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THE KLABS PROJECT: LESSONS AND FUTURE PERSPECTIVES

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THE KLABS PROJECT: LESSONS AND FUTURE PERSPECTIVES

F R U I T F U L D I V E R S I T Y

The Erasmus+ project KLABS - *Creating the Network of Knowledge Labs for Sustainable and Resilient Environments* gathered eleven partners (six from the Western Balkans and five from the EU), aiming to support the modernisation of higher education in the Western Balkans by implementing a strategic approach in developing innovative platform for the delivery of knowledge in the field of sustainable and resilient environments.

During the three years of various project activities (2015-2018), partners had the opportunity to interact and work together, addressing the core project topics

from different perspectives as participating institutions varied in size, available resources, organisational structure, teaching methodology, historical legacy, experience, languages, cultural background, etc. The diversity of project team soon emerged as one of the most valuable characteristics: the common issues were easily identified while the local specificities were experienced first-hand and further processed and absorbed. This diversity has enabled all participants to become richer, wiser, better and more effective – broadened personal experience and quality of the results have confirmed the value and immense power of diversity in relation to adequate addressing of topics of sustainability and resilience.

The KLABS diversity is reflected in this issue, since contributions come from four different institutions: TU Delft / Faculty of Architecture and The Built Environment, University of Banja Luka, Faculty of Architecture, Civil Engineering and Geodesy, Faculty of Civil Engineering at the Džemal Bijedić University of Mostar and University of Belgrade – Faculty of Architecture.

L A Y E R S A N D S C A L E S

Addressing the challenges of sustainability and resilience of built environments in the scope of climate change involves multiple issues, often contradictory and/or overlapping approaches, complex and ever-changing tools, often leading to more questions than providing reliable answers. Professionals, students and academics alike expectedly end up either being confused or at times even discouraged in their pursuit for ‘optimised, sustainable and resilient’ design. They get attached to oversimplified ‘solutions’, recipes disguised as ‘methods’ and ‘tools’, losing the basic layers of architectural along the way.

An analytical overview on ‘how did we get here’, as well on the approach that is based on ‘Scales to Aspects’ model developed by TU Delft’s CBE hub, presented in the article by Ioannou et al., provides a valuable contribution to the topic. Further along the way, this issue takes us through a series of scales, from landscape and urban morphology (Novaković et al.), through building and its immediate surrounding (Ignjatović et al.), all the way to the structure and materials (Šarančić et al.). The main common denominators for all four texts are the evident need for multidisciplinary approach and inevitable thinking through various scales, confirming that intertwining of all ‘layers’ and ‘scales’ is imbedded in the research and pedagogical aspects of dealing coping with the issues of sustainability in (re)shaping the built environment.

T H E V A L U E O F ‘N O W’

The global overspending of all resources reflects on built environment somewhat differently. The construction process uses a wide range of resources, but at the same time it produces a new ‘man-made’ one: buildings that often outlive their initial programme and design brief. Built structure, and built environment in general, should therefore be treated as a valuable resource in all previously mentioned scales – from wider scale of urban tissue, over the building scale all the way down to the issues of materials, production and circularity. In that sense, each article in this issue provides an idea of a path to innovative use of existing buildings/resources, simultaneously creating a quality resource for the times ahead of us. The ‘now’ in the process of architectural design is being assigned new values, embedding the existing heritage as well as a changed perspective on the future life of our creations.

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PLANNING FOR CHANGE: A METHODOLOGICAL FRAMEWORK FOR INTEGRATING CIRCULARITY INTO TU DELFT'S FACULTY OF ARCHITECTURE AND THE BUILT ENVIRONMENT'S CURRICULA

A B S T R A C T

This paper introduces a methodological framework to integrate circularity in architectural curricula and the building blocks that led to its conceptualisation. The first block (Part A) examines how complexity has affected learning and architectural education, in particular. The paper departs from the notion that knowledge produces further uncertainty in conditions of critical complexity. Moreover, the highest levels of complexity require the least scientific of approaches. It then examines the main challenges resulting from this shift: one is that learning identifies with individuals' ability to make informed decisions and is now conceptualised as actionable knowledge. Second to that, education should opt for a pedagogy that can support learning through decision making. Architectural education, in particular, should be able to foster a new type of professionalism, where individuals assume accountability for their design decisions that extends beyond the aesthetic realm. But what can drive curricula to become more responsive to the current environmental, social, and political realities? The second block (Part B) looks into the issue of circularity. It examines its relevance to architectural education for its potential to function both as an operational scheme as well as a value system. Furthermore, being a concept in the making, circularity can benefit from academic research but can also support a pedagogy that focuses on helping students learn how to learn. The proposed methodological framework (Part C) builds on these two blocks and on the faculty's research on circularity to develop a scheme of what constitutes content for teaching circularity, how the goals for integrating it into the curricula can be formulated, and what type of pedagogy is suited to support the integration.

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INTRODUCTION

The built environment is largely responsible for raw materials exploitation, waste production, and greenhouse emissions.[1] Globally, more people live in urban than in rural areas, and by 2050, two-thirds of the population will be living in cities.[2] Current architectural approaches cannot affect the change required to tackle these challenges.[3] Confronted with complexity and entrapped in knowledge fragmentation as well as its own disciplinary limitations,[4] architecture must reconsider its relevance and re-examine its ethics for 'protecting the Earth.'[5] Rethinking the traditional subjects and clarifying what is particular to the discipline[6] is a necessity that significantly affects architects' training. The need for a new type of education is emerging: an education that enables learners to fully engage with critical realities[7] by developing human qualities such as criticality and resilience, which, in turn, provide them with the capacity to think and act purposively despite complexity.[8]

This paper introduces a methodological framework to integrate circularity into architectural curricula as well the pedagogical implications the framework entails. The framework is grounded on the belief that architects' sense of accountability needs to be extended beyond the aesthetic realm while acknowledging that the world is inherently complex. However, here lies a strange paradox which has been one of the main challenges behind the framework's conceptualisation: if, in times of critical complexity, the knowing-of-the-world can only be imperfect,[9] then where can this extended accountability draw its relevance from?

The authors argue that one implication of critical complexity is that learning is now situated in making decisions.[10] This requires that individuals must prioritise the information at hand and make distinctions. Another notion that emerges across the different accounts of complexity theory is that the highest levels of complexity require the least scientific approaches. Basarab Nicolescu calls this a new spirituality;[11] for others, it simply translates to revisiting humanity's values discussion and setting a new ethical background against which design decisions can be made.

It is here that circularity enters the discourse and why it becomes relevant in architectural education; its power lies in its capacity to organise the socio-technical while also claiming a change of ethics. Moreover, as circularity is a gradually evolving phenomenon and therefore still indeterminate, its integration into architectural curricula constitutes a mutually beneficial strategy. Circularity can feed on academic research, and, in return, architectural pedagogy can benefit from experimenting on how to teach students to learn in conditions of critical complexity.

The first part of the paper examines how the world's complexity and individuals' growing sense of uncertainty have affected knowledge creation. It also looks into how emerging learning theories and the latest pedagogies have adjusted in order to explain and address the impact of complexity in teaching and learning processes. In the design methods movement and – by extension – design education, complexity can be traced back to the 1960s and the multiple ways it challenges humanity with the current environmental crisis and thus climate change and the depletion of resources. The second part of the paper is dedicated to circularity and its relevancy for architectural education. In the third and final part, the paper builds on these blocks to create a new methodological framework along with the reasoning behind its creation and its projected implications for pedagogy. Finally, a discussion section identifies the barriers and limitations of the proposed methodology and critically reflects on how circularity can ultimately creatively reshuffle educational priorities.

PART A - Teaching and Learning

1. Teaching And Learning In Times Of Complexity And Uncertainty

> The world is not all in, it is in the making.[12]
> We change the world and the world changes us.[13]

In popular parlance, complexity is often used to describe situations of controversy, ambiguity or multiplicity when the new worlds that emerge are clashing with the existing order.[14] Although interest in complexity can be traced as far back as the first half of the twentieth century,[15] a more systematic understanding of complexity was established by the 1984 Santa Fe Institute Workshops, when the term was first used to define systems with 'a very large number of interactions and feedbacks, inside which processes are very difficult to predict and control take place.'[16]

Edgar Morin further distinguished between two types of complexity: what he calls restrictive (or theory of everything) and generalised (or critical): whilst the first encompasses chaos, disorder, and uncertainty in the most common sense and use of the word, it remains within the epistemology of classical science. The latter, however, requires an epistemological rethinking, a new paradigm for creating knowledge.[17] Critical complexity resists scientific reductionism, determinism or holism of systems theory because it focuses on understanding the intricate interrelations between the whole and the parts where only certain aspects can be understood at a time.[18] Therefore, descriptions of complex systems cause further distortions, making our models imperfect renditions that introduce further uncertainties.[19]

In a surprisingly similar line of thought, Roland Barnett makes a parallel claim from an educational perspective: if the knowing-of-the-world produces further uncertainty, education should not support learners to acquire knowledge or skills, but instead help them create a self that is adequate to an uncertain world.[20]

1.1. Learning theories and pedagogies for complexity: from systems to networks

Complexity theory and its contribution to epistemology did not give rise to a specific learning theory or pedagogy right away. In the late 1980s, around the time complexity theory was developing, the prevailing learning theories of 'Communities of Practice' (CoP)[21] or 'Situated Learning'[22] tried to expand the idea of social learning as a system with an identity of its own, a developing structure as well as self-organisation and meaning-making processes. Similarly, the 'Communities of Inquiry' (CoI) learning theory looked closer to social learning in the framework of online communication and exchange. It perceived it as a system with closed boundaries that provided 'order, heuristic understanding, and a methodology for studying the potential and effectiveness of computer conferencing.'[23]

Even though limited to restricted complexity, both of these theories contributed greatly to pedagogy: CoI promoted autonomous learning that flourished in later theories like Heutagogy[24] and self-regulated learning.[25] CoP, on the other hand, – by nature outside formal educational organisations – promoted the importance of informal learning[26] that later became the prevailing concept in the pedagogy of virtual learning communities.

Critical complexity manifested as a core learning principle only twenty years later with connectivism: the theory poses that learning occurs within 'nebulous environments of shifting core elements that are not under the control of the individual.'[27] Learning, in this case, is identified as 'actionable knowledge' and is described by the ability to make decisions by drawing distinctions between important and unimportant information and by recognising when new information alters the landscape.[28]

In connectivism, the dominant metaphor is that of networks; systems that are intentionally open to their environment, can classify their own interaction with it, and change their structure accordingly.[29] Integration of connectivism in pedagogy, however, has been characteristically slow.[30] What makes connectivism relevant for critical complexity is what makes it controversial in an academic setting: its distributed, destabilising nature and informality clashes with the formal, hierarchical order of academic institutions as well as established forms of education[31] such as the design studio model in architecture – still the main vehicle for learning in the discipline.

2. Complexity In Architectural Design Methods And Education

2.1. How complexity has been confronted by design methods and design education

Complexity challenges designers and engineers, who are at the forefront of change. It has been central to this debate ever since the launch of design methodology as a research topic in 1962 at the London Conference. In his book 'Notes on the Synthesis of Form' published as early as 1973, Christopher Alexander, one of the founding members of the design methods movement, stated that 'more and more problems are reaching insoluble levels of complexity.[32]

Until the 1980s, design methodology – and by extension design education – systematically tried to tackle world complexity by exploring its synergies with science to gain validity and relevance.[33] Influenced by modernity and analytical thinking, complexity was to be tamed by breaking a problem down into smaller, manageable parts. Knowledge creation followed the analysis-synthesis model,[34] matching systematic observation and inductive reasoning in the analytical phase, and subjective and deductive reasoning in the creative phase.[35]

Theoretical constructs, such as the distinction between 'tame and wicked' design problems formulated by Horst Rittel and Melvin Weber in the early 1970s, established that while science needs methods with replicable results, design does not. Therefore the scientific method was inadequate for resolving complex design problems which are unique by nature.[36] Design methods theorists' original fascination for scientific certainty gradually succumbed to the appeal of systems theory and cybernetics. Following the interdisciplinarity paradigm of systems theory, design methods theorists extended their interest in the neighbouring disciplines, especially art and the social sciences, as the study of design itself grew to become an independent discipline. Research became predominantly perceived as cross-disciplinary experimentation, and theoretical courses proliferated.

As a result, in the years that followed, architecture largely shifted its focus from the end product to the design processes.[37] Its theoretical base grew significantly; however, at the expense of its technical and operational capacity.[38] The advent of digital technologies and computer-aided design in the early 1990s announced 'a massive, technology-driven change' but even so, in this initial stage, design remained largely dependent on the preceding theoretical discourse.[39]

Meanwhile, complexity gave rise to a new type of architecture: non-linear architecture.[40] Architects set out to tame complexity, this time, by means of computation. However, while the tools developed for form-generation, structural

and environmental analysis, simulation and optimisation were excellent, this kind of architecture failed to acknowledge social, political, and economic qualities and conditions. It was highly criticised both for its insensitivity to local contexts as well as its reliance on bespoke production chains.[41]

2.2. Complexity unresolved: the future that is now

Complex geometries ultimately gave rise to expressive, iconic architecture made possible by the market boom of the early 2000s.[42] However, these signature buildings, 'sculpturally assertive but signifying nothing but the vanities of self-expression and the vacuous pursuit of novelty,'[43] further strengthened the predominant notion of continuous growth and neoliberal economics as well as the modernist tradition of the individual architect, while severely undermining the criticality of climate and material emergencies.[44]

Environmental concerns had been expressed as early as the 1960s, focusing on the idea of waste as a negative force: however, the notion of sustainable development that flourished in the late 1980s (Brundtland report was published in 1987) gave way to new ideas about waste management with a more positive take.[45] Although the complexity of the debate increased in the following years, clear answers could still not be obtained.[46] Mainstream architecture never engaged with the premise of sustainability; buildings continued to be produced without any regard for their environmental impact, while any emergent form of architecture that showed a concern for the environment was dismissed as ugly, condemning sustainability as an aesthetically irrelevant issue.[47]

Gaver et al. suggest that design may only be aesthetically accountable, not epistemologically.[48] Meaning that maybe designers do not have to justify their methods as scientists do. But what about their accountability in acknowledging the critical issues of their time and acting accordingly? Contemporary challenges identified include, but are not limited to, preserving biodiversity, identifying transparent and egalitarian forms of governance and economies that are sufficient and accountable, and managing production and consumption habits within the planetary limits.[49] According to Jeremy Till,[50] current approaches are incapable of affecting the change required for current emergencies. Therefore one should break away from architecture's attraction to certain systems and values. If the only certainty we can rely on is that our current ways of doing and thinking about architecture can no longer be sustained, then we need to 'actively start designing the conceptual spaces we depend on as we design.'[51]

From here onwards, designers mainly appeal to two domains to resolve complex issues: either the premise of technology or the more challenging – and perhaps even more controversial – values discussion. On the one hand, the 'what' and

the 'why' of architecture are expected to arise from the wide dissemination of digital fabrication techniques and the power of programming. Philippe Morel, co-founder of EZCT Architecture & Design Research, argues that we now need to address the question of architecture beyond mimesis and beyond humanly thinkable thoughts where computation takes over all aspects of everyday life (highlighting is ours).[52] The second line of thinking follows Nicolescu's[53] quest for a new spirituality: counteracting the Anthropocene and resisting the dynamics and effects of neoliberal capitalism is to be found in the subjective dimensions of psychology and culture,[54] and gearing towards an architecture of caring, 'not just for the built environment, but for the whole planet including its human labour force.'[55] Emergent terms like 'sharing economy' and 'degrowth' have been introduced to propagate systemic change by downscaling production, either by promoting peer-to-peer consumption and platform economy in the first case or through community-based forms of production, exchange, and consumption in the latter.[56]

Needless to say, a certain tension exists between the two directions: in the first case, information technology and open knowledge are expected to democratise production, and it is computation and auto-construction that will provide the basis for the social aspect to evolve.[57] Today's non-standard robots, says Mario Carpo, will create the automated version of the pre-industrial artisan, and the social import of this revolution will be unleashed almost accidentally.[58] In the second case, architectural positivism is renounced altogether along with the whole growth doctrine: complex issues such as climate change cannot be solved by ecology and technology nor by any means that originate in the current regime, for that matter.[59] Rather, it takes a different paradigm altogether and a complete restructuring of our being in the world if we are to conceptualise a sustainable future, that is to find the symbolic language and the new spirituality Nicolescu is arguing for.[60]

Institutions are required to think afresh about how they can participate in rethinking the responsiveness and relevance of their curriculum and mode of pedagogy against current environmental, social, and political realities.[61] So, how should architectural education respond? We argue that its role is to continue developing those concepts that can help model reality while streamlining the preferred, the imaginary and the visionary. And this is why circularity has become a central theme in our research: situated at the intersection of the two aforementioned trends, it constitutes both an operational and a value system. The following sections attempt to provide a brief profile of what circularity is, why it is relevant today in architectural studies, and how it can become instrumental in dealing with complexity and, therefore, essential in architectural education.

PART B - Circularity

3. The Advent Of Circular Economy And The Circular Built Environment

The notion of *circular economy* (CE) as an alternative to the linear take, make, waste model first appeared in the early 1970s and was further developed in later years, amongst other factors driven by increasing energy prices and high unemployment.[62] CE is closely connected to different schools of thought such as Regenerative Design; Performance Economy; Cradle to Cradle; Industrial Ecology and Biomimicry.[63] CE developed on five principles advocated by the aforementioned schools of thought: designing out waste; building resilience through diversity; relying on energy from renewable resources; thinking in systems; and waste being food.[64] The circularity component of CE particularly pertains to material use, aiming to narrow material flows (use less), slow material flows (use longer), and close material flows (use again)[65] while striving for systemic value retention rather than value destruction.

Circularity has gained increasing relevance since 2015 when the EU adopted the first CE Action Plan.[66] And after successfully implementing a series of targeted actions,[67] the EU launched a second Action Plan in March 2020 that builds on the knowledge and know-how produced in the first, while continuing to refine the concepts introduced half a decade earlier. What is more, the EU increasingly focuses on policies that bond circularity with energy consumption, as the recent launching of the EU Green Deal attests. 'Enacted globally,' the authors of the latest version of The Circularity Gap Report claim, 'a CE can close the Emissions Gap,' leading us to a below 2-degree world by 2032.[68] The same report further accentuates the need to apply circular strategies at 'the intersection of materials and emissions hotspots.'[69]

CE has been extensively scrutinised for being too vague, fragmented, dependent on other scientific concepts, and for downsizing conflicts, trade-offs, or the fact that even cyclical systems require energy and produce waste.[70] Moreover, CE is not politically neutral, meaning that circular strategies - such as repair and remanufacturing - may overlook potentially transformative, political, and future-oriented roles based on integrity, care, and legibility values rather than merely new forms of capitalist commodification.[71]

Implications of CE for the built environment remain underexplored. In this regard, the Circular Built Environment (CBE) Hub of the Faculty of Architecture and the Built Environment of TU Delft has systematically undertaken research projects to uncover how the built environment affects and is affected by circularity. Research findings have culminated in a definition that reads as follows:

> The Circular Built Environment (CBE) is a system designed for closing resource loops at different spatial-temporal levels by transitioning cultural, environmental, economic & social values towards a sustainable way of living (thus enabling society to live within the planetary boundaries).[72]

The definition bridges the two ends of the discourse examined in the previous section. On the one hand, it builds on the socio-technical aspects of CBE to conceptualise it as a designed system, where technology holds a key role. But what it also suggests is that CBE requires a transition of values against which the use of technology can be put into context. In this light, circularity is bound to the inherent complexity of architectural practices that enmesh 'cognitive, cultural and material elements.'[73]

4. Why Is Circularity Relevant In Architectural Education?

Below, the relevance of circularity in architectural education is discussed both as an organising principle that can be used to read and manage critical complexity in the built environment as well as for its inherent values. Moreover, the pedagogical potential of integrating into curricula is assessed.

