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The *resilient city* in architectural engineering education: a joint design studio between Gdańsk and Chalmers universities of technology

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ABSTRACT: Challenges to society, such as those posed by climate change require a new approach to the education of the engineer-architect. Contemporary solutions should serve future generations and that is why the idea of the *resilient city* should be discussed and implemented, both in theory and in practice. It is necessary to teach students to design urban structures in such a way that they are resilient to dynamically changing conditions. In this article, the authors have presented a new teaching model based on international co-operation: a joint design studio. In presenting opportunities, the authors have also identified challenges of this new approach based on their experience over three years of co-operation between Gdańsk University of Technology (GUT), in Gdańsk, Poland and Chalmers University of Technology (CUT), in Göteborg, Sweden. This teaching format could be a valuable instrument in the education of future engineers-architects. If properly implemented, it could also be beneficial for cities during the participatory design process.

INTRODUCTION

The world is rapidly changing. With globalisation and the human impact on the environment and the rapid development of destructive technologies, such as artificial intelligence, autonomous vehicles, 3D printing and advanced virtual reality affecting the shape of modern cites, the need has arisen to change curricula for teaching architectural engineering students. The new generation of engineers will need to focus on the opportunities that will arise but also deal with the challenges in the context of societal change. Climate change has a strong influence on present-day cities and the new generation of architects and engineers should be equipped with the knowledge and know-how that allows them to deal with such issues.

To illustrate how the changes above influence skills and knowledge needed to educate engineers-architects, the authors have outlined in this article the challenges and opportunities of implementing a joint design studio conducted between Gdańsk University of Technology (GUT), in Gdańsk, Poland and Chalmers University of Technology (CUT), in Göteborg, Sweden.

The co-operation was instituted to produce a programme that prepared engineering students from various planning cultures to deal with climate change in urban design. The authors analysed these processes from two perspectives: 1) from the point of view of change because of new challenges connected to climate, and the role of the planner; and 2) in international practice, where future professionals gain skills to enable work in the global environment with varying planning cultures. In both cases, there is a need to build new skills and competencies to work in the inter- and transdisciplinary environment.

DESIGNING A RESILIENT CITY: MAIN DEFINITIONS AND ASPECTS

Cities have always played the role of *development locomotives* and nowadays they are habitats for more than 50 percent of the world's population [1]. Cities especially are threatened by the consequences of climate change, such as: an increase of thermal conditions in urban areas; and the occurrence of extreme phenomena, in particular precipitation (torrential rain) causing local flooding and disturbances in the functioning of infrastructure, as well as drought and resulting water deficits. Specific urban hazards also include air circulation disorders reinforced by pollution. The phenomena particularly dangerous for cities are an increase in the frequency of extreme phenomena and their adverse effects [2]. This is why there are actions to mitigate the negative effects of climate change, and the resilient city is being implemented during the planning and designing of cities.

Organisations, urban researchers or administrative units have varying definitions of resilient cities, usually highly general. According to ICLEI Resilient Cities [3] (ICLEI - Local Governments for Sustainability began in 1990 as the

International Council for Local Environmental Initiatives), a resilient city is one *that supports increased resilience in institutions, infrastructure and in social and economic life. Resilient cities reduce sensitivity to extreme events and creatively respond to economic, social and environmental changes to enable long-term sustainable development* [3].

This is a strategic concept, determining the actions a city should take to increase resilience [4]. Desuoza and Flanery propose an even more generalised understanding of the concept [5]. They understand resilience in relation to cities as *…the ability to absorb, adapt and respond to changes in urban systems* [5]. Understood generally, an *urban resilience* is the ability of individuals, communities, institutions, companies and systems in the city to survive, adapt and grow regardless of the types of chronic stress and sudden shocks to the city.

It is expected that in coming years, cities will be key to the implementation of adaptation policies in EU member states. The need to prepare the urban plan for adaptation to climate change resulted from EU policy directives and, in particular, from the strategy for adaptation to climate change of the European Union of 16 April 2013: to introduce the threats from climate change to the local (city) level [6]. In the face of those threats, the education of engineers-architects should address changes to the urban condition caused by climate change, as well as teach a new generation of designers to employ the principles of resilience. That is why it is important to include as a part of the education for urban planners and architects, the issue of resilient city design. Education could be a tool of rising awareness of future professionals on how to deal with climate change in cities around the world.

