THE REGENERATIVE NEXUS: GREEN TRANSITION IN ARCHITECTURAL EDUCATION (THE "INCEPT" MODEL)/

Angelica STAN, Mihaela HĂRMĂNESCU, Daniel ARMENCIU, Sorin MANEA - *University of Architecture and Urbanism 'Ion Mincu' Bucharest.*

Ana MRĐA, Mia ROTH-ČERINA, Zoran VERŠIĆ, Marin BINIČKI, Stanka OSTOJIĆ - *University of Zagreb, Faculty of Architecture.*

Georgi GEORGIEV, Eleonora GAYDAROVA, Zdravko GEORGIEV, Petar PETROV - *New Bulgarian University.*

Email: armenciu.daniel@gmail.com

Abstract. The INCEPT project introduces a critical pedagogical shift to align European Architectural Education with urgent Climate-Neutrality goals, specifically addressing the vast challenge posed by the existing built environment. Recognizing that regenerative design must fundamentally oppose linear "design and demolish" practices, INCEPT developed three interconnected intellectual outputs to cultivate a high-conscious and action-oriented professional generation. Firstly, the project produced a comprehensive Compendium on the Green Transition which systematized theoretical knowledge in key areas: circular economy principles, low-tech sustainable design, and life-cycle assessment (LCA). This resource provides a foundational knowledge base essential for transitioning architecture away from high-carbon materials and operational inefficiency. Secondly, the creation of an Online Training Course extended this essential knowledge—from zero-emission strategies and bioclimatic design to digital lifecycle management (BIM/Digital Twin)—to a wider professional and academic community, ensuring broad dissemination of current best practices across the European building stock. Thirdly, the innovative Climate-Neutral Building Design Atelier functioned as a "Living Lab" across Zagreb, Bucharest, and Sofia. This interdisciplinary studio centered its methodology on the adaptive reuse of complex urban sites, including heritage buildings and brownfield voids. By applying the learned principles to real-world interventions, students successfully integrated regenerative systems, low-carbon materials, and circular design details, validating an educational model focused on heritage respect and systemic environmental thinking. The collective results demonstrate the efficacy of making adaptive reuse the central, necessary skill for architects committed to a truly regenerative and circular future.

Keywords: Climate-Neutral, green transition, architecture students.

Introduction: 1.1 The global imperative: redefining the built environment. The architectural and construction sectors stand at a critical crossroads, facing a crisis of relevance rooted in the global climate emergency. With buildings responsible for approximately 40% of worldwide CO2 emissions (Lucon et al., 2014), Europe's strategic objective of achieving climate neutrality by 2050, as outlined in the Green Deal, necessitates a radical transformation of the Built Environment. This imperative is formalized by ambitious energy directives, including the imminent shift toward Zero Emission Building (ZEB) standards. This evolution fundamentally challenges conventional practice, pushing the focus from purely addressing operational energy (energy used during a building's life) to aggressively mitigating embodied carbon (emissions locked into materials, construction, and demolition). This paradigm shift spotlights the critical value of the existing building stock. Every structure embodies significant materials and cultural history, yet urban development frequently targets neglected spaces (including urban voids, abandoned lands, and brownfield sites) for demolition and replacement. A truly regenerative approach cannot succeed by perpetuating this linear, resource-intensive model. Instead, it must treat existing structures, irrespective of their condition, as invaluable material resources ripe for adaptation.

1.2 The Pedagogical Gap: cultivating the regenerative approach in architecture. To meet these complex challenges, the architectural profession requires a new generation of practitioners equipped with systemic thinking that seamlessly integrates ecology, engineering, circular economics, and heritage conservation. Unfortunately, most contemporary architectural education suffers from a pedagogical gap, often treating sustainability as a fragmented, technical add-on rather than a foundational design principle. We argue that the future architects must possess the capacity to perceive the global material and energy flows inherent in local design decisions. This requires moving beyond merely designing sustainable buildings towards actively designing for regeneration and net-positive impact. The core skill set for this transformation is anchored in adaptive reuse and the application of circular economy principles.

1.3 The INCEPT Response: An Integrated Educational Framework. The Erasmus+ INCEPT project directly tackles this educational deficiency by developing, validating, and implementing a comprehensive framework for a circular and climate-neutral curriculum. INCEPT operationalized this vision through three interconnected Intellectual Outputs:

The INCEPT COMPENDIUM on the green transition, conceived as a systematized body of knowledge covering circular economy principles, Low-Tech design, life-cycle assessment (LCA), and bioclimatic strategies.