4.1. General appeal

The most obvious argument would be that circularity is being widely adopted and promoted as a key strategical approach in both top-down and bottom-up initiatives. Arguably, grassroots initiatives have paved the way for a broad societal appeal, including support from industrial and business perspectives. Not only, but particularly in the Netherlands, this societal support was rather quickly accompanied by the establishment of top-down regulatory frameworks. As outlined above, policies to support circularity have come into action at the EU level. Circularity is thus a phenomenon relevant to present times.

4.2. Necessity

Another critical motive for integrating circularity in education is dire; in light of 'planetary boundaries' awareness,[74] including urgencies around climate change and the depletion of resources, future generations of students need to be equipped with the necessary tools to facilitate or carry out the required transition to avoid, mitigate or reverse environmental tipping points. Since circularity is highly relevant in the built environment,[75] it is also relevant to the criticality and the challenges of our times.

4.3. Dual character

Another characteristic of circularity is its capacity to manifest both as an operational scheme and a value system. It is pragmatic as much as it is idealistic. Take the R strategies for example: on the one hand, they propose concrete ways of either closing, slowing or even narrowing material loops. On the other, inherent to these strategies are the values of caring and sharing. These are expressed by either prolonging a material's life cycle through repair or manufacture, or by intensifying a material's use through rethink. Or in the more extreme cases, by even refusing to make use of a given material in the first place.

4.4. Social prevalence

A greater opportunity lies in the fact that circularity forges the recalibration of society. The mentality change it requires affects and is affected by a wide range of actors and individuals in different capacities in the built environment. Integrating circularity in architectural education can therefore ensure a more socially inclusive perspective.[76] In this case, circularity is relevant for its capacity to penetrate society and for becoming owned by a larger audience.

4.5. Circularity as a designed system

Wide collaboration and exchange between owners and stakeholders require new types of synergies. Therefore, systemic processes related to the built environment need to be reconceptualised and redesigned: from extraction, manufacturing, construction, and maintenance to deconstruction and reverse supply chain logistics. While engineers are 'part and parcel of the hardness of socio-technical landscapes,'[77] the architect's role, says Andre Jaque, 'is to expose the socio-technological apparatus to mobilise and rearticulate the elements at play.'[78] Transitioning to a circular built environment thus requires architects to have the critical capacity not only to identify all actors involved and/or affected but to also design their interactions.

4.6. Ethical basis for designers

In an interview with Hans Ulrich Obrist, Jaque also claimed that 'differences are constructed by the way they interact.'[79] This would ultimately generate a way of thinking ethics in architecture in which the authors' intentions are less important than the result of their intentions as the process is socialised.[80] Design value is thus directly related to the relevance it acquires in the social realm.[81] The debate is not new, of course. In a paper written in 1971, Thomas A. Markus claims that none of the design models produced in his time had focused on the social and political status of the designer. Thus, all failed at relating design systems to other social and political actions.[82] Markus went on to describe three potential

roles for future designers: he argued that they could either increase the emphasis on their expert role, adopt a sympathetic stance to the so-called participatory design processes, or reject both solutions and look for 'a real transfer of power in design decisions.'[83] All three roles depend on how designers ultimately place themselves in the broad spectrum between 'environmental control and all other control in the system.'[84] Circularity challenges architects' ethical framework by confronting them with this decision.

4.7. Circularity indeterminacy

Circularity, being in its infancy, enters education with many uncertainties. Architects still lack the tools necessary to evaluate circular endeavours; they are still uncertain as to which value models are adequate. An accurate materialisation of this principle or an upscaling strategy remains at large despite the need for modularity having been recognised.[85] This is exactly what makes circularity relevant in academia. Industry and practice may have picked up on the phenomenon and may have already started producing tangible manifestations of how it can be applied; however, there is a need of making sense of what already exists and to what extent it can be generalisable. At this point, academia can be conceptualised as a platform that allows continuous feedback looping within the knowledge creation system.

4.8. Learning to learn

Because circularity remains uncharted territory, it can be instrumental in a pedagogy whose values rely on helping students acquire the skills needed to survive the uncertain world, Barnett described.[86] In this regard, the role of education becomes that of developing ways to teach individuals not only particular concepts or skills but also learning as such. Teaching about circularity will then enable individuals to develop their own toolbox for understanding and managing its complexity, making connections and decisions and most importantly, acting on them in order to learn.

5. What is the current landscape of architectural education in relation to circularity?

Whilst various aspects of circularity are widely discussed in current academic research, there is only a nascent body of literature for teaching circularity in higher education institutions. It is mostly focused on individual case studies at course level, students' assessment, and feedback on the process.[87] It is most notable that, in most research papers on architectural education, circularity appears as a sub-domain within the larger domain of sustainability and rarely as

an independent concept. Knowledge of CE and the ability to apply its principles, however, must be embedded in the curriculum so that they become integral to design practice.[88]

A recent study focusing on integrating sustainability in Asian architectural schools revealed that the concept manifests mainly in (building) technology courses and much less in theory courses or design studios.[89] Some of the main

difficulties of integrating circularity in design studios across levels are attributed to its systemic character and the fact that it extends into knowledge domains that, whilst being very relative to circularity, are not traditionally related to design.[90]

Another study commissioned by the Ellen MacArthur Foundation[91] found that at least 138 higher education institutions have learning offerings in CE and that TU Delft scores the highest on the list. Nevertheless, considering the fragmented landscape of practices in architectural circularity education, the next section is dedicated to the possibilities of creating a methodology for teaching circularity both in terms of content as well as pedagogy. The approach is being developed by a team of researchers of the Faculty of Architecture and the Built Environment at TU Delft.

PART C - A Methodology

6. Methodology: How Does One Integrate Circularity In Education?

Summing up what was discussed thus far, there are at least five key points to consider for developing a methodology that integrates circularity in architectural education curricula:

1. We are at a point where knowledge produces further uncertainty, and thus, we need to come to terms with the notion that any attempt to describe our reality, let alone manage it, will always be lacking;
2. Learning can be considered as actionable knowledge, as in making decisions/choices in the nebulous, unstable environments we encounter;
3. Science has not been able to fully address the complexity of design issues, and a need to establish a new values system is emerging;
4. Designers' aesthetic accountability and fixation on form obscures the critical imperative of their accountability in addressing the complexity of the problems of our times;
5. Despite being complex and currently underexplored, the relevance of circularity adds value to architectural education by providing a way of organising the socio-technical while also claiming different ethics.

A methodology for integrating circularity in architectural education is founded upon these points and will be further presented and explained in this section of the paper. It is essential to note that it is not directed towards a specific course; rather, it addresses change at the curriculum level.

6.1. Contextualising content by what we know: the 'scales to aspects' model

So, how does one plan education knowing that any given concept cannot be fully represented, let alone a concept that is still in the making? We suggest that this happens by contextualising the concept within a space that includes what is currently known about it but also has the ability to transcend the limits of these notions.

Returning to Morin's taxonomy of restrictive and generalised complexity, Woermann argues that, in both cases, the necessary condition for creating meaning is modelling.[92] But while modelling remains descriptive for the first category, it involves a normative component for the latter as we must make choices, judgements, and assumptions as well as recognise that our modelling strategy represents one choice among many.[93]

It is our understanding that circularity - as an evolving knowledge domain – is an issue of generalised complexity (and therefore, in Barnett's terms, it is not only unknown but, at times, even indescribable). To model it, we adopted CBE Hub's 'Scales to Aspects' model as our canvas for carrying out research and contextualising research findings.[94] The CBE Hub model's primary function is to relate the concept of circularity to the built environment; it does so by distributing its entanglement to six distinct scales and an equal number of aspects.[95] Figure 1 represents an abstract representation of this selection. Despite its apparent simplicity, the model poses that in a CBE all scales are interconnected and therefore cannot be considered in isolation, while the outer ring of aspects suggests at least six topics identified as conditioning the scale interdependencies.

The model introduces a thinking-in-systems framework (and not a cognitive scheme) that is neither finite nor exhaustive; it simply states that any meaning-creation process regarding the CBE is necessarily mediated by the interpretative duo of scales and aspects onto which multiple combinations and interpretations are possible. Complexity theory, says Mark Mason, 'seeks the sources of and reasons for change in the dynamic complexity of interactions among elements or agents that constitute a particular environment,' and he argues that education research should therefore:

> […] move away from causal models to modelling the specific, local linkages that actually interconnect actors, practices, and events across multiple levels of organisation; and away from single interventions and simplistic solutions to the recognition of the need for coordinated changes throughout the system and to its constraining and enabling contexts and resources.[96]

Furthermore, the model pertains to a moment in time in the process of addressing circularity in the built environment: its components depend on the temporal occurrence in which a reading is attempted and are therefore likely to change. Circularity evolves, and so does our understanding of it.[97] Acknowledging and allowing for change is a fundamental principle for conceptualising concepts in times of complexity: the openness and flexibility of the 'Scales to Aspects'

Fig. 1. The "Scales to Aspects" model

model relates to the shifting ontologies of the network metaphor of connectivism as well as the principle of reciprocity, introduced by Kirchherr & Piscicelli.[98] While for the two authors reciprocity is limited to the ability of learners to reiterate the content and modes of delivery of a course on circularity, in this case, reciprocity is scaled up and used to account for learners' ability to sustain, enrich or question the dynamic equilibrium this model proposes.

6.2. The circular learning objectives (CLO) list

Based on the 'Scales to Aspects' model, a new conceptualisation of how circularity can be integrated into architectural curricula emerged that allowed to create what is now addressed as the list of Circular Learning Objectives (CLO) (Figure 2). The list was devised in early 2021 and has since been used in guiding discussions related to how circularity should be integrated into the faculty's curricula.

Barnett was quoted earlier claiming that complexity and uncertainty require more than knowledge or skills; they require a pedagogy that enables individuals to prosper in uncertainty. Despite following the classical taxonomy of knowledge, skills, and competencies/attitudes, the CLO list does not claim to be exhaustive of what a curriculum should entail. Rather, it seeks to establish a coherent narrative and relatedness to the research implemented thus far as expressed by the 'Scales to Aspects7' model as well as to the system the faculty currently employs to efficiently channel its guiding principles and vision throughout its study programs.

6.3. It all starts with systems thinking

The most critical aspect of the CLO list lies in the introduction of the first two blocks: Context and Basic Knowledge. Context allows for circularity to be introduced as a fluctuating concept dependent on a larger context within which its presence marks a value. The teaching of systems theory and complexity theory introduced in this block informs learners about what the systemic change circularity calls for means. The relation of circularity to sustainability is also included here to relate the two notions and to challenge learners to relate to them. Finally, the social relevance of circularity and its potential in contributing to the establishment of new design ethics need to be discussed at this preliminary stage. This last part relates to points 3-4-5 to support learners in conceptualising design as a political act and in assuming accountability for their own design decisions.

The Basic Knowledge block, on the other hand, offers the basis for a shared understanding between learners. It features a series of terms that have a proven

		CIRCULAR LEARNING OBJECTIVES		
		KNOWLEDGE	SKILLS	COMPETENCES/ATTITUDE
BLOCK 1	CONTEXT	systems theory/ complexity theory/ holistic theory: contextualise circularity as a key concept of the design process in continuous interaction with other methods and tools	to engage in design/research work related to circularity/ handling (complex) problems/ learning to work with the context	be able to identify/acknowledge the relevance of circularity in design discourse
		relation of circularity to sustainability		be able to distinguish between sutainabilty in relation to circularity/ position circularity
		the ethical/political position/ circularity as a cultural shift; a new mentality/ design as decision making across multiple dimensions of accountability		be able to support conscious decisions/ endorse systems thinking
BLOCK 2	BASIC KNOWLEDGE	basic terminology		be able to identify what distinguishes a circular approach
		basic definitions		be able to tell the difference between the different terms and what they stand for
		circular materials: biological, technical		to be able to understand and manage the different possibilities/ to choose the most relevant material per case
		basic strategies: R strategies; Smart Manufacturing/ Extended Life Span/ End of Service/ End of life; Slowing-Narrowing-Closing the loops		be able to integrate the terminology in their own argumentation
		basic design approaches: design for disassembly; design for reassembly; design for adaptability; regenerative design	to design for disassembly/reassembly for their own design work	be able to make circular choices/endorse circular principles in terms of materials; design methods such as design for disassembly
			to design for adaptability for their own design work	be able to recognize how circularity affects their own design decisions
			to use regenerative design for their own design work	be able to communicate circularity verbally and designerly
LEVEL ONE: DISCIPLINARY	APPLIED KNOWLEDGE	scales: material; product; building; neighborhood; city; region	to contextualise/adapt design decisions according to scale	be able to identify the interdependency between scales
		aspects: design; technology; flows-resources; society-stakeholders; economy; management	to analyse and highlight further dependencies	be able to identify the plurality of actors affecting circular decisions
		case studies; examples from all scales and circular manifestations	reproduce design details/ methods	be able to recognize/illustrate/represent/reconstruct/ model/ embody how circularity affects design decisions in examples/ case studies
			represent circular approaches in a designerly way	be able to recognize/ /illustrate/represent/reconstruct/model the impact of circular decisions
LEVEL TWO: INTERDISCIPLINARY	CRITICAL KNOWLEDGE	deepening of systems theory/ complexity theory/ holistic theory/ interdependencies	to frame/reframe design approaches in order to optimize circular characteristics and tackle foreseeable limitations and barriers via research/design	be able to anticipate/recognize/detect intricate connections; complexity and diversity
		detailed overview of critical theories/practices on circularity: systems and services, policies and regulations		be able to select/apply the right circular approach per case
		critical thinking about limitations and barriers/ optimization tools		be able to anticipate/recognize/detect connections and barriers and to ultimately highlight/resolve them respectively
		assessment methods for circulartiy (LCA-LCC-MCI etc)		be able to compare info-data/ make informed decisions per project
		materials/ components/ construction/ spatial framework	to design innovative ways/methods/tools for material use	be able to make informed decisions via all scales/ contextualize
LEVEL THREE: TRANDISCIPLINARY	GENERATION OF (NEW) KNOWLEDGE	synthesis of all of the above+ current ongoing research/ systematic practice+experimentation across different contexts and disciplines and beyond disciplines/ assocative thinking/ network thinking	to contribute to existing circular approaches through further design/research using existing methods or hybrid/new ones	be able to create impact
			to experiment with and embody circular thinking in new design challenges	
			to determine/design/formulate innovative courses of action/ to expand/explore/elaborate hybrid forms and collaborations/ or optimise existing ones	be able to increase impact
			to experiment and to develop/formulate new research/design tools and methods in developing circular plans/ or optimise existing ones	be able to facilitate/enable and further communicate/propagate circular thinking through tangible ways
			to develop case to case contextualised/ tailor made circular solutions/ to practically implement circular design approaches	be able to map/ detect/ recognize opportunities for circularity in different contexts
			to use the existing and to further develop research/design tools and methods for evaluating circular actions	be able to measure circular impact
				be able to evaluate circular impact
			to consistently/ continuously embed circularity in design and research in a widely communicable way	be able to generalise research results/ findings about circularity endeavors/ feed the two precedent categories and ongoing research

Fig. 2. The CLO list

value in representing circularity verbally or designerly. The main role of this block lies in facilitating communication, where different approaches can be distinguished and thus design decisions can be based upon.

6.4. Sharing what we know and how we do it

The list further distinguishes between three learning approaches: Level One represents the disciplinary approach and focuses on circularity as it currently manifests within the design discipline. This level of learning examines

circularity as an organising principle of design and refers mostly to the model's configuration of the scales' interdependency. Knowledge and skills of that level are related to getting learners acquainted with the most prevalent design approaches and engaging them in circularity in a designerly way. We call this knowledge *applied*. Ultimately, learners should be able to distinguish between the scales and identify their interdependencies, acknowledge the existence of aspects (outer ring) as to what conditions the scales' interdependency, and recognise how circularity specifically affects design decisions.

Level Two represents the interdisciplinary approach: it looks more closely into the synergies that circularity stirs between the design discipline and other affiliated disciplines (mostly what the model describes as aspects), such as economy, management, social studies, as these have already been identified. We call this knowledge critical. It pertains to an attitude of recognising the intricate relations between disciplines and their limitations as well as coming up with ways and tools of making informed decisions.

Level Three represents transdisciplinary learning. Bararab Nicolescu calls this space 'beyond the disciplines.'[99] Neri Oxman, using the Krebs Cycle of Creativity, follows knowledge creation as the sequence between the four domains of Art, Science, Design, and Engineering where everything starts 'when new perceptions inspire new scientific explorations.'[100] Transdisciplinarity is intended here as the ability to work in the space in between the well-defined disciplines to explore new ways of thinking; the combination of 'a scientific-technical problem-solving competence with an understanding of the problems that need to be solved; a mixing of scientific knowledge and technical skills with what might be termed cultural empathy' otherwise referred to as hybrid imagination.[101] This approach alludes to coming up with novel ways of increasing the impact of circularity as well the recognising opportunities for circularity to benefit from different contexts. We call this knowledge *new*.

There is neither a strict division between the three levels nor does this listing necessarily represent a temporal sequence; it simply represents different approaches in understanding and managing how circularity challenges design thinking. Thus, new knowledge can always be created within any of the three approaches. Furthermore, the scheme does not imply a causal, deterministic relation between knowledge, skills, and attitude: the system is not closed. Therefore, what comprises knowledge and skills is not finite. It is itself subject to change, should new understandings or perceptions emerge.

6.5. Pedagogy transformed

> The task of educators is surely to call attention to the world, and thereby to attention itself. In essence attention involves looking at – or better, being with – the other, whether that other is the object of educational inquiry, or the student herself […] in the context of pedagogy, the other is the world that calls to be known by the student.[102]

Lewin's quote summarises the two main ambitions of the proposed methodology and describes where the structure of the CLO list gains its relevance from. The first ambition is to ensure that educators open up education to the otherness that is circularity while limiting their role to simply attracting attention to it. The second, a direct implication of the first, is to allow students to determine themselves their object of inquiry and, more importantly, who they choose to be in this otherness.

Drawing attention to otherness calls for establishing ubiquitous encounters with circularity in different learning environments, in both formal and informal settings: from small plug-in modules to be integrated into existing courses of the official study program in on-campus or blended formats, to autonomous online learning spaces, to cross-disciplinary spaces of collaboration between departments or even faculties, to the systematic exchange with industry and practice or even to highly intensive one-time events. Besides providing for these encounters, however, the role of academia becomes that of reaching out to a broader audience. The encounters should not only target students; instead, they should aim at building a community of learners, including professionals and other interested parties, as well as the teachers themselves. And in whatever form these encounters manifest, academia should allow for the more experimental academic or practice research to be brought into a curriculum despite its 'not-yetness.'[103] Or, as Ranulph Glanville frames it, to position creativity as 'looking outwards into this enormous network of everything that isn't me, treating it as a resource.'[104]

This first ambition is addressed at curriculum level by the CLO list modularity. It allows educators to choose which of the objectives fit into their curriculum and the level at which they wish to engage their students with the content. Flexibility of modular design also facilitates translating objectives into learning materials and resources.

The second ambition, minimising the role of educators while increasing that of learners, calls for establishing a new pedagogy. As explained earlier, one step towards the new pedagogy is to situate learning in the connections a learner forms by encountering a wider community of learners. This pedagogy acknowledges the learning that occurs from the exchange between individuals and their peers and with the rest of the world. But it needs to be capable of decentralising learning processes and redistributing power in learning. It needs to be a learner-centric pedagogy, thus a pedagogy that does not aim at providing definitive answers but rather enables individuals to look for knowledge relevant to their cause, allowing them the freedom to choose and focus on what is relevant to them.