CLIMATE CHANGE: EDUCATING ENGINEERS-ARCHITECTS AT GUT AND CUT

Gdańsk University of Technology (GUT) is an engineering school with a long tradition. Curricula at the University are being transformed to meet the needs of changing trends and conditions. An example of a new generation planning and urban design curriculum is the Master's studies in spatial management, *Integrated Spatial Management of the Coastal Zones,* implemented in the Faculty of Architecture (FA) at the GUT. The programme is based on training modules that consist of theory, as well as practical seminars, studios and field visits. The aim of the course is that graduates acquire basic knowledge, as well as important skills and social competence to work in the development process [7].

In recent years, the Faculty developed a new, interesting form of practical design education: the joint urban design studio. More recently co-operation has taken place between HafenCity University in Hamburg; the University of Oregon at Portland in the USA and Lviv Polytechnic National University in Ukraine. The joint design studio is a formula which allows students from two universities to work on the same design. It is interesting to compare approaches based on differing planning cultures. A joint workshop allows peer-to-peer learning between students attending other engineering schools.

The FA-GUT is devoted to creating a platform for various stakeholders of urban regeneration (municipal and regional government; the private sector, including SMEs, NGOs and civic society), to promote inclusiveness and resilience of the solutions. This is because urban regeneration is both a major societal challenge for European cities, with special regard to Central and Eastern Europe, and also is a core research area for the University. A good example of such an approach is a joint studio, which is an advanced practical course on urban design taught at Master's level for engineers, architects and planners who wish to develop their design skills. The problem-solving nature of this course prepares future engineers, architects and urban planners to work with real-world problems in design.

JOINT STUDIO: *GÖTEBORG - DESIGN FOR THE RESILIENT CITY*

It is now three years since the GUT and CUT began to work together. First-year design was located in Sweden, in Göteborg (Ringön district). A common exhibition in June 2017 at Göteborg allowed students to see different possible approaches to addressing design issues. Also, a common workshop provided an opportunity for students to work in international groups. Success in the first-year of co-operation encouraged thoughts about further collaboration on sustainable urban development, the resilient city and urban solutions to climate change.

The two following design studios in 2017/2018 and 2018/19 had the aim of teaching students design skills allowing them to prepare an urban design on the transformation of brownfields, with particular attention to climate change and cultural heritage. In modern cities, the problem of brownfield transformation is an extremely important element in planning and designing sustainable urban spaces. That is why it was vital to explore this subject, searching for new solutions for the development of resilient and sustainable cities. In contemporary teaching at the FA-GUT, importance is given to problem-oriented design. That is why the joint studio between the GUT and CUT also followed this concept.

The focus of the design studio this year was exploration of how urban transformation and challenges of sustainable development can be merged into an integrated approach to urban transformation. Special attention was given to the problem of adapting to, and mitigating the effects of, climate change by means of planning and design. The existing built environment contains numerous cultural and functional values, as well as resources and energy built into the materiality. There is much pressure on existing buildings and urban structures to serve new purposes. Transformation of existing built environments is thus a major field of work for architects, urban planners and engineers. At the same time, climate change and rising water levels pose new challenges to existing urban structures.

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Projects and the Area for Design

The area for design was located in Sweden, in Gothenburg, in the Gullbergsvass district, which is a strategic area for a city development (see Figure 1).

Figure 1: Project area Gullbergsvass district in Göteborg, Sweden (Source: Authors' photo).

In Göteborg, former harbour-related functions have been moved out of the city's central area. The area of Gullbergsvass is identified as renewal space in the *Comprehensive plan* for development of the city of Göteborg. The waterfront strip of the area is in an early phase of development (see Figure 2), and it is connected to several of the projects in progress in the inner-city area.