The CLIMATE-NEUTRAL BUILDING DESIGN Atelier, an innovative Living Lab methodology, validated across the diverse urban contexts of Zagreb, Bucharest, and Sofia, dedicated to the hands-on transformation of existing structures.

The ONLINE TRAINING COURSE ON SUSTAINABLE ARCHITECTURE, a suite of coursees designed for professional outreach, extending expertise to a wider audience.

The concept of INCEPT Project is associated with the strong motivation to align architectural education with the energy and climate goals at national and EU level taking into account the paramount role of the built environment. INCEPT Project aims to contribute to the EU energy decarbonisation targets for the building stock, which requires energy efficiency measures, switching to renewable heating and cooling systems, and improving resource efficiency and circularity in buildings throughout

the entire building life cycle. As main objective INCEPT Project envisages to develop, validate and implement a curriculum on sustainable architecture, which will provide knowledge and build digital and green skills of architecture students on the major principles of sustainability and energy efficiency in the design of different building typologies.

This paper details how this integrated educational model bridges the critical gap between high-level climate goals and practical design synthesis, demonstrating a scalable framework for integrating the regenerative potential of adaptive reuse into the heart of architectural education.

2.1. Systematizing knowledge for a circular future. The INCEPT COMPENDIUM. The concept of the Compendium on the green transition to affordable and clean energy in buildings, sustainable cities and communities, and climate resilience for architecture students was to represent a main tool for implementation of updated curricula designated for architecture students' courses. The structure and the content of Compendium answer the understanding of the participating universities and relevant experts involved in INCEPT project about the necessary improvements in educational content for architecture students and additional target groups proposed by the project in order to meet the changing needs of the environment and the society.

The role of this deliverable in the overall project is a very important one, generating the entire proposed research and education process. The Compendium determines new curriculum on sustainable architecture and identifies and suggests the knowledge types and associated thematic cores/modules in line with the concept and main objective of INCEPT Project.

2.2 Thematic Synthesis of the Compendium. The structure and the content of Compendium answer the understanding of the participating universities and relevant experts involved in INCEPT project about the necessary improvements in educational content for architecture students and additional target groups proposed by the project in order to meet the changing needs of the environment and the society.

The INCEPT Compendium provides the foundational knowledge across 6 modules to shift architectural education toward a regenerative and circular future.

Module 1- Built Environment and Sustainability establishes the urgency of climate change mitigation within the built environment, focusing on the depletion of natural resources and energy sources. It introduces fundamental economic and analytical concepts crucial for the circular transition, including the formal definition of the Circular Economy, the Life Cycle Analysis (LCA), and Life Cycle Cost Analysis (LCCA) as essential tools for quantifying environmental and financial impact across a building's entire lifespan.

Module 2- Integrating Landscape to Built Environment Sustainability treats the landscape and urban context not as passive setting but as active, interconnected ecological systems. It defines Sustainable Landscapes and Climate Smart Landscapes that enhance urban resilience. Key concepts include the principles of Nature-Based Solutions (NbS) and Green Blue Infrastructure (GBI)—such as multifunctional parks and green roofs—for biodiversity conservation, urban heat mitigation, and stormwater management. It also covers international landscape certification systems like SITES.

Module 3- Ecodesign Basics (Low-Tech Sustainable Building Design) focus on the "fabric-first" approach and vernacular wisdom, this module re-establishes the core relationship between Climate and Architecture. It details passive design principles, often referred to as "low-tech" solutions. Topics include climate-responsive design strategies for different zones, proper building orientation, optimizing the building envelope (insulation, materials selection), and maximizing natural lighting and ventilation to reduce reliance on complex mechanical systems.

Module 4- Integrated Sustainable Building Design moves from passive strategies to active integration, covering technologies and policy requirements for high-performance structures. It thoroughly addresses Sustainable Renovation of Existing Buildings (adaptive reuse) as a primary sustainability tool, outlining renovation strategies and the cost/benefits of upgrading the existing stock. It defines standards like Nearly Zero Energy Buildings (NZEB) and the impending Zero Emission Building (ZEB), detailing the systems (BIRES) and technologies needed to achieve low-energy performance.

Module 5- Built Environment and Sustainability Management focuses on the long-term management and maintenance of buildings as a critical sustainability tool. It covers the Digitalization of Building Management, emphasizing the transition from BIM during design to Digital Twins during operation for predictive maintenance and energy optimization. It also details the financial aspects of sustainable building design, analyzing the cost-benefit relationship of energy efficiency measures and adherence to standards like ISO 50001.