Two of the existing education models come closest to the one described here; these are the research-based and the practice-based models that have gradually infiltrated architectural education in recent years. The first model, research-based, alludes to curricula designed around 'inquiry-based activities, rather than on the acquisition of subject content' and where 'the division of roles between teacher and student is minimised.'[105] This is also a model that fosters research through design, thus feeding on learners' individual fascinations and diverse cultural backgrounds. The second model, practice-based, relates mostly to the pedagogy of making and thus to a hands-on community, design-build projects. The value of this pedagogy and its relevance here lies in promoting design as a non-individualistic, non-competitive activity that promotes co-creation and learning by working together with others and setting priorities in complex, multi-actor decision-making processes.[106]

The notion that learning is not simply acquiring content but also growing and developing is inherent to connectivism as well.[107] All principles of openness, interaction, autonomy and diversity that connectivism advocates for need to be considered for their capacity to decentralise learning and placing importance on creating connective relations with others.[108] Although connectivism does not relate to a specific teaching method, it promotes the notion of networked learning not only for online formats but also for on-campus settings. Nevertheless, architectural education has always been prompted to engage in digital technologies for learning, and online collaborative formats have been around ever since the advent of the internet. Although most have been limited to reproducing traditional class exchange in online environments, in some cases

like the Design Studio 2.0,[109] the Social Networked VDS,[110] and the Cooperative Studio,[111] the integration of digital technologies has facilitated a new type of learning that relies on peer collaboration and adopts research practices as a key strategy to making meaning.

This second ambition is covered by the last column of the CLO list, the competencies/attitude list: learners are continuously contested to position themselves in regard to circularity; identify what they think the interdependencies of either scales, aspects or actors are and to recognise their intricate connections. Most importantly, they are challenged to either recognise the impact of circularity or to make decisions based on their understanding of what the impact may be.

DISCUSSION

> I am I plus my surroundings, and if I do not preserve the latter, I do not preserve myself.[112]

> Education as the practice of freedom -as opposed to education as the practice of domination- denies that man is abstract, isolated, independent, and unattached to the world; it also denies that the world exists as a reality apart from people. Authentic reflection considers neither abstract man nor the world without people, but people in their relations with the world. In these relations consciousness and world are simultaneous: consciousness neither precedes the world nor follow it.[113]

The Faculty of Architecture and the Built Environment has powerfully responded to creating encounters and bringing together a greater community interested in circularity. Apart from a large number of courses related to circularity already embedded in the faculty's curricula, smaller plug-in modules are beginning to proliferate for several additional content-related courses. The faculty has also greatly invested in autonomous learning by creating a series of MOOCs and ProfEd modules. Furthermore, the CBE Hub,[114] counting more than sixty members, is the live manifestation of interdepartmental collaboration at the faculty level, while a new project is underway that will engage other faculties in cross-domain research. Industry and practice partners have often been directly involved in joint research programmes with the Hub to create new learning materials for their members or employees,[115] while a new format for intensive exchange, the Summer School, is to be launched this year. One major challenge that lies ahead, however, is finding ways of integrating the knowledge generated in these formal or informal formats into educational curricula and making sure the CLO list remains responsive to change.

Coming up with the proper pedagogy for circularity is a challenge that will continue to require attention in the future: both for finding new models of delivery and exchange that can engulf the qualities needed for learning in a complex and uncertain world, but also for finding ways of evaluating learners' experiences and allowing for their feedback to inform these models. In a world in which we don't have exhaustive answers, pedagogy should turn to support students to ask the relevant questions while remembering to listen to their answers.

Circularity is an emergent phenomenon in the network metaphor of a complex world. Some claim it has been there since before the Industrial Revolution and the advent of the Anthropocene and is only re-emerging.[116] Be that how it may, today, circularity is growing and evolving in ways that cannot be predicted, just like its re-emergence as an organising principle for reality could not have been predicted. However, the ideas that circularity operated at scale brings forward can have a significant impact on value chains, industries, and other networks.[117] Among the many reasons why circularity is relevant - and perhaps the most critical - for architectural education lies in its capacity to establish new ethics. And this is why understanding its possibilities and limitations is a task that needs to be pursued at least until consciousness is retuned to the world.

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68 Circle Economy, *The Circularity Gap Report* 2021, 8, https://www.circularity-gap.world/2021

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80 Ibid.

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90 Alexander Wandl, Verena Balz, Lei Qu, Cecilia Furlan, Gustavo Arciniegas and Ulf Hackauf, "The Circular Economy Concept in Design Education: Enhancing Understanding and Innovation by Means of Situated Learning," *Urban Planning* 4, no. 3 (September 27, 2019): 63, https://doi.org/10.17645/up.v4i3.2147.

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92 Minka Woermann, "What Is Complexity Theory?" Project Performance International's (PPI) Systems Engineering Newsletter (SyEN), March 22, 2011, accessed March 12, 2022, https://www.ppi-int.com/systems-engineering-newsjournal/ppi-syen-30/.

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94 "The Scales to Aspects model," Circular Built Environment Hub, accessed March 12, 2022, https://www.tudelft.nl/bk/onderzoek/onderzoeksthemas/circular-built-environment

95 Olga Ioannou, Bob Geldermans, Tillmann Klein, Thaleia Konstantinou, Mariette Overschie & Alexander Wandl, "Integrating Circularity in Education: The CBE Hub Approach at the Faculty of Architecture & the Built Environment, Delft University of Technology," TU Delft: BK Books, 2022 (forthcoming).

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SITUATED LEARNING IN A THEORY COURSE ON URBANISATION:LESSONS FROM BANJA LUKA

A B S T R A C T

Many theoretical and methodological efforts have been made to extend the disciplinary field of architecture and urbanism from the urban in the traditional sense to the larger territorial scales of contemporary urbanisation. This paper- discusses the ways of studying the dispersed and polymorphic urban form that still needs to be understood. The discourse is developed around the situated learning model adequate for understanding the planetary urbanisation theory and the dispersed city. The learning model is applied inside the Urbanisation in the Western Balkan Countries course at the master's studies in Architecture and Urbanism (University of Banja Luka). The situated learning model engages students in the research of real-life context, culture and situation, and therefore, connects the theories of large-scale urbanisation with the inquiry about familiar space. Furthermore, the learning approach advocates an inquiry-based strategy to learning about urbanisation and a dispersed urban form in theoretical courses. The course employs the techniques typically taught in design studios, such as mapping, collage imagery and three-dimensional modelling. The paper could contribute to the considerations on the education of architects as professionals that will deal with the growing scales of contemporary urbanisation, specifically in the Western Balkan countries..

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BANJA LUKA

INTRODUCTION: LEARNING ABOUT CONTEMPORARY URBANISATION

Contemporary urbanisation worldwide is characterised through the expansion and reshaping of rural and natural areas and, at the same time, transforming historic city cores. In a fast changed urban landscape, the boundaries between the cities and their surroundings are not easily definable. A city can hardly be seen as a spatial and functional whole, while its large-scale perimeter is characterised by highly dynamic forms and sizes. In short, compared to the traditional city, the new city is vast, dispersed, without strict functional distinctions, with elusive boundaries and with many centralities. Thinkers in the field of urban studies put forward the urgent need for the new theory of the urban, confronted with the discrepancy between the urban theory, design practices and the real social and environmental change on a planetary scale.[1] The question for architectural education and pedagogy is how to learn about contemporary urbanisation in the context of its undeveloped comprehension and theoretical premises?

The most elaborated theoretical reactions to contemporary urbanisation come from the advanced urbanism research hubs, such as Urban Theory Lab (Harvard Graduate School of Design), Future Cities Laboratory (ETH Zurich), Contemporary City Institute (ETH Studio Basel), and TU Delft. They offer emerging approaches to the study of the new urban fabric and socio-spatial configurations on different scales. Also, they reach for an understanding of the urban transformation, comprising both built and unbuilt environments and landscapes. These research practices put forward the benefits that design disciplines bring to dispersed city consideration: synthetic ways of thinking, rooted in urban history knowledge and sensitivity to cultural differences.[2] Some of the research approaches are put in further testing in Master's programmes and courses, such as the Architecture of Territory – the platform that groups several theory and studio design courses at ETH Zurich, or the Master's programme in Urban and Territorial design at Habitat Research Center and École Polytechnique fédérale de Lausanne. Although these study programmes have a different problem focus, they all adopted inquiry-based strategies to learning about urbanisation and a dispersed urban form.[3]

The Urbanisation in the Western Balkan Countries course at the Architecture and Urbanism Master's studies at the University of Banja Luka follows the same learning perspective.[4] The course provides an understanding of the historical and contemporary growth of cities and theories about their transformation. The course takes on an inquiry-based approach inside the theoretical curriculum and further argues for the situated learning model.[5] Situated learning means

inquiry about real and lived space, and it engages students in historical and theoretical research in their socio-spatial milieu. Situated learning translates the urbanisation and dispersed form from abstract theoretical descriptions into the actual place of everyday experiences. Furthermore, it leads to an in-depth understanding of the theory using it as an analytical device. This article, firstly, presents the theoretical and methodological framework of the course. More precisely, it demonstrates how the theory of planetary urbanisation and the metropolitan form concept was integrated into the research strategy of a specific urban territory. Secondly, it presents the research results obtained in the period of four years of the Urbanisation in the Western Balkan Countries course implementation. The subjects of the course inquiry were urbanisation and the urban form of Banja Luka, the city in Bosnia and Herzegovina. The discussion aims to contribute to the pedagogy and education of architects in the context of growing scales of contemporary urbanisation.

1. URBANISATION IN THE WESTERN BALKAN COUNTRIES - A THEORY COURSE

Urbanisation in the Western Balkan Countries is an obligatory theory course that enrolled the fifth generation of students in the fall of 2021. The number of students over five years varied between five and twenty per year. The course links the historical development and contemporary urban condition of cities in the Western Balkans to the main theoretical body on urbanisation. The course content is structured according to three learning outcomes. Students are expected to acquire the knowledge about the key theoretical interpretations of contemporary urbanisation and urban form. Since it is a part of architectural education, the course focuses on the spatial dimension of urbanisation. Furthermore, students are expected to acquire the knowledge of the historical process of urbanisation in the Western Balkans context through its specific morphological patterns on different spatial scales. It is developing awareness of the urban heritage in the Western Balkans and its restraints and potentials in the context of contemporary urbanisation. Finally, by the end of the course students are expected to have developed skills for critical thinking and argumentative and logical description of learning results, contextualised in architectural and design culture.

1.1. Theoretical Framework Of Learning: Planetary Urbanisation And Metropolitan Form

Many theoretical and methodological efforts have been made to extend the disciplinary field of architecture and urbanism from the urban in the traditional sense to the larger territorial scales of contemporary urbanisation.[6] Discipline adjustment and a larger view are necessary against the classical architectural understanding of the city. The new urban condition was first recognised by urban theorists at the beginning of the twentieth century. The sociologist Georg Simmel called it a *metropolis*.[7] The concept of a metropolis was not a simple synonym for a new form of a city, 'but, on the contrary… the manifestation of a distinctively modern spatial-productive logic which opposes and unsettles it.'[8] Then the overwhelming transformation of a traditional configuration and the experience of the city as a dense, walkable, and core-dominated unit was evident in the fifties. The image of a metropolis came forward through post-war decentralising urban politics, such as the construction of large-scale infrastructural systems, demolition of old city centre neighbourhoods, and spreading of low-density peripheral fabric. Today, these environmental transformations are even more extreme and extend to villages, farming fields, forests, deserts, wetlands, etc., producing new social and spatial relations. The concept of *planetary urbanisation* comprehensively describes the contemporary urban condition. But, radical in the seventies, the hypothesis of the planetary scale of urbanisation as Henry Lefebvre called it in *The Urban Revolution*, hardly can be considered a hypothesis today.[9]

Urbanisation changed the cities from centric formations to the new polymorphic fabric deeply extended in the once rural and natural environment. But the growth of urban fabric is not a banal extension of the concentrated city. It is a simultaneous process of 'implosion' and 'explosion'[10] with three mutually constitutive 'moments': concentrated, extended, and differentiated urbanisation.[11] Urbanisation is still the concentration of population, and means of production and investment, as commonly seen, but also it involves the operationalisation of distant places, territories, and landscapes. They support the economic and social way of life of urban agglomerations. At the same time, the previously emerged and inherited socio-spatial configurations are constantly being changed and 'creatively destroyed' to make room for new, therefore differentiated ones.[12]

There are three 'dimensions' through which the 'imploded' and 'exploded' fabric could be comprehended as well. Referring to Lefebvre's theory of space

production,[13] dimensions are defined as spatial practices, territorial regulation, and everyday life.[14] The dimensions explicate the urbanisation not only as the intensive production of the built environment that embed the urban functions but also as the production of various kinds of rules concerning land, labour, and resources, formal procedures of planning, and management of territorial development. At the same time, urbanisation is materialised through everyday routines and practices of people who use and appropriate the urban fabric.

The thesis on urbanisation as a process explicitly put forward by Henry Lefebvre has been developed through the work of critical urban thinkers such as David Harvey and, more recently, Neil Brenner.[15] Urbanisation is a dynamic and historically evolving process that materialises itself across different socio-spatial configurations and various scales. Important for the research on the spatial dimension of urbanisation is the focus on spatial scales. 'In this alternative approach, urban space was delineated not through a horizontal contrast of cities to other (suburban or rural) settlement zones, but instead through a vertical positioning of urban scales within dynamically evolving, multitiered organisational-geographical configurations.'[16] Therefore, urbanisation can no longer be comprehended as a universal form, settlement type, or bounded spatial unit. An important part of the inquiry on urbanisation is the multiscale perspective. The question of scale is important here not just as the theoretical premise of planetary urbanisation, but as methodological as well.

Another theoretical study important for learning about urbanisation and today's urban form is the metropolitan landscape theory.[17] This approach to the urban brings together the various scales of dispersed urban fabric and brings the concept of landscape in focus. According to the theory, the concept of landscape is the main methodological device that enables the composition of basic metropolitan forms that 'addresses fragmentation and disorientation'. But it does so without relapsing in the hierarchy-based organisation of the traditional city that has proven inadequate for the metropolitan condition. The theory proposes the identification of fundamental patterns of metropolitan form ('basic forms' or 'archetypes') and the possibilities of their composing into new formations – the design of metropolis.[18]

The metropolitan landscape theory recognises the three basic patterns of the metropolitan form: flowscapes, plantation and landscape theatre. Reduced to their formal and spatial properties they exist on different scales and constitute a metropolitan landscape. The flowscapes are linear structures in which the road is the main spatial, functional and visual backbone. Infrastructural 'lines'

became the cultural phenomenon of our time and the mediums of human-environment experience through movement. Plantations are the urban surfaces under the programme with diverse morphological properties. They can be large, and as such, developed through time with the urban programme as the main ordering principle (dwelling, work, leisure, etc.). In addition, they can be spatially autonomous urban islands. The landscape, in this case, gains architectural expression through the interaction of the new programme grid and existing natural and cultural framework usually seen as a substrate for design. The landscape theatre refers to urban voids, unbuilt space in the inner city locations and and those distant from the city centre, where natural processes are inherent, visible and exposed to human experience.

The analytical apparatus of the metropolitan landscape theory was supplemented with the fourth pattern based on previous research by authors of this text. This spatial pattern the authors propose as a distinctive fourth archetype of a dispersed urban form is called the carpet. It consists of the collage of green bits and pieces, separately covered with trees, crop plants or grass, and tailored according to heterogeneous geomorphology. It also contains sparsely arranged built structures of different sizes, sometimes in small groups and commonly near the local roads. This pattern is characteristic for the Bosnia and Herzgovina context.[19]

1.2. Methodological Framework Of Learning

The Urbanisation in the Western Balkan Countries course integrates conventional and specific learning forms. Conventional learning forms integrated into the course are lectures with discussions and a colloquium as a student's critical reflection on selected literature in series of short presentations. The specificity of the theory course stems from the teacher's decision to dedicate a part of the course to research. Therefore, the overall learning methodology applied in the Urbanisation in the Western Balkan Countries course is inquiry-based. Research is understood as the producer of knowledge in the context of the course content.[20]

Research is conducted individually, in small groups and at the generation level with a smaller scope, and with continuous consultations with teachers. It is important to note that each generation of students has a defined programme of comprehensive research, but those four years of research within the course should be viewed as a whole. Although the research is not conceived in

advance as a four-year project, the integrity stems from a reflective view of the experience and results of the previous generation that significantly influences the goals of the next. Since it was the inquiry of the specific territory and the results were not known in advance (therefore it is not an exercise), students and teachers reflected on the chosen methodology and revised the path if necessary during every year. Of course, students of one generation did not experience different topics and research methods discussed during the four years. However, each subsequent generation of students was familiar with the inquiry results of the previous ones. The learning methodology is, therefore, student-focused with students as participants in knowledge creation. Since the students are writing essays or seminar papers and have a consequent discussion with teachers, the link between the research and learning is also research-tutored.[21] The direction of knowledge production is two-way because the students' investigations helped the teachers to further their research.

The specific model of inquiry-based learning applied in the course is the situated learning model. The model stresses the relation between the cultural and social context and learning. Knowledge is linked to a specific task within a particular context in a given social environment, and therefore learning is situated.[22] The students were learning about urbanisation and urban form through inquiry about the urban form of Banja Luka. They were linking the contemporary theories of urbanisation and the analysis of a familiar territory. After reading the course materials on urban history and theory, students were challenged to read the city itself in their seminar assignments.

The urbanisation and urban form of Banja Luka were researched through historical transformation and contemporary conditions. Following the theoretical framework, the research relates the urban form to three dimensions of urbanisation: spatial practice, spatial regulation and everyday life. The contemporary urban condition inquiry was separated into two parts. One generation of students was studying urban form related to spatial regulation, while the other to spatial practices and patterns of everyday life. The research of each student involved three steps in which space is observed through different scales. They are named as describing the large, finding and describing the small, and relating the large and the small. Dialectics of scales are bringing forward the awareness of a large-scale urban territory, not only as a morphological, infrastructural and planning issue, but also as a place and human habitat. This kind of approach calls for the phenomenological and qualitative dimensions of research, with a mixture of research tactics. They included the data collection and document analysis, map studies, and in the last year, the field research

as well. Besides maps, diverse techniques of architectural description and representation were used, such as a photo essay, diagrams, collages, sketches and axonometric drawings.

2. INQUIRY BASED LEARNING: LESSONS FROM BANJA LUKA

2.1. Urbanisation In Historical Perspective

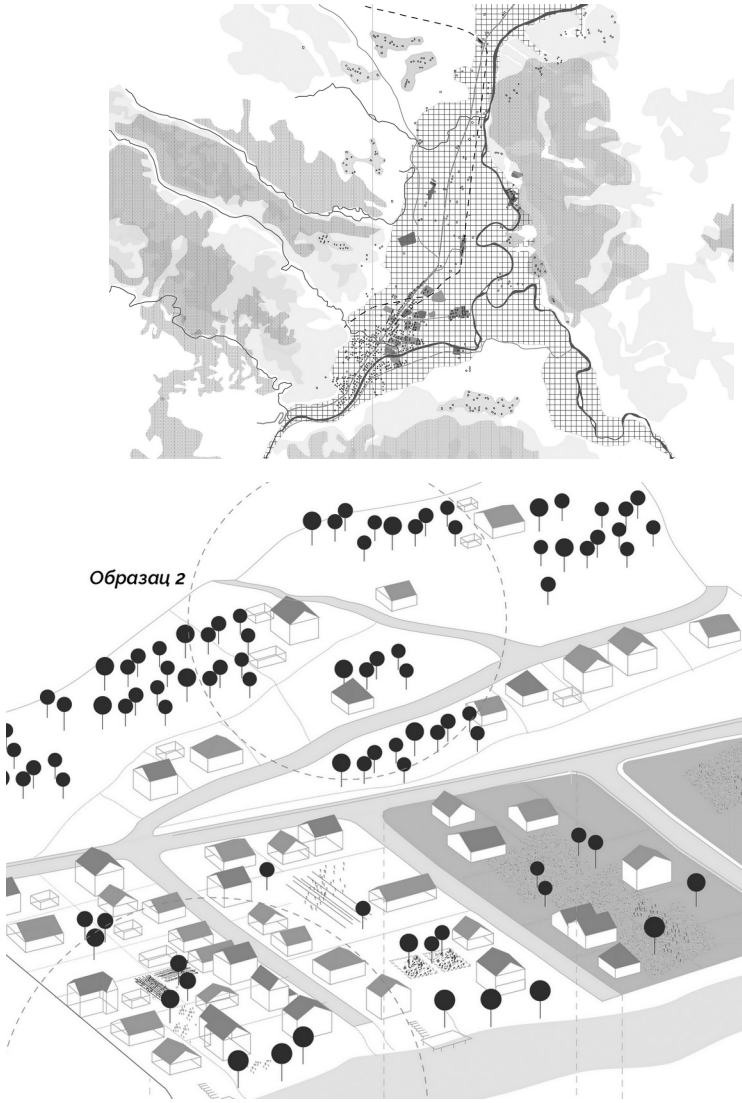
The historical research of urbanisation of Banja Luka from the end of the nineteenth century through to the present was divided into five periods as distinct research projects. The periodisation stems from the city's urban history, usually described by five different narratives in socio-political, cultural and spatial terms. They all left recognisable traces on contemporary urban culture. Every period is observed through several spatial scales. The research was repeated for two years. The results from the first year were partially used in the second year to reduce the time for data collection and document analysis and to get stronger conclusions on each research aspect.