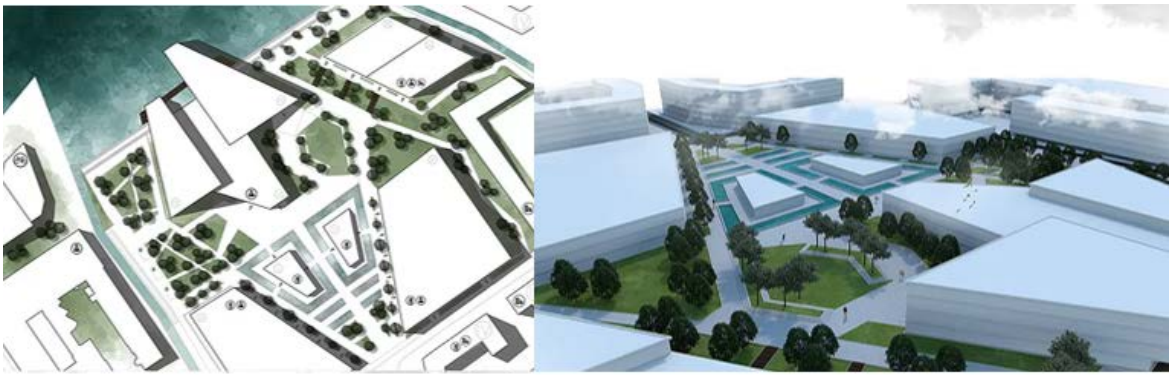

Figure 2: Design of the multifunctional waterfront (Source: project by Anna Kruża, Agata Müller, Klaudia Stanio and Kamil Wronkowski).

There is a mental distance that separates Gullbergsvass from the city centre, even though the area is close to many other so-called central neighborhoods, among these the Göteborg Central station. This makes the Gullbersvass an area with much potential, as well as having major issues yet to be solved. Risk of future flooding, because of rising water levels caused by extreme weather conditions is eminent in the area. This is also a reason why this area was chosen as a project site for the joint studio on designing a resilient city.

The overall aim of the studio was to teach and apply knowledge on urban transformation in an historic and contemporary context and in a sustainable way; to give insight into planning and design within existing urban and constructed areas with regard to climate change, infrastructure and transformation; and to test new knowledge in a critical and reflective way. The design studio consisted of a seminar and design session, as well as an optional study visit to Gothenburg between 6 and 10 March, 2019. Collaboration between the two universities intersected in many fields: teacher-student, teacher-teacher, student-student.

Importantly, a course Web site served as a communication platform that facilitated co-ordination between different project groups. The students' work can be found on their dedicated Web site. During the semester, it was an important link between students and teachers and between students themselves. The groups of students addressed the issues of resilient public spaces (see Figure 3), water-sensitive design of public spaces (see Figure 4), flood issues, biophilic design and sustainable transport, including active mobility.

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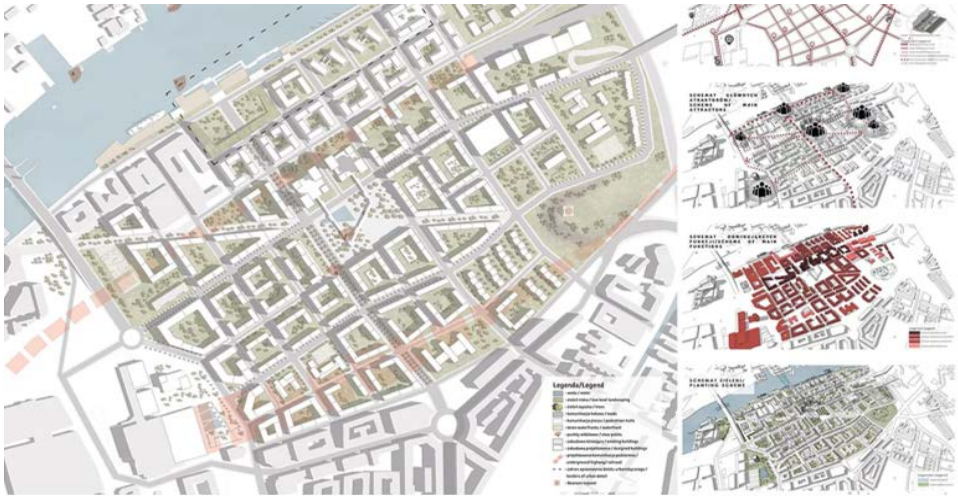
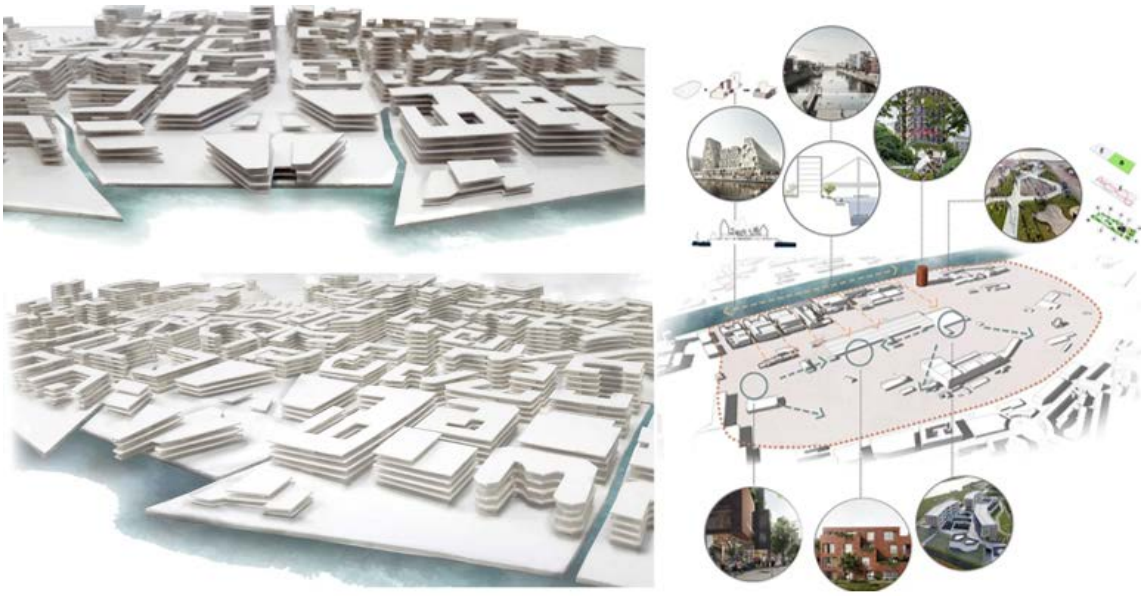