Module 6: Measuring/Evaluation of Sustainable Architecture addresses compliance and market mechanisms. It details the EPBD and National Energy Efficiency Standards, the methodologies for Measuring and Certification (Energy Audits, Energy Simulations), and provides an overview of the future Zero Emission Building Standard. Finally, it compares and contrasts global integrated building certification systems such as BREEAM and LEED, positioning them within the context of market transformation and quality assurance for green design.(Figure 1)

3. The INCEPT- CLIMATE-NEUTRAL BUILDING DESIGN ATELIER. The Climate Neutral Building Design Atelier is the second core-component of the INCEPT project, implemented as a dynamic Living Lab across Zagreb, Bucharest, and Sofia during 2023 -2025. Our central argument posits that cultivating a hyper-conscious awareness of intricate global and local interplays must be intrinsically linked to a fundamental pedagogical prioritization of adaptive reuse within a circular economy framework. This integrated approach equips future architectural professionals with the critical skills and necessary mindset to move beyond wasteful demolition practices and to embrace a regenerative, heritage-respecting design ethic.

The Atelier's pedagogical methodology is built upon an integrative curric-

ulum that blends theoretical insight with hands-on experience acquired through targeted workshops on case studies. This paper advocates for the wider adoption and systematic integration of the practical applications into master-level architectural curricula throughout Europe, suggesting that the Atelier model offers a successful framework for cultivating this crucial "hyper-conscious" and proactively action-oriented approach within the education of future architects.

Functioning as a vibrant "living lab," the Atelier engaged master's-level architecture students across three diverse European urban contexts and specific sites: Zagreb, Bucharest, and Sofia. The core methodological framework is centered on the deliberate creation and dynamic delivery of a novel, highly integrative curriculum aligned with Europe's paramount energy and climate goals for a green transition. Its curriculum was specifically developed to challenge deeply conventional architectural paradigms and actively promote the adoption of demonstrably sustainable design and construction practices.

The Atelier actively fostered interdisciplinary collaboration, encouraging participation from students specializing in architecture, heritage conservation, urban planning, landscape architecture, structural engineering, energy expertise, and product design, being oriented toward a holistic understanding of the built environment. The effectiveness of the Atelier's pedagogy was assessed through student project evaluations, feedback surveys, and observations of engagement and learning outcomes. (Figure 2, Figure 3, Figure 4)

4. The ONLINE TRAINING COURSE ON SUSTAINABLE ARCHITECTURE. As part of the INCEPT Work Package 2, The ONLINE TRAINING COURSE ON SUSTAINABLE ARCHITECTURE establishes a foundational understanding of sustainable architecture, focusing on its meaning, approaches, and objectives as essential tools for achieving climate neutrality in building stock and maximizing resource efficiency throughout a building's life cycle. Additionally, this work package sets the groundwork necessary to fulfil the project's main goal: to develop, implement, and validate a sustainable architecture curriculum within Master of Architecture programs at participating universities. This curriculum aims to equip students with insights into contemporary challenges facing the architectural profession, specifically in responding to climate change and the crucial role of buildings in the transition to low or zero carbon emissions. Moreover, the sustainable architecture curriculum developed by INCEPT seeks to enhance the quality of architectural education at the participating universities by introducing innovative content, fostering the development of new skills, and applying progressive teaching methods. It also aims to promote interconnectivity among educational systems, supporting contextual improvements and novel approaches tailored to each university's unique environment.

The Online Training Course was composed of four key courses designed for the wider professional community and students, offering a holistic view of the shift towards a regenerative and climate-neutral built environment.

Course 1: Implementing Zero Emission Building Strategies in Architectural Education (delivered by University of Zagreb)

This module establishes the urgent necessity of aligning architectural education with high-level European climate goals, specifically the transition to Zero Emission Buildings (ZEB). The lecture frames sustainability as a core design principle, moving beyond its traditional role as a supplemental topic, but it promotes systemic thinking and interdisciplinary collaboration across architectural, urban, and technical scales. A major focus is placed on distinguishing between operational carbon (emissions from daily use) and embodied carbon (emissions from materials, transport, and construction) (Ebert et al. 2011). The module details strategies for mitigating emissions, including the use of optimized, low-carbon materials (e.g., carbon-sequestering wood), efficient building envelopes, and on-site renewable energy systems. (Cole, Valdebenito, 2013). The pedagogical model introduces the INCEPT "Living Lab" approach as a model for applying these principles to real-world tasks like urban regeneration and brownfield site reuse, directly addressing the challenge of the existing built environment.

