk Tech.

Figure 4: *Inverted Tower - Self-sufficient Architecture Withstanding Future Conditions*. Created by: Katarzyna Górska, Maryia Tokar, Milena Lemańska, Faculty of Architecture, Gdańsk Tech.

Analysing the results of their work, students linked the proposed architectural concepts for future buildings with social and cultural trends, such as demographic changes, the decline of a sense of security, threats of natural disasters and wars, ageing society, and Industry 4.0-related changes, including the tendency to work remotely. The final element of the speculative design studio was a discussion on what the preferred future is and what actions should be taken to achieve desirable goals.

CONCLUSIONS

The speculative design studio brought mutual benefits - both to the participating students and the foresight company. The main academic gains are innovative learning outcomes, such as the ability to build scenarios as a mode of critical thinking, understanding the role and responsibilities of architects in society, linking design with emerging technologies or questioning theory-practice and nature-built relations as irreconcilable oppositions. Discussing the effects of the design studio students pointed out the importance of going beyond architectural practice that is focused on clearly defined architectural or urban projects, and delving into more critical design experimentations. The control survey conducted at the beginning and the end of the design showed progress in understanding the role of technology in shaping architecture, and the role of architecture as a response to the observed social and cultural trends. As students pointed out, some of these trends are already changing the image of architecture, but in a slow and continuous - and thus almost imperceptible - manner. The speculative design studio, as a creative thinking laboratory made students more sensitive to the observation of these changes.

Satisfied with the studio results, students voluntarily get involved each year in the post-production of their work for exhibitions and publication purposes. The most prominent dissemination of their work was on the New York-based Web platform Bisnow [25], which is the world's leading platform serving the commercial real estate industry, and through the invitation to participate in the Łódź Design Festival - one of the most prominent design exhibitions in Poland.

Additionally, the studio boosted transdisciplinary collaboration between architectural engineering and other disciplines at Gdańsk Tech, such as mechanical engineering, material engineering, ICT, automation and clean energy research hubs. As the discussion between the educators revealed, many of the findings, particularly those related to the integration of natural and biotic components into engineering structures, as well as the very speculative design methodology, could be extrapolated to other engineering disciplines opening new perspectives in the pursuit of innovations. The studio brought also benefits for the non-academic partner, enriching the reports on the scenarios for a sustainable future of buildings by means of visual materials, such as drawings, schemes and visualisations.

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