2.1.1. Describing The Large

In this step students were reconstructing the urban form concerning the wider territory, topography, planning regulation and socio-political context. They were producing several maps of the urban territory on the same scale, according to the analysis of relevant literature, periodical journals, planning documents and historical photography. Among the conventional territorial maps, students also produced more site-specific maps, indicating distinct cultural and social elements of urban territory (Figure 1).

2.1.2. Finding And Understanding The Small

In the next step, the smaller scale patterns were recognised and described, each rooted in the historical period through which the city is produced and lived. The pattern features were described morphologically and functionally, but also in the context of regulation and everyday life. The scale of inquiry was not prescribed but discovered, with various techniques of description and representation. The results were diverse and included diagrams, collages, sketches and axonometric drawings, sometimes positioning everyday life scenes from historical photographs juxtaposed with maps of geopolitical-political narrative into a dialectical position (Figure 2).



UP: Fig. 1. Mapping the large (students: Maja Radmanović and Dajana Papaz)

DOWN: Fig. 2. Axonometric view on the small (students: Isidora Gačić and Vanja Đurđević)

2. 1. 3. Relating The Large And The Small

In conclusion, students produced a synthesis map for each historical period, showing the distribution and composition of spatial patterns along the centralities, borders, and networks (Figure 3). Besides the maps, the seminar works depicted relevant documents and photographs as a part of the historical narrative.

The essential character of urbanisation and urban form was recognised in each period. Consequently, Banja Luka was co-named based on discovered socio-cultural and morphological characteristics, such as 'city along the railway', 'modern city', and 'city of fragments'. The new concepts were accompanied by a rich original material presenting urban history and urbanisation features. The general conclusions illuminated a longitudinal expansion of the urban fabric following the main road as an axis until the second half of the twentieth century, when the city began to expand in a transverse direction, more concentrically. At the same time, the smaller portions of the urban fabric were formed in more distant places and separated from the central to merge over time. The maps depicted that the city centre was re-established along the main road axis through several historical periods, moving from south to north. The urban form was generated through the permeation and almost equal representation of built and open space in all the historical periods. Banja Luka has never taken the form of a densely built European city but a very porous urban form. The disintegration of sharp boundaries of urban form started in the second part of the twentieth century.

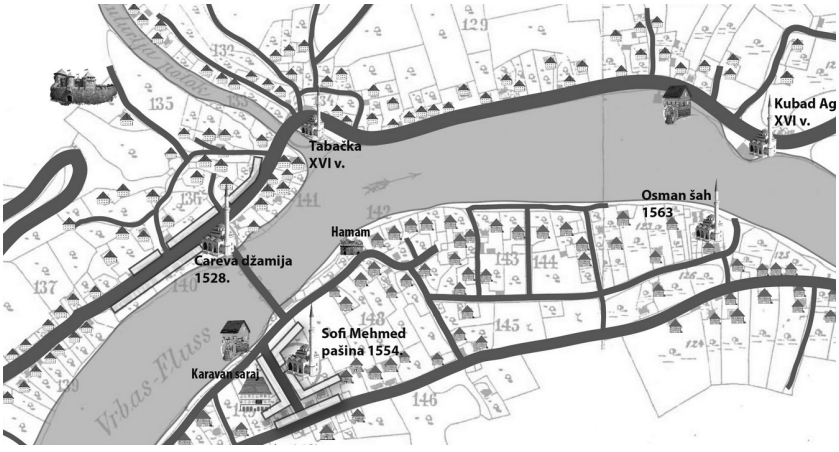


Fig. 3. Understanding the large by mapping the small (students: Srđana Borković, Jelena Kretić, and Tamara Paštar)

Students also identified and described specific spatial patterns for different historical periods. For example, small ensembles of family houses with green courtyards organised around the mosque on the slopes along the river (mahala) are recognised as a characteristic socio-cultural and spatial framework for everyday life and units by which the city grew during the rule of the Ottoman Empire. One of the urban patterns in the period of Austro-Hungarian rule was a green boulevard. It was surrounded by residential villas and usually completed as a cul-de-sac with an administrative building on the end of the axis. Besides the residential neighbourhoods built in the second part of the twentieth century (stambena zajednica and mikrojeon), the factories were dominant working places, but also the confluencies of social and cultural life. Both patterns were the basic spatial units of city planning at the time. In Banja Luka's urban form today, historical patterns are overlapping, touching, superimposing, and creating a colourful collage in the city map and everyday life experience.

2.2. Contemporary Gaze On Urbanisation

2.2.1. How Is The City Growing Today?

The correlational research 'How is the city growing today?' was done in 2019 by a small team of six students. By investigating the administrative territory of Banja Luka (1238 km^2), the research aimed to understand the contemporary urban form concerning the urban planning regulation. How does the spatial dimension of urbanisation, in reality, correspond to the urban form visions in planning documents? Which elements of the form are subject to regulation and to what spatial scale? What are the regulation paradigm and mechanisms applied? The urban form was investigated with regard to three planning regulation themes: territorial scope of planning documents, mobility network, and landscape protection. Each theme is analysed in three steps concerning the scale.

2.2.1.1. Describing the large

The first step was mapping the contemporary state of urban form. The mapping was done by using the most recent planning documents and orthographic photography for an update. It was supported by analysis of several planning documents and relevant laws and rulebooks. The first map showed the contemporary urban form with a description of a built structure, open spaces and green structure. The second set of thematic maps was done on the same scale, representing the coverage of the territory with planning documents and the administrative division of territory, mobility network, and categories of

protected land. The comprehensive map study with conventional techniques of map representation was followed by an in-depth description of contemporary urban form and its features in the planning documents (Figure 4).

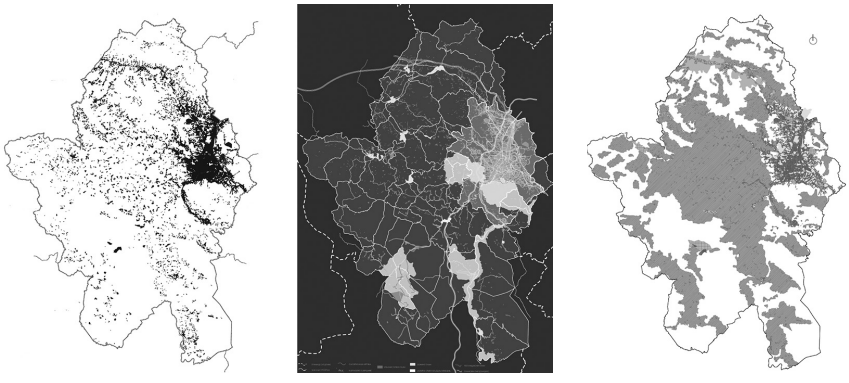
2.2.1.2. Finding and understanding the small

Based on data from the previous step, students identified spatial regulation mechanisms on a smaller scale and the spatial elements regulated concerning the three themes. The basic concepts within the plans were recognised and described, such as the system of centres, green belts, cultural landscape, etc. A brief history of the concepts was reconstructed from the previous plans. The scale was not prescribed but discovered, and the technique of description and representation was of free choice.

2.2.1.3. Relating the large and the small

The last phase in the research was the comparison of the large-scale maps from the first step. The students were putting in correlation the existing condition of the urban form and the thematic layer of the urban form as it is envisioned in the planning documents. Furthermore, smaller-scale spatial patterns, resulting from regulatory mechanisms and planning considerations, were observed in the context of large-scale territory. Their role in the formation of the urban fabric was discussed.

Students learned that a large part of the city's administrative territory, which is changing intensively, is covered only by the City Spatial Plan without adequate regulatory mechanisms on a smaller scale. That could be called the blind spot



LEFT AND CENTER: Fig. 4. Mapping the built structures and areas under regulation for understanding the large (students: Ivona Knežević and Biljana Petrović)

RIGHT: Fig. 5. Mapping the form patterns for describing the large (all students from 2020/21 generation)

of urbanisation when it comes to planning mechanisms. At the same time, the regulatory plans covering a smaller part of the city urban core are often changed, sometimes only because of one smaller plot. From the perspective of the regional and city policies, the envisioned network of urban concentrations is planned to grow and expand by defining the close construction perimeter around the existing built areas. The network of urban centres and other settlements are supposed to welcome new urban services and functions as a part of Banja Luka 'metropolisation' vision. The control of this urban condensation and densification strategy is supported by a selection of territories that will be covered by planning documents.

Banja Luka on site is not following this plan of the urban condensation network. The majority of the city territory, that is not planned for construction or protection, is extensively under transformation. The question of that 'other' land remains open. On the other hand, the growth of the urban form is directly related to the planned road network and it directly affects the spatial dimension of urbanisation. In general, the urbanisation narrative of Banja Luka in policies is fundamentally functional. The space is understood as an exploitative resource ('productive' and 'nonproductive land') for urban development and growth and it is controlled sporadically with restrictions. The open spaces are overlooked as compositional elements of urban form, and as a means of urbanisation control. The architectural view on qualitative properties and values of spatial morphology is almost entirely neglected.

2.2.2. Qualities Of Urban Form

The qualitative research entitled Qualities of Urban Form: Lessons from Banja Luka was conducted in 2020. It covered the administrative territory of the city. The research focused on the description of today's urban form. The intention was to recognise and describe form qualities in the social and ecological context on different scales. The research is based on the metropolitan landscape theory application.[23] The theory defining morphological properties based on scale dialectics and place experiences was considered appropriate for the inquiry about urban form related to spatial practices and everyday life. The seminar papers were based on the description and representation of the metropolitan landscape of Banja Luka through four distinct spatial patterns (flowscapes, plantation, landscape theatre, carpet), their characteristics, distribution and composition within the city territory.

2.2.2.1. Describing the large

To understand the metropolitan landscape theory, the students drew a diagram of each of the four patterns by following their theoretical description. They showed the basic spatial elements of the patterns, their relation as well as the general human perspective through which the pattern is predominantly experienced (moving by car, staying in a small open space, etc.). In the next step of the research, patterns were mapped individually inside the city territory and then assembled with a clear perspective on their relationships in the composition (Figure 5). The map study was followed by discussions about each pattern presence, morphological characteristics, and territory composition.

2.2.2.2. Finding and understanding the small

The research was continued on the territorial samples 1km x 1km or 1km x 2km size distinguished from territories previously categorised as one of the four patterns. Map study of the small-scale areas represented the relations between the figure/ground ratio, green structure, mobility network and urban functions (Figure 6). Axonometric views of specific parts of the sample territory depicted the most pronounced characteristics of the pattern, along with the photo essay named poetics of the everyday. Identifying and describing the urban functions, abundance of green structures, temporal layers of space and the use of open space was a significant part of small-scale research.

2.2.2.3. Relating the large and the small

The sample analysis (four for each pattern) intended to bring forward the general characteristics of four patterns concerning their social and ecological qualities, coming from their smaller-scale structure. Moreover, the analysis of the spatial

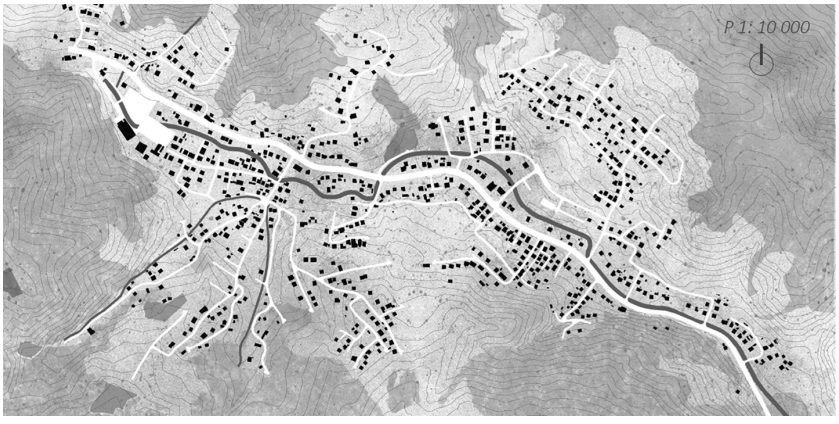


Fig. 6. Understanding the small (student Jovana Janjić)

relationship of one pattern to other types of patterns, such as the overlapping or linking, was aimeded at understanding its morphological and functional origin. Finally, the role of each pattern in the characteristics of urban form on the scale of the entire urban territory was analysed and discussed, taking into account its social and ecological qualities.

Students recognised three layers of the metropolitan landscape composition of Banja Luka: the city core, belt area and wider area. The city core and its surrounding belt have much denser built fabric than the rest of the city territory. It is possible to identify it with the plantation pattern on a larger scale view. The thick core fabric has an irregular and porous edge, penetrated with finger-like unbuilt areas along the perimeter. Many unbuilt spaces (voids) of different shapes and sizes are embedded in the form of the city core area, equivalent to the theatre patterns (Figure 7). From the relatively dense core, the built tissue expands linearly in several directions, and from there it expands linearly again in several directions in a smaller size, forming the fractal-like formation. Therefore, the flowscape pattern is also present in many sizes. These elongated structures are following the road capillary organisation. Where it is not dominantly linear, the edge of the built core dispersedly expands towards the open landscape.

Generaly, the city core is one large plantation and the belt area is a dynamic collage of plantations, flowscapes and theaters of different sizes and shapes. The belt area contains the most diverse building and open space morphology, the amalgam of megastructures, small houses and a vast palette of infrastructural elements. The rest of the city territory is characterised by a different pattern of small-grained built fabric, evenly and finely distributed all over the green

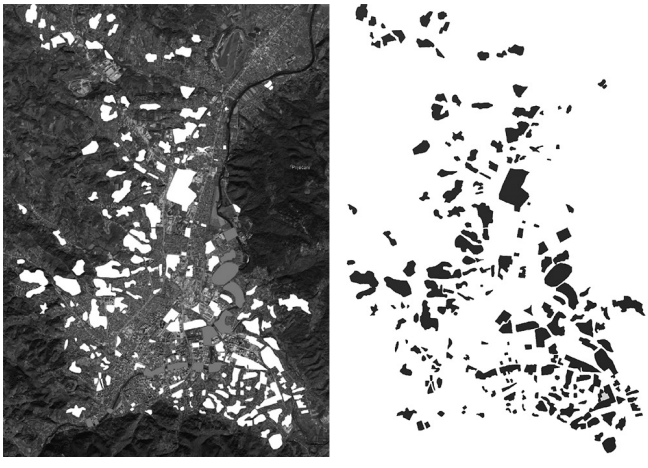


Fig. 7. Understanding the large by mapping the voids (student Iliković Stefan)

landscape of 'non-urban' area. It could be seen as a distribution of small-size plantations. However, its genealogy is different and it is identified as the carpet. This pattern is created beyond the overall plan or programme, house by house, road by road, and plot by plot over a long period. The small pieces of built space, forests, agricultural land and grasslands intertwine in a distinctive urban landscape. It is ingrained in diverse geomorphology, from valleys and hills of mild contours and tame appearance to the slopes of mountain ranges. The carpet pattern also represents a kind of transformation of rural fabric and culture into the urban. The change occurs not through the expansion of the existing urban but the differentiation of the remote rural fabric.

3. DISCUSSION

Observing the course at the one year level, students have acquired the knowledge about the theory on urbanisation process, urban form, and the historical transformation of cities in the Western Balkan countries. Focus was given to the theory on planetary urbanisation and concept of a dispersed city. Furthermore, students gained the practical knowledge of recognising the spatial patterns of urbanisation on different scales. They learned to read the spatial patterns as the compositional and functional constituents of urban form on a large scale. Also, they learned to read the contextual connection of spatial patterns with the dominant spatial ideology and culture of everyday life. Uncommon for a theory course, students improved research skills through team and individual work and by combining different techniques of theoretical and historical research with the techniques of spatial analysis and fieldwork.

Besides the improvement of knowledge of local urban history, the historical inquiry offered students the platform for understanding urbanisation as a socio-spatial process over a long period. Through this inquiry in the first two years of the course, students learned to identify the key characteristics of urban form transformation on different scales and understand its embeddedness in the social and cultural context. Therefore, the research provided knowledge about the emergence of the contemporary urban condition through the twentieth century and a better understanding of its contemporary characteristics. It offered the comparison of urban landscapes and everyday life through historical periods and thinking about the concepts of development, transformation, memory and erasure. In other words, the students linked the insights from the historical inquiry about specific territory with the theoretical premises about urbanisation. The inquiry about urban form and planning regulation in the third year of

the course offered students an understanding of the relationship between urbanisation and planning instruments in a specific context and planning model. By acknowledging inconsistency between the planning vision of urban space as compact and dense and existing urban form as porous and dispersed, students became aware of how the planning efforts to direct urbanisation are not always productive. The plan, as the main outcome of the planning practice and the crucial regulatory mechanism of urbanisation, failed in coping with real-life processes. More generally, it enabled them to understand that the rational planning tradition still applied and based on the hierarchical spatial order and linear scenario is hard to relate to the complex contemporary urbanisation processes. Nevertheless, students gained knowledge of the local urban planning system, learned how to read the city from planning and other regulating documents and learned how to critically observe them.

The territorial inquiry within the administrative boundaries of the city was timely recognised as a weak point of the research. Nevertheless, it was conditioned by the lack of spatial data. Observing the urban form as a much larger territory would enable students to identify the actual directions of the urban explosion and implosion and their relation to the administrative boundaries of cities and municipalities. Furthermore, due to the domination of large-scale investigation and graphic representation, more diverse spatial scales could be incorporated into future research on urban form regulation. At the same time, an in-depth reading and analysis of large scale maps resulted in an interpretation of the relationship between built structures and underlying landscape and valuable preliminary identification of local patterns of dispersed urban form. It was concluded that the open spaces were overlooked as compositional elements of urban form and as a means of urbanisation control in planning documents.

The research on the metropolitan landscape in the fourth year enabled students to understand the contemporary urban form as a large-scale territory and dispersed and polymorphous fabric. It also enabled them to acknowledge the existence of specific urban landscapes compared to the concept of a dispersed city that is learned from literature and lectures. Through this inquiry, the urban form was related to spatial composition and the use of space at the level of a larger territory, and everyday life experience. In other words, inquiry enabled students to see the urban form in the function of the urbanisation process by following the dimensions of spatial practices and everyday life as well as to identify qualities of dispersed urban form in that context. Open spaces of different sizes and morphology are recognised as equally important structuring elements of a dispersed urban form, just as built spaces. Their social and ecological properties are of the highest value for the future of a dispersed city.

All student seminar assignments were structured methodologically through the dialectics of scales, presented here as describing the large, finding the small, and relating the large and small. This method enabled students to understand the concept of a dispersed city through practical experience of inquiring different spatial scales and discovering their relations, in which horizontal separation of categories of the urban, rural and natural is no longer applicable. In this context, the urban was conceptualised less as a bounded territorial unit than as a socio-spatial relation embedded within a broader, dynamically evolving whole.[24] The study of the large territory of a dispersed city on a smaller scale enabled a qualitative and phenomenological observation of the urban inherent to architectual profession. Scale dialectics can play an important role in the potential bridging the planning and design disciplines and bringing together social, cultural and spatial issues in the transformation of urban landscapes.