Figure 3: Resilient district - land-use development plan (Source: project by Karolina Zorn, Viktoriia Taraban, Natalia Kontowska and Artem Pasichnyk).

Figure 4: Detailed design of public space (Source: project by Agata Kielecka, Nadia Kocaba, Paulina Kummer and Adrianna Dębowska).

During the course, the students worked in groups with 3D models that allowed them from the start to work with the third dimension of the city structure (see Figure 5). They constructed one large model of the existing neighborhood and individual models for their concepts.



a) b)

Figure 5: a) working with 3D models during the design studio (Source: project by Anna Kruża, Agata Müller, Klaudia Stanio, Kamil Wronkowski); b) vision for a resilient district (Source: project by Ada Witkowska, Igor Bętlejewski, Maria Zajączkowska, Martyna Zielińska).

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LESSON LEARNED AND CONCLUSIONS

Design for the built environment is one of the most multidisciplinary practices in all of the engineering professions [8], and the design studios, because of their interdisciplinary character, were excellent platforms from which to learn competencies for interdisciplinary work. Building those skills …*require collaborative readiness, robust platforms, negotiation of differences, management of conflict, interactions in trading zones of language communities' construction of common ground*, as well as *collective communication competence and mutual learning* [9]. Also, it stresses the importance of processes of capacity and competence building in solving real-life problems [10]. By analysing and creating design, during this joint studio, for existing areas in need of urban transformation allowed students to gain knowledge and improve skills in solving such types of problem.

At present, significant changes in the urban planning paradigm, as with finding answers to societal challenges, such as climate change, can be observed. Moreover, there is also a rising understanding that education of both architects and engineers must be socially responsible, as engineers need to be, not only competent professionals, but also the agents of change responsible to the community they work in [11].

Graduates should have knowledge and understanding of sustainability principles, both in general theory and especially of how to implement them in their design practice. Introduction of place-base specificity is required, but also considered must be the planning culture specific to the country. At the same time, international co-operation and capitalising on varying experience could be useful tools to achieving these goals. International experience applied in the GUT - CUT joint studio gives better results than does the traditional urban design studio. Students learned not only the site itself, but the cultural differences and other types of design method.

Under these conditions, it is necessary to evaluate the education of engineers and architects: a new generation of urbanists is needed, who will be not only skilled craftsmen (which is necessary), but also skilled professionals who see the broader picture and be able to answer the needs of the community they work for and the environment they work in. In this context, the design studio fulfilled a role: it was both an interesting adventure and also an important voice in the discussion about building a resilient city. This type of attractive teaching formula engaged students in the discussion on the resilient city, and showed them new approaches to designing sustainable urban structures.

Further challenges for the education of engineers and architects include recognition of the needs, validation and verification of the present programmes and courses offered in regard to requirements and paradigm changes. It is vital to link the educational offer with global challenges, such as development of resilient urban structures.

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