CONCLUSION

The presented case study of the theory course on urbanisation aims to contribute to the discussion on architectural education. More precisely, it aims to enrich a discussion on pedagogical approach and learning models in the specific context of elusive comprehension and undeveloped theory of contemporary urbanisation. The new urban condition could be called, in Donald Schön term, a 'messy, indeterminate situation' for architectural practice, but education as well.[25] 'Because the unique case falls outside the categories of existing theory and technique, the practitioner cannot treat it as an instrumental problem to be solved by applying one of the rules in her store of professional knowledge.'[26] The contemporary urbanisation is 'not in the book' of technical rationality and calls for a new approach to learning.

The Urbanisation in Western Balkan Countries course chose an inquiry-based learning within the theory curriculum and the situated learning model as adequate for studying contemporary urbanisation and urban form. Inquiry-based learning produced several benefits. As a pedagogical manoeuvre, certain theories of urbanisation were translated into a research strategy and analytical tool and as such used by students in their inquiry. Thus, learning about urbanisation and urban form went through strategic concepts and perspectives that contemporary theory finds relevant. Such an approach enables students to clearly understand the specific theory and acknowledge the relevance of theoretical knowledge in research-based activities. As a learning model, research led students to capture the complexities of the urban phenomenon through personal research experience and case study method.

While research can be done in many ways, the course employed the situated learning model that brought forward the inquiry of real and lived space. For a better understanding of the course content, the situated learning model offered an effective way of translating the concept of a dispersed city into the actual place of everyday experiences and students' socio-spatial milieu. The model engaged analytical activities that connected theories of urbanisation with the analysis of familiar space. Therefore, students contextualised, or more precisely situated, their theoretical insights and further connected them to problem-solving skills to analyse the past and the present urban condition. Such knowledge could provide an inspiration and data for their future work.

The overal approach equipped students with new methodological and intellectual skills for inquiry of contemporary urbanisation and urban form. The research methods applied do not belong under a rigorous scientific domain but are more open, creative and contributive to the design way of thinking. The application of analytical methods common to design courses resulted in creative and authorial contributions by students and brought the theory course closer to the design environment.

Although urban theorists and researchers are putting forward the need for a refreshed epistemological framework, new theory and concepts about the urban condition, that is not a substitute for the specific research on the local urban condition. On the contrary, the planetary urbanisation discussion emphasises that urbanisation is always rendered by historical and geographical circumstances, with endless possibilities of morphological results and temporal dynamics of socio-spatial transformation. However, the local urban condition is also generated through its relations to a larger scale. The local urban condition is a part of the planetary urban fabric, which is 'at once the framework and the basis for the many forms of socio-spatial differentiation.'[27] Therefore, apart from general theories of urbanisation as a planetary process, architecture and urbanism need methodological platforms and conceptual tools for the research of the local urban condition. The presented research on the urban form of Banja Luka (conducted in the education environment) aims to contribute to that domain of site-specific investigations by testing the analytical theories and bringing forward the Western Balkans urban condition peculiarities.

NOTES

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4 The second cycle study programme Architecture and Urbanism at the University of Banja Luka and Faculty of Architecture, Civil Engineering and Geodesy was developed within the European Commission Erasmus+ capacity building project in the field of higher education, entitled Creating the Network of Knowledge Labs for Sustainable and Resilient Environments (KLABS). For more information on the study programme see https://aggf.unibl.org/en/studies/master-studies/architecture-and-urbanism.

5 Tony Cunningham, Julie Gannon, and Mary b. Kavanagh, "Theories of Learning and Curriculum Design - Key Positionalities and their Relationships. Working paper", DIT (2007), doi:10.21427/taah-e493.

6 For more information see Cristian Schmid, "Networks, borders, differences: towards a theory of the urban", in *Switzerland: an urban portrait*, eds. Jacques Herzog, Pierre de Meuron, Roger Diener, Marcel Meili, Christian Schmid and ETH Studio Basel - Contemporary City Institute, (Basel, Berlin, Boston: Birkhauser, 2006), 164-173; René Van Der Velde and Saskia de Wit, "The Landscape Form of the Metropolis", *FOOTPRINT* 5 (June 2009), 55-80. https://doi.org/10.7480/footprint.3.2.709; Topalovic, "Architecture of territory", (2015); Paola Viganò, Christian Arnsperger, Elena Cogato Lanza, and Martina Barcelloni Corte, "Rethinking Urban Form: Switzerland as a 'Horizontal Metropolis'", Urban Planning 2, no. 1, (2017), 88-99, doi: 10.17645/up.v2i1.871.

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ENERGY REHABILITATION OF EXISTING BUILDINGS: DESIGN STUDIO

A B S T R A C T

This paper presents the methodology and results of design studio whose main topic is sustainability, specifically relating to existing building energy refurbishment, at the postgraduate level - specialist academic studies – *Energy efficient and green architecture* at the University of Belgrade-Faculty of Architecture. Weaknesses and opportunities in teaching sustainability in a design studio are discussed. It points to concrete challenges that the theme of building energy conservation and refurbishment present, and to ways in which they might be integrated in education. This paper considers how the design studio pedagogy could encourage deep and active learning for sustainable design in an attempt to expand the role of the architect to be more responsive to the environmental needs of contemporary society.

Methodology of this studio uses the approach of project-oriented learning by simulating a real-life multidisciplinary project development environment. Three phases of design development are described as: research phase, refurbishment phase and redesign phase. It starts with the research phase, which is developed in parallel with the refurbishment phase. This is because the refurbishment process in this studio is not just limited to the technical aspects of energy efficiency improvement, verified through calculations and simulations. Several design scenarios are developed, examining the minimal, optimal and maximal range of energy efficiency improvements in technical systems and building thermal envelope. Analysis of these scenarios, but also analysis of a much wider spectre of aspects influencing the refurbishment design, results in a final redesign proposal which is a comprehensive, deep refurbishment proposal, tackling not only energy (under)performance, but also possibilities for upgrade of functional, technical and aesthetical aspects of existing building.

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INTRODUCTION

Contemporary challenges of environmental degradation, economic instability and social integration have brought the concept of sustainability into the main focus of contemporary society and scientific community. Bearing in mind that out of the total global CO2 emissions about 40% is generated in buildings, out of which 28% is related to the exploitation phase of the building (heating, ventilation, cooling, electricity supply) while the remaining part is related to the process of materials and components manufacture and transportation,[1] it is imperative to integrate sustainability principles into architectural education on all levels. It is also necessary to highlight the importance of building refurbishment as a primary action in need on the road to built environment sustainability. This is highlighted in the newest legislation acts in the EU,[2] but also through a growing interest of the professional community on design practices which put refurbishment into their focus.[3]

While there is a need for conveying broad and general knowledge base on the environmental aspects of the field through theoretical courses and seminars, the design studio-based education process, as the dominant platform of architecture education,[4] should enable meaningful learning for sustainable design and needs to develop students' skills in integrating acquired theoretical knowledge in the design process.[5] Existing teaching methods, which focus on lectures and assignments to equip students primarily with theoretical knowledge, are not enough for integrating sustainability in the architecture education[6] since studies show that students tend to forget theoretical knowledge in one year if it is not applied somewhere.[7] This said, the design studio presents the perfect platform to incorporate the teaching of sustainability in regards to built environment. Still, as literature overview shows, despite a broad consensus on the need to integrate more sustainability in the curriculum, there is no clear consensus regarding teaching methods or curriculum design for integration of sustainability in architectural education.[8]

This paper presents the methodology and results of design studio whose main topic is sustainability, specifically energy refurbishment, and discusses weaknesses and opportunities in teaching sustainability in a design studio. It points to concrete challenges that the theme of building energy conservation and refurbishment present, and to ways in which they might be integrated in education. This paper considers how the design studio pedagogy may encourage deep and active learning for sustainable design in an attempt to expand the role of the architect to be more responsive to the environmental needs of contemporary society.

1. DESIGN STUDIO AND SUSTAINABILITY EDUCATION

Design studio-based teaching is the dominant method of university education for young architecture and urbanism students throughout the world.[9] It is the primary space where students acquire and use previously acquired knowledge and explore their creative skills. As such, it has to constantly adapt to the new forms of knowledge that is preceding it, and remain a platform where students can use the gained knowledge. However, there are numerous theories how the creative design process is informed through previously gained knowledge, and how this knowledge is embedded in design solutions.

As indicated previously, the research presented here is based on design studio process that seeks to integrate knowledge gained from theoretical subjects and design studio activities. In the majority of schools of architecture, a traditional, mechanistic paradigm is used, meaning the educational process of architecture is reduced to a large number of disconnected components.[10] Yet, from a constructivist viewpoint, knowledge domains are not separated in the reality, and need to be perceived together, as a whole. Tempelman and Pilot propose the synthesis of the three design principles (context, content and chain of activities) as a new approach for linking theory and practice in design education.[11] Similarly, different authors explain how critical thinking, linked to procedural knowledge, is developed in the design studio through a three-level process of developing creative thinking.[12] As stated before, there is no definitive way of teaching sustainability in a design studio. There are many different views regarding the best way to tackle this body of knowledge. Linking critically reflective practice with sustainable design education is widely advocated in recent works as it highlights the need for students to critically evaluate sustainable development ideas.[13] In the field of architecture, this is especially needed due to many possible design approaches. Some authors argue that in order to produce a truly sustainable solution (a design that works properly for a particular society), the architect must adopt the role of mediator between different social actors and design solutions.[14]

The papers advocate the need for integration of research into teaching and exposing the students to primary source materials that enable them to get as close as possible to the realities being studied.[15] Project-oriented learning in particular is recognised as an appropriate approach for constructivist concepts. It is a student-centred approach which involves real life problems and helps students in acquiring and integrating new kinds of knowledge in the project.[16] Researchers generally agree that deep learning is a best way of teaching

sustainability in the design studio setting due to its interdisciplinary and holistic nature.[17] Deep learning presents a critical approach to learning in which the student is questioning every action or design decision he/she makes along the way. In this process, through experience of the iterative process of design, students produce new knowledge and gain a deeper understanding of the subject matter. This process is similar to Schön's *reflection-in-action* learning process,[18] which describes how professionals conduct the process of design through a constant reflection during the act of creation. However, it is criticised for defining learning process as not so dynamic, limited to the relation between peers and students, while today it is more in need of a learning community, allowing for *inquiry and investigation* as activities central to studio pedagogy. Authors agree that in this *active and experiential learning*, while very similar to deep learning, instructional strategies encourage higher-order thinking and group work instead of individual research.[19] Experiential learning refers to learning in which the learner is directly in touch with the realities being studied and in active learning students are involved in thinking that simultaneously involves analysis, synthesis, and evaluation of a wide spectrum of issues and phenomena.[20] The value of these approaches becomes evident when looking at the literature and research findings that were developed over the past several decades, which indicate that students favour discussion methods over lecture and one-way mode of knowledge. This only highlights the importance of a design studio as a platform for research and discussion, flexible enough to encompass all new methods and techniques that are developed with the rising complexity of topics being studied, sustainability being the most prominent one.

1.1. Studio Methodology

While the student's design process exhibits difference in detail sequences, timing and approach, the general design studio process generally consists of three distinct phases including research, design proposal and project development. Research is used here to describe the activity of gathering or producing knowledge relevant to the project. The research phase consists of predesign research, but the research itself continues in parallel with the design proposal as well as project development phase. One of the main characteristics of the studio that is present here is its multitude of outputs (design proposals) which are developed throughout the entire design process.

This paper presents the methodology and results of a design studio at the postgraduate level of studies, namely specialist academic studies – *Energy efficient and green architecture* at the University of Belgrade – Faculty of

Architecture. Design studio named *Energy rehabilitation and certification of existing buildings* – case study is an elective studio that students can choose at the end of the one-year studies. Other subjects are mostly theoretical, with student outputs of either classic exams or seminar papers dealing with different topics that are taught in the study programme. This studio is therefore the only opportunity within these studies for application of the design studio methodology and project-oriented learning.

Students who enrol in this specialist course are mainly young professionals[21] who want to gain specific knowledge in the field of sustainable buildings design and performance evaluation, related legislation, certification procedures and theoretical background. Therefore, not all of them have a background in architecture or design education. This can be challenging from the perspective of task formulation and expected outputs from each student. On the other hand, the opportunity for group assignments, where mainly young engineers of similar interests (sustainable building) but different educational background work together on a complex assignment (energy efficient refurbishment project), provides an excellent opportunity not only to apply gained theoretical knowledge in other subject matters, but also to simulate a real-life multidisciplinary project development environment.

Incorporating built environment into the curriculum helps students focus on specific aspects of the built environment; particularly those that pertain to human - environment interactions. By studying the actual real-life environment students can understand the practical realities and different variables that affect real-life situations, which helps them apply and synthesise knowledge gained in other theoretical, lecture-based courses. Haase states that by introducing more realistic problem parameters, students are better equipped to critically understand and overcome challenges they might confront in design studio or their future careers.[22] The main aspects of student's research in this studio are analysis of the selected building for the case study, which covers its urban layout and architectural aspects of the project together with context - including the built and natural environment, as well as constructive, technological and material features in order to determine constraints and potentials in the refurbishment process. This phase is of utmost importance for the later design stage since inadequate refurbishment in technical as well architectural sense can degrade the quality of existing building stock, while supreme design quality and energy performance achieved through energy rehabilitation can upgrade the material value, cultural identity, comfort and sustainability in numerous ways.

Integrating real-life environment into the classroom for discussion, reflection and critical inquiry, as stated by Salama, enables students to shift from being passive listeners to being active learners and cogent thinkers.[23] Well prepared in the research stage, students enter the second phase of design proposal, where the conditions of the site serve as analytical, conceptual and strategic points of departure for the student's design visions and proposals. The goal of design studio is translating the knowledge gained from research on the project to the design solutions and learning by doing. Such an approach, linking relevant knowledge with design projects, as shown by Saghafi, assists students to create responsive design.[24]

Methodology of this studio emphasises the research stage, which continues also in the phase of defining refurbishment solutions. All the activities which occur in these stages serve as an input for the redesign phase. The output of the refurbishment stage consists of some solutions for the building's energy (under) performance: three refurbishment scenarios that are defined according mostly to the technological and material features in order to determine constraints and potentials in the refurbishment process.[25] These scenarios are defined as following:

- 1st level improvement scenario: building fabric upgrade to the level satisfying current legislation.[26] Not all of the building fabric (thermal envelope) is being refurbished. This can be considered the minimum of refurbishment activities that put the building in compliance with current regulation for existing buildings upgrade. Technical systems for heating and hot water preparation are not considered in this refurbishment.
- 2nd level improvement scenario: upgrading the entire building fabric, so the all elements of thermal envelope satisfy current energy efficiency targets (U-values). Technical systems for heating and hot water preparation are also not considered in this refurbishment.
- 3rd level improvement scenario: this scenario deals with upgrading technical systems for heating and hot water preparation, and regarding building fabric, superior fenestration components are incorporated.

Although described improvement scenarios can be considered as design proposals in terms that the existing building under further project development would be refurbished, these scenarios lack the design component and therefore cannot be considered a valid output of a design studio. This phase of development improvement is defined as a refurbishment phase since the work on defining these scenarios informs future design decisions in terms of constraints

of the fabric and technical systems upgrade regarding energy performance. It is clear that further improvements can be achieved only through a holistic refurbishment proposal - a comprehensive approach that deals not only with upgrade of existing structure in its technical and material properties, but also tackles functional, structural and aesthetic aspects of the existing building.
This redesign proposal is the result of the final, redesign phase, and it is considered the main output of this design studio. The improvement scenarios which are defined in the refurbishment phase are compared to the final design in terms of energy performance (reduction in energy needs, energy consumption and CO2 emissions), and economic viability (investments and payback periods).

A diagram summing up the design studio methodology is presented below (Figure 1). Throughout the entire design studio student can either work in groups or independently. It is usual for students to work in groups in the research and predesign phase, and for students to develop their own design proposals in the design phase. Students with no background in architecture education usually work in groups in all stages of the design studio.

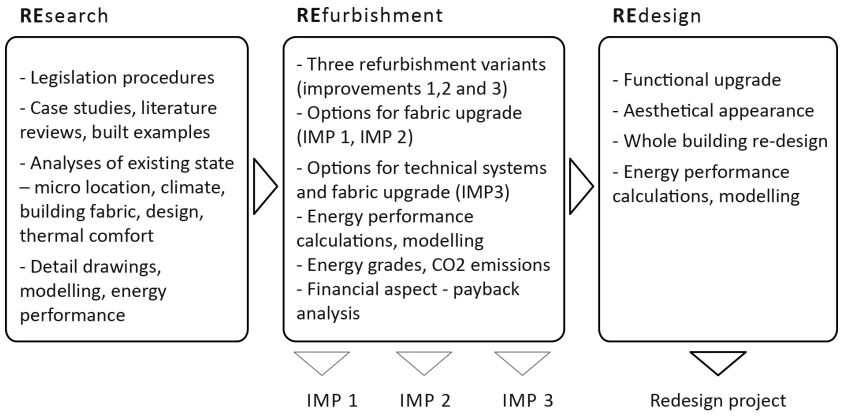


Fig. 1. Design studio methodology

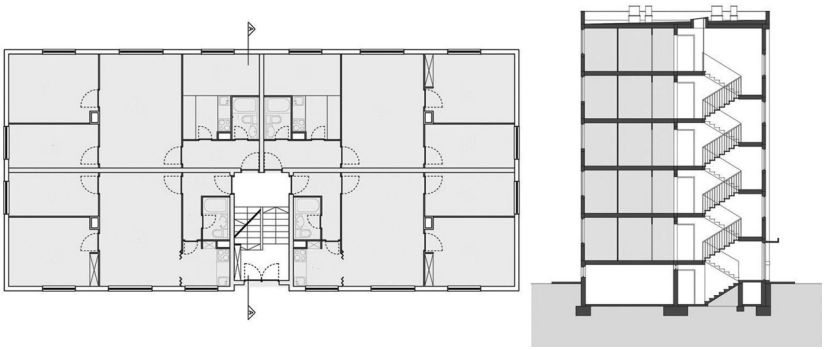
1.2. Design Studio Case Study

1.2.1. Research Phase: The Existing State

The assignment of the design studio presented in this paper is refurbishment of a typical multifamily residential building, which is part of a housing block located in Bežanijska kosa in Belgrade's New Belgrade municipality. This housing block consists of 16 typical five-storey buildings (Figure 2). These buildings were built in the 60s, and are characterised by simple flat roofed volumes, with

no specific architectural features or design elements. Each building has 20 residential units, 10 smaller ones (51 m2) and 10 larger ones (58 m2), two of each on each floor (Figure 3). Buildings do not have elevators or terraces. The heating system is individual, with heating stoves and electrical boilers in every apartment. The construction system is massive, with longitudinal massive walls built of 'durisol' blocks.[27]

Research phase is characterised by gathering information about building's material, technical and performance characteristics, analysing the location, climate data, prevailing wind directions, Sun exposure. These analyses were done as a group work of entire class (four students). The aim of these analyses is to inform design decisions. This research phase is universal in design studio



UP: Fig. 2. Part of the analysed housing block, layout of typical multifamily residential buildings

DOWN: Fig. 3. Typical floor layout and cross section of analysed building

methodologies, but the scope of different analyses varies depending on the topic of the studio. The emphasis may be on characteristics of the location (microclimate, vegetation, native species, etc.), cultural issues, population, demographic, property value, public transport infrastructure, or available public facilities. Also, a wider area may be analysed, entire neighbourhood or municipality if the topic of the design studio is more complex, and the programme of the future project also needs to be defined. This particular design studio focused on analysing natural elements of the location, which influence the typical building in terms of its comfort issues (thermal, daylight, acoustic, indoor air quality), and also functional, material and technical characteristics of the building itself. Analysis of natural elements showed that the building layout is favourable in terms of the sun and wind exposure (Figure 4), allowing redesign solutions which enable passive solar heating. Longitudinal building facades are not exposed to dominant winds, which enables new design elements that provide better connection between apartments and outdoor space (large glazed windows, balconies, terraces, loggias, etc.).

Also, this design studio specifically deals with energy performance characteristics of the building in question.[28] As an input for energy calculations/simulations a detailed 3D model is required, done based on the archive documentation (technical drawings of the building and description of constructive elements and finishing) or in-situ measurements.

Detailed digital drawings are done, and based on them modelling of a single thermal zone model with definition of all elements of thermal envelope is carried out. Calculations are done in the KnaufTerm software.[29] For the present state of the analysed building the calculations showed that none of the elements of thermal envelope satisfy current legislation (U values much higher than the minimum allowed), as well as the achieved energy grade (F energy class, energy need for heating of 170.33 kwh/m^{2}y). Dominant transmission heat losses occur through facade walls, (44%), followed by losses through flat roof and windows, (22% each). These data serve as input for definition of refurbishment scenarios, limited to interventions on thermal envelope and technical systems in the predesign phase.

1.2.2. Refurbishment Phase: Improvement Scenarios

As described within the studio methodology, the refurbishment phase, which follows the initial research phase, is aimed at defining three refurbishment scenarios that are designed mostly according to the technological and material features to determine constraints and potentials in the refurbishment process.

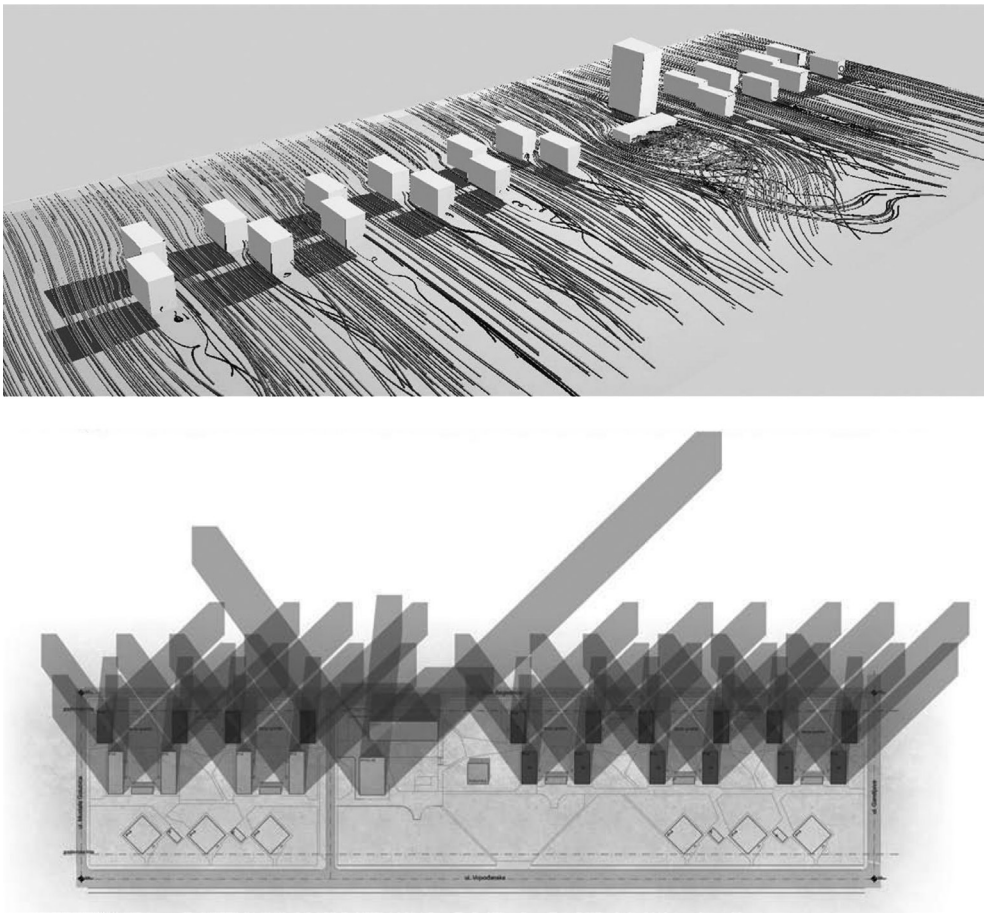


Fig. 4. Dominant wind direction and shading analysis

The interventions that are envisioned as part of these improvement scenarios are limited to the upgrades of elements of thermal envelope and technical systems. Technical systems for heating and hot water preparation are considered in the 3rd stage of improvement. In the first two scenarios only elements of thermal envelope are improved: in the first, only the ones that make the overall energy performance for one energy class better than the current one (current regulation for buildings that are being refurbished). In the second, all elements are improved to the level which is according to current regulation in terms of maximal allowed U-value. In the third improvement scenario, windows are the only thermal envelope component which is further improved, while other measures focus on improvements of heating system and sanitary hot water preparation system to further lower primary energy and CO_2 emissions.

In the case of the analysed building, since the largest share of transmission heat losses occurs in façade walls, flat roofs and windows, these elements were first options for improvement. In further analysis, and on-site visits, it is concluded that façade walls and flat roof are in extremely bad conditions, and that only refurbishment scenario which could significantly improve the standard of living must include improvements of both elements. Further calculation showed that by their improvement energy rating is improved by two levels, cutting energy need for heating by 50% (84.56 kwh/m^{2}y).

In the second refurbishment scenario improvements of all elements of thermal envelope bring the building's energy rating on the level of compulsory energy rating for new buildings (C level). Also, energy need for heating is lowered by 70% compared to the existing state (49.47 kwh/m^{2}y).

The third refurbishment scenario mainly deals with outdated and energy inefficient systems for the heating and hot water preparation aimed at further reducing primary energy and CO_2 emissions. Regarding the thermal envelope, only windows are further improved in this scenario, from U-value of 1.3 W/m^{2}K as envisioned in the second refurbishment scenario to U-value of 1.0 W/m^{2}K. The heating and hot water preparation systems are proposed as a single central system, operating through a low-temperature gas boiler. This cuts down initial primary energy by 90%, while CO_2 emissions are lowered up to only 4% of the initial value. Comparative energy performance data for three levels of improvements are shown in Figure 5.

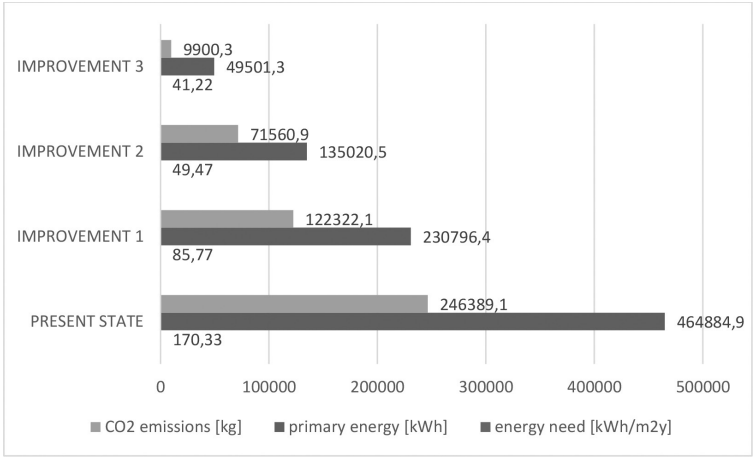


Fig.5. Comparison of three variant solutions developed in the refurbishment phase in terms of energy performance

As much as these are impressive results in terms of energy saving, these refurbishment scenarios offer no solutions to the recognised problems in functional and architectural qualities of the analysed building. These interventions would surely contribute to the improved comfort issues, but would not resolve some of the spotted problems such as lack of connection to nature (no terraces, small windows), no elevator, functional organisation of the apartments and their size (small kitchens and inadequate spatial distribution of rooms). Therefore, a comprehensive deep refurbishment proposal needs to be designed for these issues to be tackled.

1.2.3. Redesign Phase: Comprehensive Refurbishment Proposals

In this stage, both individual and group student work is possible. In this studio there was a combination of individual and group work, so three redesign projects were developed (Figure 6). All redesign projects considered the enlargement of usable area and improvement of functional issues by activating flat roof in forms of additional level, adding terrace volumes and its construction, and adding an elevator shaft. All proposals paid special attention to detailing, connections of new constructive elements to the existing ones, and solutions of thermal bridges. The enlargement of usable area of the building by activating available areas for intervention, such as attic space or flat roof, as well as addition of volumes adjacent to the building, is the method which proved to be effective in improving the building's energy performance and material value.[30] All three refurbishment

Fig.6. Redesign projects: 1) By students Bojana Čanković and Nataša Jovanović 2) student Marija Stanić 3) Aleksandra Nikolić

design projects tackled this issue through various design solutions. One of the main functional issues of the existing state is certainly the lack of an elevator. According to domestic legislations, buildings up to four floors do not need to have an elevator. However, with planned activation of the flat roof level and the addition of a withdrawn floor, the elevator becomes a necessity. A diagram shown in Figure 7 depicts the process of design development of the first design proposal (by B. Čanković and N. Jovanović), which incorporates additional volumes of elevator shaft, additional floors and additional volumes of terraces

(glazed or open ones). Roof is inclined towards favourable orientation for positioning of PV panels and enables duplex apartments on the added floor. Construction of the additional volumes (new facade walls elements, roof slabs, terrace slabs) is a lightweight wooden construction.

Elements of glazed or open terraces bring additional quality to all apartments since their structure was modest in the existing state, with no elements of outdoor connection (terraces, balconies, large glazed elements). A typical floor layout of

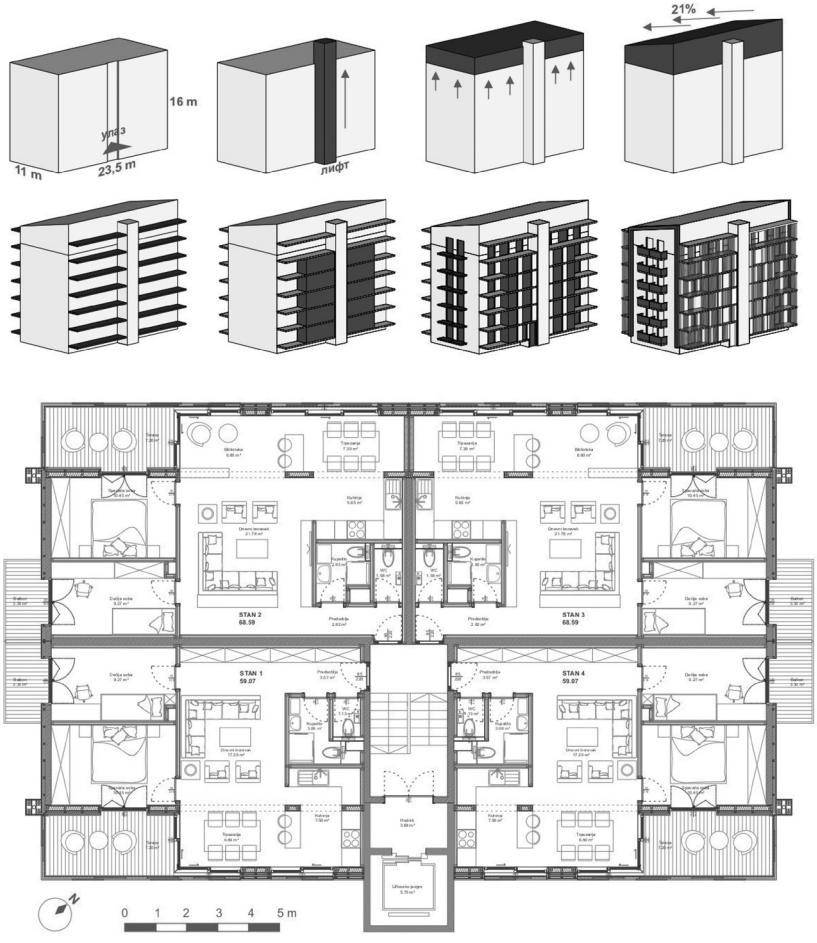


Fig. 7. Refurbishment design development diagrams and functional organisation of a typical floor (design by students B. Čanković and N. Jovanović)

this redesign proposal is shown in Figure 7. Each apartment gets additional space in the dining and living areas as well as two terraces, so each room has a connection to the outdoor space.

Similar functional organisation is presented in other design proposals, with variations in the size of added volumes. In the second proposal, (M. Stanić) additional elements of the typical floor layout are limited to the open terraces (Figure 8), built as light steel construction anchored to the concrete loadbearing elements of existing building. This is also the solution for the construction of the withdrawn floor, with flat roof ending suitable for positioning of PV panels under the most optimal angle. The last floor consists of two large apartments with three-sided orientation, opening to large roof terraces on north-east and south-west side.

The most radical functional reorganisation of existing apartments, followed by the design of the facade is in the third redesign proposal by student A. Nikolić. The modular design of the facade, defined by the position of constructive elements, is followed by different materialisation of facade fields, solved functionally either as loggias, vegetative screens or glazed portions (Figure 9). The typical floor plan thus does not exist – each floor and each apartment have a unique structure in terms of number of loggias, terraces, window positions,

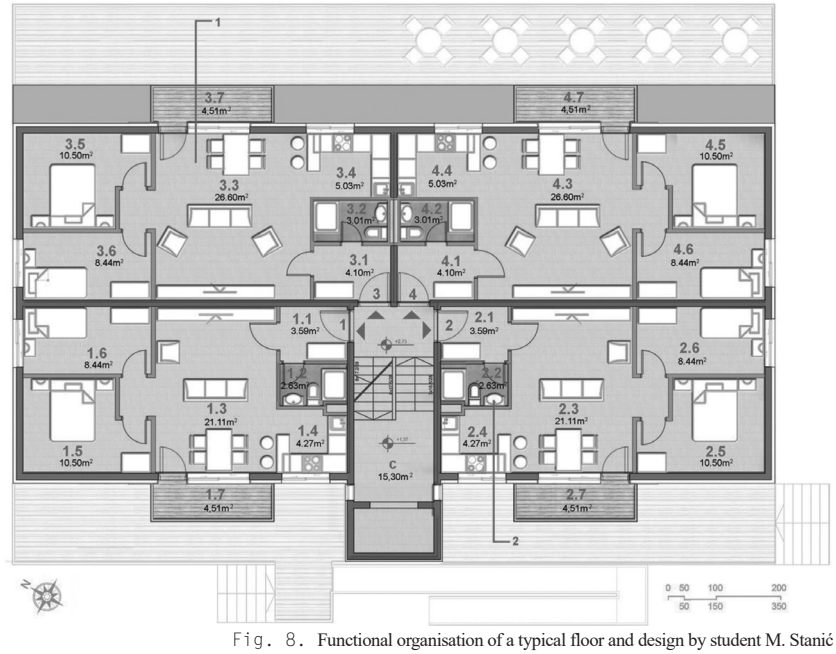
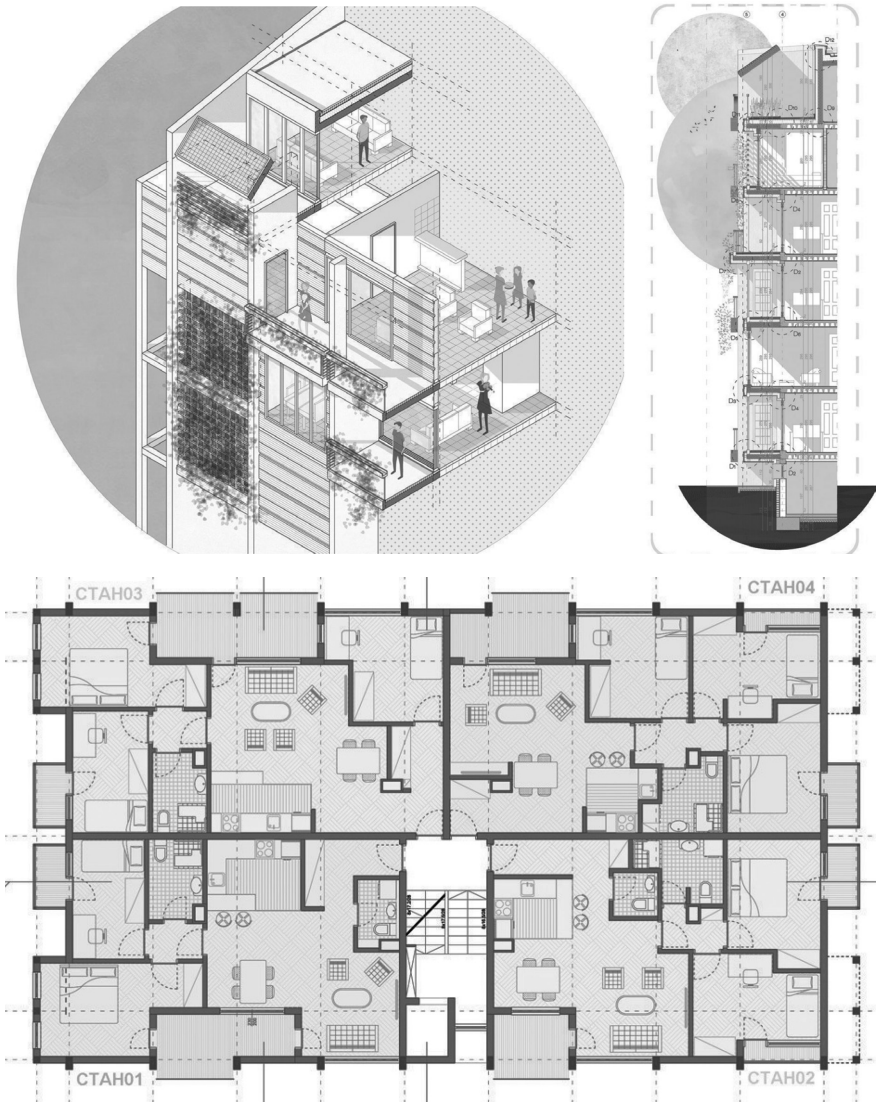


Fig. 8. Functional organisation of a typical floor and design by student M. Stanić



UP: Fig. 9. Axonometric section and section detail, design by student A. Nikolić

DOWN: Fig. 10. Functional organisation and design of the 2nd floor by student A. Nikolić

sizing of rooms and their facade solutions. The core of all apartments is solved as an open plan consisting of living, dining and kitchen areas, with varying position of the adjoining loggia (Figure 10). The last floor, added withdrawn floor is solved as two larger apartments with adjoining roof terraces on both longitudinal sides. The entire construction of new structural elements (terrace slabs, façade walls, roof slabs) is envisioned using CLT panels.

This enlargement of functional living space in all proposed redesign projects significantly influences the rise of the entire property value. Not only do these existing apartments become significantly improved, but also new apartments are built on the added floors, which could, from the financial point of view, create impetus for investing in this type of refurbishment, either from the community of the tenants or from the third-party investors (private companies).

Regarding energy performance, all redesign solutions have significantly improved aspects of thermal comfort and energy efficiency through design interventions. All elements of thermal envelope have been improved to the level of complying with current regulations or even surpassing it. Connections of new structural elements have been detailed in order to reduce thermal bridges. The first and second redesign proposals achieve energy savings of about 80% placing the buildings into the B energy rating (energy need for heating about 35 kwh/m^2y). The third redesign proposal achieves a C energy rating, with energy savings of about 70%, primarily due to a less compact design compared with the other redesign proposals.

2. DISCUSSION

All presented refurbishment scenarios and redesign project proposals achieve significant energy savings and energy performance upgrades compared to the existing state. Compared to the refurbishment proposals, redesign proposals achieve energy performance level which is between improvement proposals 2 and 3. This means that all presented solutions achieve energy performance in range with standards for new construction through the process of deep energy refurbishment. However, in comparison to these improvement scenarios, the redesign approach provides solutions with additional quality in terms of functionality of the building and each apartment. Also, the process of redesign is an opportunity not only to conduct energy performance upgrades, but also allows for a thorough refurbishment of all building elements, installations and finishings. This is the real opportunity for the ‘second life’ of existing

buildings which have surpassed their proposed lifespan. Also, in terms of energy efficiency, the redesign process takes into account the enlargement of usable space, which not only improves the geometrical characteristics related to energy performance, but also provides an added value which offers opportunity for various investments, rental and usage schemes. Tackling these relations should also be part of the design studio since the social and economical aspect of redesign proposals cannot be neglected in the process of sustainable refurbishment. The unquestionable higher investment cost of redesign solutions can be tackled through higher market value not only of the existing apartments, but also through the newly formed apartment units. The higher property value achieved through the redesign of existing buildings would also affect the entire housing complex and its surroundings, raising its overall living quality and aesthetic appeal.

CONCLUSION

This paper presents methodology and results of a design studio with the topic of energy rehabilitation of an existing building. Results of this design studio are different refurbishment proposals, varying in the scope and design principles. Refurbishment scenarios which follow simple improvement algorithms, focusing on the upgrade of thermal envelope and technical systems, are defined in order to inform future design decisions in terms of constraints of the fabric and technical systems upgrade in relation to energy performance. The redesign phase is a comprehensive approach that deals not only with upgrade of existing structure in its technical and material properties, but also tackles functional, structural and aesthetic aspects of the existing building.

Three refurbishment proposals and three redesign proposals are presented. All proposals achieve significant energy savings compared with the existing state. The redesign proposals achieve similar level of energy savings as refurbishment options 2 and 3, which can be considered the level of deep refurbishment, but with many wider benefits following the redesign proposals. These benefits include higher property values, added value in the newly formed apartment units, functional and aesthetic appeal of the entire neighbourhood and a better life quality.

NOTES

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2 The European Commission *Renovation Wave Strategy* from 2020, as key element of the *European Green Deal* and *The New European Bauhaus*, aims to at least double renovation rates in the next ten years and make sure renovations lead to higher energy and resource efficiency.

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27 'Durisol' is a type of lightweight concrete block, built from mixture of concrete and wood-processing residues, usually with a concrete infill, acting as lost formwork in wall construction. It was widely used during the last decades of the 20th century in Serbian building practice.

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ONE APPROACH IN EDUCATION INNOVATION - EXPERIENCES FROM DŽEMAL BIJEDIĆ UNIVERSITY OF MOSTAR

A B S T R A C T

Teaching sustainability and resilience on the level of both materials and structure is today‘s imperative for a more environmentally friendly tomorrow, but also for the enrichment of human life and preservation of historical structures.

Re-examining sustainability in its reverence for pre-existing structures, conceiving projects by first taking inventory of what already exists, has become the starting point of defining research cases for students in the past few years at the Džemal Bijedić University of Mostar’s Civil Engineering Faculty. The paper presents the approach developed and work done in the past several years, mainly within two subjects at the Civil Engineering Faculty. The developed methodological approach was based on the combination of the knowledge creation and case-based learning method. Case studies are always based on heritage buildings.

The aim of the approach is to teach how to find an opportunity of doing more with existing structures, and argues their future use and possibilities for improvement, upgrade and re-use. Demolishment is a decision of easiness and has a major impact on the history and identity of the city and its community. Therefore, it is our task to search for various conservation approaches in order to preserve the city‘s layers and provide progress.

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KEY WORDS

EDUCATION INNOVATIONS,
TEACHING INNOVATIONS,
EDUCATION SUSTAINABILITY,
HERITAGE CONSERVATION

INTRODUCTION

The Džemal Bijedić University of Mostar was one of the eleven partners of the KLABS project.[1] One of the main outcomes of the project, regarding the Faculty of Civil Engineering at the Džemal Bijedić University of Mostar that was implementing all the activities, was the creation of a new study programme at the II cycle titled 'Environmental Infrastructure Management.'[2] The study programme within its curriculum has offered, to some degree, connection and direct transfer of knowledge from the practical work to students. The students saw this as one of the most positive changes in the education programme, and therefore, the idea was to create similar possibilities for other study programmes as well. The primary goal was to make some changes to the programme of the Department of Structures. The Department of Structures is one of the pillars of the faculty. Currently, education is based on the approach of knowledge creation, but many subjects have started introducing case-based learning methods as well.

Regarding the two mentioned methods used in education, it is important to note that many types of research carried out by students was aimed at trying to identify which approach is most useful for them – knowledge creation or case-based learning method. Case-based learning has supported the learning process more effectively than the course based on knowledge creation. Nevertheless, applying creation-based learning is highly relevant in education. Both methods are very important, especially in engineering education.

Looking back to the past, the case-based learning method was present in the curriculum of the Faculty from the beginning. It established its institute from the very beginning in 1977. One of the main reasons for this was to facilitate working closely with the industry. This link was a driving force for both the academy and industry. Unfortunately, this link was broken as a result of the 1992-1995 war.

Time was needed to adjust to new circumstances, but the faculty has recently started to again explore, develop and implement innovative educational approaches based on the link with industry. The implementation of the KLABS project[3] was used to initiate changes in the faculty's curriculum. A new study programme was developed, as mentioned earlier, and some innovative educational approaches were implemented in several courses within it. Innovation, essentially, is the creation and implementation of new processes, products, services, and methods of delivery. Educational innovations are processes aimed at changing teaching or learning activities that produce improvements in learning outcomes.[4]

Two subjects within the Department of Structures programme - durability and maintenance of the structures and reconstruction of the historic buildings - were aimed at seeking innovation in education, inspired by positive outcomes of the KLABS project as well as previous experiences of the teaching staff. In order to improve learning outcomes, teaching staff teaching in two different subjects decided to act mutually. The aim was to teach the students that problems are not related to one subject, i.e. that they cannot be solved from the perspective of only one subject.

Problems in engineering are always complex, and their solution in real life requires a multidisciplinary team and a more perspective approach. Further improvement of the outcome was related to preparing students for the real cases and helping them to break the ice in the fieldwork. Therefore, exercises of the two subjects were merged, and real buildings were defined to be examined over the semester work. The idea behind this was to learn about existing structures/ buildings in the city of Mostar, focusing on the possibilities of their reuse as well as their sustainability and resilience.

Mostar today, over twenty five years after the war, is still a city in after war recovery process. On the one hand, this fact cannot be just ignored but on the other, it does not necessarily need to be viewed only as a problem. The teaching staff have decided to take the current condition as a challenge. The aim was to introduce some innovative learning approaches based on real-life problems in order to help students to gain, not just knowledge but also competencies for the rapidly changing job market and unknown future challenges.

In order to prepare the students for complex situations, not just on construction sites, they were required to widen their perspectives while working on real-life problems or cases. Problem-based learning and cases based on exercises on real building/sites and their problems were used. Each case needed to be analysed from the urban, architectural, construction, energy efficiency, heritage conservation, identity, and economic point of view. In addition, it was necessary to do the work in teams, focusing on the creation of the interdisciplinary teams. Over the years of the implementation of this innovation in education, interdisciplinary teams created among students from different programmes, even different faculties. The team and project work had been identified as one of the best ways to train competencies and the ability to work in a group.[5] Therefore, the teaching staff has prepared cases and organised exercises in a new way in order to achieve all of the above-stated goals.

This paper will present the approach developed and work done in the past several years within two subjects at the faculty. It will also point out the main positive outcomes as well as obstacles we have faced over the years. The paper is structured following chronology of the implementation of the educational innovation; presenting a case study, approach, and outcomes related to each year of the work.

It is important to stress the fact that similar interconnection of the subjects have also been created among three other subjects, at the first year of the cycle I, the Environmental Infrastructure Management programme. The work on these subjects is related to urban planning and urban rehabilitation. However, this paper focuses on the presentation of the activities based on structural analyses of the buildings.

1. EDUCATION INNOVATION IN TEACHING STRATEGIES: BACKGROUND FOR INTRODUCTION

Interaction between the industry and the academy is the foundation of the Džemal Bijedić University of Mostar, as well as its Civil Engineering Faculty. The faculty was created, among other reasons, due to the implementation of the project that is of national importance – the building of several hydropower plants along the Neretva river. Members of the industry were among the founders of the faculty.[6] The faculty's institute used to work with major companies in the region at the time, and students were thought from the problem-solving experiences of that time.

Mostar and its Stari grad Agency[7] were laureates of the Aga Khan Award for Architecture in 1986 for the Conservation of Mostar Old Town project.[8] But work done was not a time defined project, it was more of the approach, i.e.; it was the development of the new methodology in conservation management based on securing sustainability and maintenance of the buildings. The teaching staff of the Civil Engineering Faculty were among the agency's members. Therefore, possibilities of the progress through interaction and interconnection of the industry and the academy have been familiar to the teaching staff at the faculty for decades. Unfortunately, wartime and post-war developments in the recovery process of the Mostar and its university have only deepened many broken links and good practices.

The historical core of Mostar has suffered an enormous number of damages during the 1992-1995 war. Stone structures were almost all destroyed; the Orthodox church, a landmark on the hill, was bombed and reduced to a pile of stones; the symbol of the city and region, the famous Old Bridge was all gone within the seconds. Lines of the city, created over centuries, were changed for a few months.

Big-scale conservation projects were actively implemented at the Mostar historic core from 1996 through to 2005. But despite all efforts and restoration projects, its historical core still conjures up a picture of war with numerous ruined buildings. Today, many buildings, some of the major values for heritage, are still capturing views in the city skyline, but not because of their architectural and artistic values. Without roofs, architectural façade decorations, and partly covered by vegetation, these buildings are ruins and perceived as a threat to citizens because of the possibility of them collapsing, and these sites also became rubbish dumps over time. The number of these structures in the historic urban core of the city is not negligible. Their presence is even more notice in the urban matrix and everyday life due to their sheer size and location on prominent streets, and because of rusted scaffoldings with worn out nets surrounding and occupying pedestrian pavements.

On the other hand, for the same reasons of size and position accompanied with historical, documentary, and artistic values preservation of most of these buildings is of big importance for the preservation of authenticity and integrity of city skyline, landscape as well as the city's identity, the memory of place and memory of citizens. Besides natural elements, these structures are at risk of being deliberately destroyed by humans because of neglect, lack of understanding of their importance, the desire for new development in historic cores, etc. Current state of the buildings and their importance in the historical landscape requires professional research on these buildings from different points of view – civil engineering, architectural, urban planning, sociological, structural, economic, etc.

Another significant feature in the urban tissues is the reuse of old buildings, regardless of their value regarding heritage. Former military buildings are being reused for high schools and archives, the military complex is being transformed into a university campus, small stadiums for internal use by the former factory employees are being used as stadiums of premier football clubs, etc. This

extensive reuse can also be studied from different points – architectural, urban, energy efficiency, structural, sociological, etc. Reuse provides sustainability, but it is not as simple as that. What other requests must be met in order to reach real and long-term sustainability and resilience of various buildings is a question that must be answered prior to adaptation works.

Unfortunately, different aspects and potentials for ruined buildings, like various potentials and obstacles to their reuse, are not being studied. In addition, our reaction toward them is based purely on economic grounds. In the near future students will become engineers, those who are proposing new solutions and city development paths. This is especially true for Mostar where a significant number of civil engineers are finding jobs at urban development and spatial planning departments of the city or at architectural firms. In the near future, they will be required to work in interdisciplinary teams on projects dealing with building reuse or demolishment as well as those aimed at the future development of the city. Their understanding of buildings and streets, understanding of the city's structure and way of life, is of crucial importance for the preservation of the city's identity and creation of a smarter sustainable city. Their competencies for teamwork, project work, knowledge update, innovation, and lifelong learning are relevant for their self-improvement, and for the quality of future works in the city of Mostar.

KLABS project, in a way, was a turning point for the faculty. Experiences of the members of the consortium, sharing of the thoughts and problem-solving ideas, have encouraged its staff to make big revisions of the study curriculum and educational approaches. One of the results was the creation of the new study programme. Another was the implementation of the positive outcomes of that programme into other existing study programmes at the faculty. Several years ago, with research efforts, the Faculty started to introduce both project-based and problem-based learning with case studies[9] located in the city of Mostar. Educational innovations were introduced within two subjects thought at the Department of Structures Programme.

2. START OF THE ACTIVITIES

Innovative teaching strategies should engage and support effective learning. As stated by Serdyukov, to innovate is to look beyond what we are currently doing and develop a novel idea that helps us to do our job in a new way. The purpose of any invention, therefore, is to create something different from what we have been doing, be it in quality or quantity, or both.[10]

For the Civil Engineering Faculty, it was not about doing something on the ground, but revising the past and doing some of the educations in a new way. The development of a new study programme, under the umbrella of the KLABS project, has secured interaction between several courses organised within the programme. The idea was to choose one case study and study it from different points of view, through different subjects over the course over one academic year. The research was created and implemented from the perspective of durability, sustainability, conservation, resilience, and possible future use and maintenance of buildings that were being studied. A new study programme even had one subject, named professional project or study project depending on the semester, created with the aim of securing an interdisciplinary approach in solving one problem from the industrial and infrastructural sector. The teaching staff transferred good experiences into other study programmes.

3. DEVELOPED APPROACH IN EDUCATION INNOVATIONS

The approach in education innovation was prepared and developed in an interdisciplinary cooperation of two subjects: Durability and maintenance of the structures (run by civil engineers) and Reconstruction of the historic buildings (run by architects). The aim was to use Mostar as the background and source of the case studies due to numerous reasons; UNESCO heritage site, legal constraints in conservation approach to many buildings, numerous ruined buildings, but also reconnection of the youth to the city urban and its heritage core.

The question was how to create a methodological approach in teaching sustainability and resilience in real case studies that are based on heritage buildings in the city of Mostar. In the end, the defined methodological approach was based on the combination of knowledge creation and case-based learning methods. Knowledge creation was winded by close interaction of two subjects, and case-based by the creation of mutual exercises based on one complex case study. A case study always involves a building located in the Mostar historical

core. Usually, the building is of heritage importance, not in (regular) use, and with different structural problems. Each year a new case study is defined in cooperation with the representatives of the city heritage authorities or religious communities (as building owners).

The approach in the research is well known (identification, analyses, valorisation, and plan of the intervention). Education innovation has to be practiced by the students in all of its steps over the course of the semester. In the end, students must prepare the whole project of the current condition and intervention design. Along with the work itself, they work in teams that are, sometimes, interdisciplinary.

Used types of research are field and laboratory research related to the case study. Students are obliged to go on-site, make on-site observations and collect data. Some of the needed material testing is done on-site and some in a laboratory.
Sometimes, a case study is extended from the semester work to the master's dissertation. In addition to the above stated, comparative research is also applied, but only within the work of the thesis. Preparing the master's thesis, students are obliged to identify similarities and differences between the two conservation approaches used on similar buildings (similar in state of the condition and heritage value).

The tasks of each defined research are following:

− To make an architectural recording of the current condition of the building;
− To identify materials used for construction and their current load capacity;
− To make some on-site non-destructive and laboratory (destructive) researches on the state and load capacity of the materials;
− To make recording and identification of all damages and problems detected on the building;
− To make an in-site observation of the state of the construction;
− To explore the history and importance of the building and its surroundings, and
− In the end, based on all identification, analyses, and valorisation, to make a plan of intervention, draft conservation project, and draft maintenance project.

Students are also required to discuss the possibilities of reuse and sustainability issues of the building in question.

The goals of the developed approach were as follows:

− To teach students how to make a proper recording of the current condition of the building;
− How to organise field work;
− How to inspect structural issues;
− What is the condition and capacity of the materials exposed to weathering for longer periods;
− Can buildings exposed to weathering or damaged in different ways be preserved and under what conditions;
− How to research the importance of the building;
− Why and how to value buildings of heritage importance;
− How personal and general attitude towards ruined and old buildings affects future building's conservation and possibilities for (re)use;
− How approach toward conservation or demolishment of the building affects future urban landscape and the city's identity.

4. DEVELOPMENT ACTIVITIES

The first two years of the implementation of the developed approach, research was implemented within the two subjects: Durability and maintenance of the structures and Reconstruction of the historic buildings. Work was done over the course of one semester with the students of the second year of the II cycle, the Department of the Structures' programme.

The first research project was carried out in the 2016/2017 school year on the so-called Djokića house on Titova Street. The house was built at the end of the 19th century. The main construction material was stone with stone vaults in the basement and wooden floor and roof construction. The building was set on fire and hit with bombshells. Roof and floor construction have collapsed. All materials are still in the building. The building has been left exposed to weathering since 1993.

The second project was done in the 2017/2018 school year at Tabačica mosque (Hadži-Kurt Mosque) located in the vicinity of the Old Bridge. The 16th century mosque was severely damaged during the 1992-1995 war. The entire roof construction was damaged and collapsed as well as more than half of the minaret. The mosque was restored in 2000. Unfortunately, the building is not in permanent use and lacks regular maintenance. In addition, it has lost one of its

features – running water under part of the building throughout the year. This, as well as the current state of the surroundings, has led to a change of some characteristics of integrity and authenticity.

The work on the second project pointed out the fact that if we were about to change the opinion of young people on the importance and possibilities of uses of the old structures then we cannot focus only on the buildings in question itself. Understating the concept of sustainability is more than just questioning materials and the state of the construction. Students needed to understand the surroundings, values of the building and the area (not just heritage-related values), so they could understand urban tissue, general economic issues, advantages and possibilities of reuse, and processes of urban rehabilitation.
The results from the first two years were projects of the current condition of the buildings in the subject, and these projects included detailed descriptions of the damages and proposed interventions.

During the third school year, 2018/2019, the work was extended to three subjects and two semesters, widening research on reuses, possibilities, and obstacles. Included were three subjects from the study programme on environmental infrastructure management. The student from both years were involved in the II cycle. The case study was Konak, a former military base, located in the historical core of Mostar. The military base consists of numerous buildings and several grounds. Some buildings were adapted for new uses (schools and archives), and some are abandoned. Location, viewed in general, is unidentified and with few serious social problems that are the result of neglect and lack of urban and spatial intervention. The research on construction, materials, identity, adequate reuses, and pre-requisites for intervention to be successful resulted in several semester works and three master's dissertations.

Four different groups of students worked on this case study. One group was focused on the spatial scale of the site, relations of the site and the surrounding area as well as relations between the buildings and open spaces within the site itself. They were supposed to identify current conditions and problems, the possibilities for reuse, and present proposals for possible improvement of the condition of the site as a whole. Proposals were supposed to be based on the real needs of the institutions located in some of the buildings on the site and planed visions for the uses of the site presented through urban planning documents of the city. The results of this group were used as the starting point for the work of other groups.

Three other groups were focused on one chosen particular building from the site. Their task was to, based on identification, analyses, and valorisation, make a proposal for upgrade/restoration/reuse of that building taking into consideration analyses of the first group and needs of the institutions located in those buildings. Proposals on one building were focused on its sustainability and energy efficiency, and on the restoration possibilities for the other two. Due to the importance of the site, preservation of the values, authenticity, and integrity was one of the prerequisites in all intervention proposals.

All master's thesis were focused on the structural problems, but that was just part of the problem. Although civil engineers, students were required to discuss micro-urban location, and propose upgrades related to the needs of the users (presented through design and adaptation). During their work, they also had constant consultations with the conservation architect. Their proposal for structural interventions and improvements had to be in line with instructions from the architect.

During the work on the first two projects, students realised to some extent the value of historic structures, but not completely what was really important about these buildings as well as for the city and the identity of the place. The work in a team was significantly improved as well as an understanding of the importance of interdisciplinary teams.

Working on the third project was a big step forward. Not only did it show what interdisciplinary really means (working on the same building from conservation, structural, energy efficiency, and spatial planning point of views), but it helped students to understand the complexity of working on real buildings in real locations. The main knowledge acquired was how to approach building problems in general and not just from a construction and material aspects.

The school year 2019/2020 brought new opportunities for the development of problem-based learning. Within one of the projects being implemented by the Civil Engineering Faculty, the Research Centre was established. The results from previous ERASMUS projects implemented by the faculty were one of the inputs for the definition of the centre's work. The research and development took place within the curriculum, but based on real industrial problems and in close cooperation with companies, which was another input.

With the established centre, the faculty decided to take a wider and more serious approach toward research and innovation in learning. The project-based learning cases were now created not just by teaching staff, but also by organisations or institutions that have proposed their problems to be worked on and solved.

Four research projects were defined in the 2019/2020 school year, linking five different subjects and making teams from students of different school years, study courses, and faculties (included were also students from the Interior Design Faculty). Problems were defined by the following organisations: Velež and HP Investing, University and NSoft, Mujaga Komadina primary school, and NGO Mostar Association of Sport. The teaching staff developed the structure of each project and working methodology. All projects were dealing with the use and reuse of existing structures, the durability of materials and structures, redesign, energy efficiency, and urban rehabilitation. The aim was to secure the sustainability of the existing structures by improving their reuse.

Teaching staff supervised the research work but organisations gave their inputs and suggestions as well. In addition, competencies for students were the development of presentation skills and their appearance in front of the investors. The stated project cases resulted in eight-semester works and five master's theses. The work with NSoft and Mujaga Komadina primary school finished by the end of the 2019/2020 school year. The work with other organisations and companies was completed by the end of the 2020/2021 school year.

The teaching staff had chosen four locations for the case studies. One location was Konak – the work was based on the results from the previous year. Another location was the playground of the primary school. The work was done for a one master's thesis. This was not done in an interdisciplinary team. Yet, the student was constantly, besides the mentor, working with the school principal, a few teachers, and an architect. The proposal was focused on the use of safe materials for the school playgrounds, but it also included improvements to the walking paths, fences, and playground landscape. The final design was presented to the school's principal and the board. Following the proposal, the school made some improvements to its front yard.

The third location was the Džemal Bijedić University of Mostar's campus. It was approach similar to the Konak site: five subjects and four groups of students. The base was the zoning approach – all students needed to understand the complexity of the site from the spatial point of view. They needed to understand walking and traffic paths, the requirements of the users, and problems in the use of the site as a whole. After that, groups were focused on individual tasks.

The fourth task was the most complex one and the work was extended over three school years. Rođeni Stadium, previously known as Vrapčići Stadium, is a stadium in Mostar which has been in the process of development since 1995. It was built as a small stadium for the local football club, but it became a home ground of Football club Velež Mostar in 1995.

In order to fulfil the needs of the premier football club, it has been enlarged and adapted ever since. In 2006, a large northern and smaller eastern stand was constructed, while a large western stand was built in 2008. This was followed by additional works and expansions between 2017 and 2018. In 2019, a roofing of the western stand was finished. It is expected that the stadium would be further upgraded for Velež's 100th anniversary, end of the June 2022. In December of 2019, the eastern stand was demolished for a new stand to be built proportionally to the northern stand. Unfortunately, development works were not accompanied by maintenance and needed repair works. The site has large economic value and development possibilities, but is faced with numerous structural issues related to maintenance and enlargement.

Since the 2019/2020 school year, several basic research works were implemented on this site. The basic research projects are aimed at identifying the current condition of the concrete structures of the stadium. These projects were prepared in an interdisciplinary cooperation of two subjects: durability, and maintenance of the structures (run by civil engineers) and energy efficiency in the reconstruction of buildings (run by architects). The researchers' task was to make an architectural recording of the current condition of the building and to record and identify all damages and problems detected.

Besides students of civil engineering, and with the aim of creating an interdisciplinary team, students from the Interior Design Faculty were invited to work on the site. Their task was to give a proposal, based on identification, analyses, and valorisation, for the adaptation of the club's premises and their extensions. Students were constantly exchanging their proposals and requirements. Therefore, the proposals for maintenance and structural improvements were based on the redesign of the interior, and vice versa.

The 2020/2021 school year was entirely overshadowed by Covid-19 lockdown. Education activities were moved to online mode, which meant that organising the case study became a real challenge. In order to secure work only on the outside, the wall of the Konak campus was identified as a case study. The work

was done only within the two subjects, like at the beginning of the case study-based activities. Although students could not experience an interdisciplinary team, the case study turned to be challenging and a real teamwork. In the end, one master's thesis was developed as a continuation of this case study – the work on the sports ground, connected with the wall.

5. WORK IN PROGRESS

The 2021/2022 school year is impacted by Covid-19 lockdown, it is a year of the online education, and adaptation to new requirements for in-class school work. The implementation of the activities has continued, but the work was divided among study programmes. One case study is being studied through three subjects of the first year of the II cycle at the Environmental Infrastructure Management programme. A case study is related to urban planning, urban rehabilitation, and interventions on the street.

Another case study is being studied through two subjects of the second year of the II cycle at the Department of Structures programme. The so-called Radnički dom building is being studied in detail. The building was, during the previous year, a case study of the master's thesis. It was studied mainly from a theoretical point of view, presenting several comparisons regarding the conservation approach. This year, the building is being documented and analysed through field work and laboratory research.

Covid-related restrictions have influenced the creation of interdisciplinary teams among students of the different programmes and faculties. But the transfer of knowledge and presentation of the approach between different student groups is implemented by the teaching staff. The same case study is being researched from different points of view and different groups of students. The idea is to present all views and outcomes of the researches during open days at the university.

CONCLUSION

Classical lectures with little interaction between the lecturer and students are still dominant at the faculty. Project-based learning has slowly been introduced over the past few years within the curriculum of several subjects of the II cycle.

So far, innovative forms of teaching in form of project-based work are well accepted by students and teachers alike.

This paper has presented an approach applied by the two subjects of the II cycle. An official survey on students' opinions was never done. But their feedback is quite positive. Positive comments are related to a better understanding of the subject taught in classes as they had the opportunity to apply some of it to their field work. Teamwork is also found as a very good experience. Negative comments are mainly related to the fact that the field work is being done in winter months, resulting in hours of working in the cold and windy spaces.

Regarding the results of the students, it is very important to point out the fact that their final projects of the current condition of the buildings are done according to the professional requirements and present finished design. Of course, the projects are influenced by the fact that students document buildings using only basic equipment, and work on buildings that don't have scaffoldings (therefore students are not able to approach all the parts of the building). Another important obstacle are time limits. Time limit is the fact in the real job as well, but, during the educational phase, it adds stress. Despite the stated obstacles, the results are professional and useful for further work by heritage institutions.

It is not possible to claim that the good results of students on subjects included are based solely on new teaching approaches and methods. Nevertheless, these methods do support the development of students' interdisciplinary competencies and self-learning on understanding the wider context within the problem. In addition, they increase the activity of the students during classes. This activity is not linked only to jobs done by students, but also to them taking an active role in the implementation of the course.

Project-based learning, besides gaining knowledge, creates the basis for the development of several competencies like social competencies, conflict management, mediation abilities as well as developing self-motivation. Linked with classical knowledge transfer, which is indispensable for developing complex technical knowledge, project-based learning within interdisciplinary teams and subjects, develops young engineer that is capable to deal with various demands during his/her work life and grappling with unknown challenges of the future.

On the other hand, the implementation of this kind of teaching method focused on competencies, wider perspectives, and interdisciplinary teamwork, needs to be supported and pushed on different organisational levels. This kind of teaching offers great opportunities for the development of the academy–industry link and the development of academic communities just like the development of the students. Of course, courses and lectures with a strong interaction need more time for preparation to ensure optimised support for students. The organisational work increases in the interdisciplinary projects as well.

But this approach stimulates the teaching staff as well on constant self-improvement and lifelong learning. Therefore, teachers are more up-to-date with new developments in the fields of sustainability, resilience, and conservation, which results in them being able to transfer knowledge in a better way. The good results show the value of this effort. Both the teaching staff and students had a big learning curve regarding their knowledge, the ability for teamwork, and their development of competencies.

Implementation Year	Subjects involved in the implementation of the approach	Groups of the students	Case study	Result(s)
2016/2017	Durability and maintenance of the structures and Reconstruction of the historic buildings	Second year of the II cycle, Department of the Structures programme	"Đokića" house	Project of the current condition of the building, no detailed analyses of the materials, their state and load capacity
2017/2018	Durability and maintenance of the structures and Reconstruction of the historic buildings	Second year of the II cycle, Department of the Structures programme	Tabačica mosque	Project of the current condition of the building, no detailed analyses of the materials, their state and load capacity
2018/2019	Durability and maintenance of the structures, Reconstruction of the historic buildings, Technical Equipment of Buildings and Settlements, Energy efficiency in building reconstruction, Professional project,	Second year of the II cycle, Department of the Structures programme and First and Second year of the II cycle, Environmental Infrastructure Management programme; Master's thesis	Konak complex	Project of the urban rehabilitation of the site; Project of the energy efficiency upgrade of the central building within the complex (Secondary/High school building) along with draft of the maintenance plan; Project of the current condition of the Tabija building (no detailed analyses of the materials, their state and load capacity)
2019/2020	Durability and maintenance of the structures, Reconstruction of the historic buildings, Technical Equipment of Buildings and Settlements, GIS and zoning (utility infrastructure), Professional project, Energy Efficiency	Second year of the II cycle, Department of the Structures programme and First and Second year of the II cycle, Environmental Infrastructure Management programme; Interior Design Faculty	Džemal Bijedić University of Mostar campus	Rehabilitation and upgrade of the central area of the campus based on the detail analyses and developed zoning plan (one group); Project of the energy efficiency upgrade and redesign of the Civil Engineering Faculty building (one group); Project of the new building within the campus (one group)
			Mujaga Komadina primary school	Redesign and upgrade of the Schoolyard (Master's thesis)
			Konak complex	Master's thesis
			Velež complex	Project of the energy efficiency redesign of the main building (west stand) (three groups of the students, one master's thesis) Project of the current condition of the west and north stand with detailed analyses of the materials, their state and load capacity (one group, and three master's thesis) Project of the rehabilitation and upgrade of the stadium complex (one group)
2020/2021	Durability and maintenance of the structures, Reconstruction of the historic buildings	Second year of the II cycle, the Department of the Structures programme	Konak complex - West wall	Project of the current condition with detailed analyses of the materials, their state and load capacity (one group)
2021/2022	Durability and maintenance of the structures, Reconstruction of the historic buildings	Second year of the II cycle, the Department of the Structures programme	Radnički dom building	Project of the current condition with detailed analyses of the materials, their state and load capacity (one group)

Table 1. Presentation of all case studies

NOTES

1 Regarding KLABS project partners see https://klabs.pr.ac.rs/consortium.php.

2 The Faculty of Civil Engineering at Džemal Bijedić University of Mostar is refered as the faculty in order to make article easier to read

3 KLABS - The project Creating the Network of Knowledge Labs for Sustainable and Resilient Environments - capacity building action in the field of higher education, co-funded by the Erasmus+ Programme of the European Union. For more information visit https://klabs.pr.ac.rs/.

4 García-Peñalvo, F. J., & Colomo-Palacios, R. 'Innovative Teaching methods in Engineering,' *International Journal of Engineering Education* (IJEE), 31(3), (2015): 689-693. (PDF) https://www.researchgate.net/publication/292721376_Innovative_Teaching_Methods_in_Engineering (3 February, 2020).

5 Eva-Maria Heinendirk. Ivan Čadež. 'Innovative Teaching in Civil Engineering with Interdisciplinary Team Work. Organisation, Technology and Management in Construction,' *An International Journal*, S(2) (2013): 874 – 880. DOI 10.5592/otmcj.2013.2.6 (3 February, 2020).

6 For more infromation about history oft he Džemal Bijedić University of Mostar see https://www.unmo.ba/university/.

7 Stari grad Agency (Agencija 'Stari grad' Mostar) was, at a time, institution founded soley for the management and conservation works at the Mostar Old town (historical urban core). Over the years, it has developed into a Herzegoivina regional institute for protection of heritage with some additional authorities in the City of Mostar.

8 For more about the award and the project see https://www.akdn.org/architecture/project/conservation-mostar-old-town.

9 For definition of case-based learning, project-based learning and problem-based learning see https://teachingcommons.unt.edu/teaching-essentials/engaged-learning/problem-based-learning-vs-project-based-learning http://www.crlt.umich.edu/tstrategies/tscbt https://poorvucenter.yale.edu/faculty-resources/strategies-teaching/case-based-learning.

10 Peter Serdyukov, 'Innovations in education: what works, what doesn't, and what to do about it?' *Journal of Research in Innovative Teaching & Learning* Vol. 10. No. 1 (2017) https://www.emerald.com/insight/content/doi/10.1108/JRIT-10-2016-0007/full/pdf?title=innovation-in-education-what-works-what-doesnt-and-what-to-do-about-it (30 July, 2021).

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PLANIRANJE PROMENA: METODOLOŠKI OKVIR ZA INTEGRACIJU CIRKULARNOSTI U NASTAVNE PLANOVE I PROGRAME ARHITEKTONSKOG FAKULTETA I GRAĐENE SREDINE, TU DELFT

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Ovaj rad postavlja metodološki okvir za integraciju cirkularnosti u arhitektonske nastavne planove i programe, predstavljajući blokove koji su doveli do njegove konceptualizacije. Prvi blok (Deo A) ispituje kako je složenost uticala na učenje i, , posebno, na arhitektonsko obrazovanje. U radu se polazi od ideje da znanje proizvodi dalju nesigurnost u uslovima kritične složenosti. Štaviše, najviši nivoi složenosti zahtevaju najmanje naučnih pristupa. Zatim, ispituje glavne izazove koji proizlaze iz ove promene: jedan je da se učenje identifikuje sa sposobnošću pojedinaca da donose utemeljene odluke i konceptualizuje kao znanje koje se može primeniti. Drugo, obrazovanje treba da se opredeli za pedagogiju koja može da podrži učenje kroz donošenje odluka. Arhitektonsko obrazovanje bi, posebno, trebalo da bude u stanju da neguje novu vrstu profesionalizma, gde pojedinci preuzimaju odgovornost za svoje projektantske odluke koje se protežu izvan estetskog područja. Ali šta može da podstakne nastavne planove i programe da postanu osetljiviji na trenutnu ekološku, društvenu i političku realnost? Drugi blok (deo B) istražuje cirkularnost. On ispituje njegovu relevantnost za arhitektonsko obrazovanje zbog mogućnosti da funkcioniše i kao operativna šema i kao sistem vrednosti. Štaviše, budući da je koncept u nastajanju, cirukularnost može imati koristi od akademskog istraživanja, ali takođe može podržati pedagogiju koja se fokusira na pomaganje učenicima da nauče kako da uče. Predloženi metodološki okvir (Deo C) se zasniva na ova dva bloka i na fakultetskom istraživanju o cirkularnosti kako bi se razvila šema koja ukazuje na relevantne sadržaje za nastavu cirkularnosti, kako se mogu formulisati ciljevi za njegovo integrisanje u nastavne planove i programe i koja vrsta pedagogije je pogodna za podršku integraciji.

KLJUČNE REČI: ARHITEKTONSKO OBRAZOVANJE; CIRKULARNA GRAĐENA SREDINA; SLOŽENOST; TRANSFORMATIVNA PEDAGOGIJA

SITUIRANO UČENJE U TEORIJSKOM KURSU URBANIZACIJE: LEKCIJE IZ BANJA LUKE

Nevena Novaković, Anita Milaković, Dijana Simonović

Učinjeni su mnogi teorijski i metodološki napori da se disciplinsko polje arhitekture i urbanizma proširi sa urbanog u tradicionalnom smislu na veće teritorijalne razmere savremene urbanizacije. U ovom članku se govori o načinima proučavanja disperzivne i polimorfne urbane forme koju tek treba sagledati. Diskurs se razvija oko modela situiranog učenja kao adekvatnog za razumevanje teorije planetarne urbanizacije i disperzovanog grada. Model učenja se primenjuje u okviru predmeta Urbanizacija u zemljama Zapadnog Balkana na master studijama Arhitektura i urbanizam (Univerzitet u Banjoj Luci). Model situiranog učenja uključuje studente u istraživanje realnog životnog konteksta, kulture i situacije, te stoga povezuje teorije urbanizacije velikih razmera sa ispitivanjem poznatog prostora. Štaviše, pristup učenju zagovara strategiju učenja o urbanizaciji i disperzovanu urbanu formu u teorijskim kursevima. Kurs koristi tehnike koje se obično uče u dizajnerskim studijima, kao što su mapiranje, kolaž slike i trodimenzionalno modeliranje. Članak bi mogao da doprinese razmatranju obrazovanja arhitekata kao profesionalaca koji će se baviti rastućim razmerama savremene urbanizacije, posebno u zemljama Zapadnog Balkana.

KLJUČNE REČI: PLANETARNA URBANIZACIJA, URBANA FORMA, DISPERZOVANI GRAD, UČENJE ZASNOVANO NA UPITIMA, SITUIRANO UČENJE, METROPOLITANSKA FORMA, BANJA LUKA

ENERGETSKA REHABILITACIJA POSTOJEĆIH OBJEKATA: PROJEKTANTSKI STUDIO

Dušan Ignjatović, Bojana Zeković, Nikola Miletić

U ovom radu je predstavljena studija slučaja dizajn studija sa temom energetske sanacije postojećih zgrada, na postdiplomskim studijama – Specijalističke akademske studije – Energetski efikasna i zelena arhitektura, na Univerzitetu u Beogradu – Arhitektonskom fakultetu. Metodologija ovog studija koristi pristup projektno orijentisanom učenju, simulirajući realno multidisciplinarno okruženje za razvoj projekata. Opisane su tri faze razvoja dizajna: faza istraživanja, faza renoviranja i faza redizajna. Počinje sa fazom istraživanja, koja se razvija paralelno sa fazom obnove. To je zato što proces renoviranja u ovom studiju nije ograničen samo na tehničke aspekte poboljšanja energetske efikasnosti, verifikovane proračunima i simulacijama. Razvijeno je nekoliko scenarija projektovanja koji ispituju minimalni, optimalni i maksimalni opseg poboljšanja energetske efikasnosti u tehničkim sistemima i toplotnom omotaču zgrade. Analiza ovih scenarija, ali i analiza mnogo šireg spektra aspekata koji utiču na dizajn rekonstrukcije, rezultiraju konačnim predlogom redizajna koji je sveobuhvatan, duboki predlog renoviranja, koji se bavi, ne samo energetskim (pod)performansama, već i mogućnostima za nadogradnju. funkcionalnih, tehničkih i estetskih aspekata postojećeg objekta.

KLJUČNE REČI: DIZAJN STUDIO, DUBINSKO RENOVIRANJE, REDIZAJN, ENERGETSKA EFIKASNOST, ENERGETSKE PERFORMANSE

JEDAN PRISTUP INOVACIJAMA U OBRAZOVANJU – ISKUSTVA SA UNIVERZITETA DŽEMAL BIJEDIĆ U MOSTARU

Amra Šarančić Logo, Marko Ćećez, Merima Šahinagić-Isović

Podučavanje održivosti i otpornosti na nivou materijala i strukture je današnji imperativ za ekološki prihvatljivije sutra, ali i za obogaćivanje ljudskog života i očuvanje istorijskih struktura. Preispitivanje održivosti u njenom poštovanju prema već postojećim strukturama, osmišljavanje projekata prvo inventarizacijom onoga što već postoji postalo je polazna osnova u definisanju istraživačkih slučajeva za studente u posljednjih nekoliko godina na Građevinskom fakultetu Univerziteta Džemal Bijedić u Mostaru.

U radu je prikazan pristup razvijen i rad urađen u proteklih nekoliko godina, uglavnom u okviru dva predmeta na Građevinskom fakultetu. Razvijeni metodološki pristup zasnivao se na kombinaciji stvaranja znanja i metoda učenja zasnovanog na slučajevima. Studije slučaja su uvek zgrade od značaja za nasleđe.

Cilj pristupa je da nauči kako pronaći mogućnost da se uradi više sa postojećim strukturama i argumentuje njihovu buduću upotrebu i mogućnosti za poboljšanje, nadogradnju i ponovnu upotrebu. Rušenje je laka odluka i ima veliki uticaj na istoriju i identitet grada i njegove zajednice. Stoga je naš zadatak da tražimo različite pristupe konzervacije kako bismo sačuvali slojeve grada i obezbedili napredak.

KLJUČNE REČI: INOVACIJE U OBRAZOVANJU, INOVACIJE U NASTAVI, ODRŽIVOST OBRAZOVANJA, OČUVANJE NASLEĐA

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