Course 2: Bioclimatic Design and Landscape Urbanism (delivered by Ion Mincu University of Architecture and Urbanism Bucharest) advocates for creating buildings that harmonize with their specific environmental context, integrating design with ecological landscapes. It defines landscape urbanism and bioclimatic design as a set of solutions that create conditions using minimal conventional energy by adapting the building's form, orientation, and materials to the local climate. The Landscape Urbanism approach (Waldheim, 2016, Hărmănescu et al. 2018, Stan, 2021) focuses on Green Blue Infrastructure (GBI) and Nature-Based Solutions (NbS), treating urban green spaces not merely as aesthetic elements, but as vital frameworks that manage urban growth, mitigate climate impacts, and enhance ecological resilience. It emphasizes multiple benefits (ecological, social, cultural, and economic) from integrated land use. The module presents a clear methodological process starting with detailed Site Analysis (climate, solar radiation, human needs) that then informs design strategy and spatial configuration (Olgyay et al. 2015).

Course 3: Renewable Energy Sources (New Bulgarian University) addresses the technical implementation of clean energy, focusing on integrating various renewable sources directly into the built structure to meet ZEB requirements. It defines and identifies various types of renewable energy applicable to buildings, including wind, solar (thermal and photovoltaic), geothermal, and biomass, in alignment with the European Directive. The core concept is integrating renewable technologies directly into the building envelope or structure (e.g., PV facades, solar collectors on roofs), turning buildings from passive consumers into active energy producers (Richarz and Schulz, 2013). The module discusses the holistic approach required for BIRES integration, emphasizing site analysis, regulatory constraints, and cost-benefit analysis.

Course 4: Digitalization (delivered by New Bulgarian University) covers the crucial role of digital tools in achieving sustainable design, facility management, and long-term energy optimization across the building lifecycle. It examines Building Information Modeling (BIM) as the foundational digital tool, detailing its dimensions (3D, 4D, 5D, etc.) and its utility for enhancing efficiency in design, construction, and operational planning (asset management, maintenance). The module introduces the Digital Twin technology

as the next step in digitalization—a real-time digital replica of a physical asset (Eastman et al. 2008, Wang, et al. 2023). This dynamic tool uses sensor data and artificial intelligence for predictive maintenance and real-time operational optimization, allowing managers to predict and reduce future energy consumption. It also defines the Smart Readiness Indicator (SRI) as a metric measuring a building's capacity to use smart technologies for decarbonization, comfort, and efficiency, linking technology adoption to occupant needs and grid demands. The module emphasizes an integrated design approach where information flows seamlessly from design to eventual demolition.

The Online training course was implemented in collaboration of all three participating universities, and included the university lecturers from the teams of the project partners, along with the preparation of the content and of the promotion toward the audience. The courses were conducted on the digital educational university platform- MOODLE open-source learning management system - created at NBU for the purposes of the INCEPT Project.

The course targets specialists from the wider professional communities in the participating countries and in particular professionals in the field of sustainable development and energy efficiency of the building stock (landscape architects, civil and structural engineers, energy efficiency experts, urban sociologists, environmentalists, biodiversity specialists, social workers, etc.).

The implementation of the course was structured to maximize learning and engagement. Each two-hour session, consisting of a lecture followed by an interactive Q&A, facilitated a collaborative environment. This approach not only enabled knowledge transfer but also fostered cross-disciplinary collaboration among participants from architecture, engineering, environmental science, and urban planning. The post-course questionnaire served a dual purpose: it ensured participants had a demonstrable understanding of the key concepts and provided critical feedback for the continuous improvement of the educational approach. The use of the MOODLE digital platform ensured the course was accessible to a wider audience, fulfilling a core objective of the INCEPT project.

Conclusion. The INCEPT project evidences a significant paradigm shift in architectural education, demonstrating that adaptive reuse, circular economy principles, and systemic environmental thinking must form the foundational core of pedagogical practice in response to the climate crisis. By reorienting the discipline away from the entrenched linear model of "design and demolish" towards regenerative approaches, INCEPT not only addresses the pressing challenges of embodied carbon and resource depletion but also redefines the architect's professional agency in the context of a rapidly changing planetary condition. The project's tripartite framework—comprising the Compendium on the Green Transition, the Climate-Neutral Building Design Atelier, and the Online Training Course—illustrates a comprehensive educational model that bridges theoretical knowledge with applied practice. The Compendium establishes a structured and systematized knowledge base encompassing circular design, low-tech strategies, lifecycle analysis, and sustainability metrics, thereby recalibrating the conceptual foundations of architectural curricula. The Atelier extends this knowledge into practice through an immersive "living lab" format, where students engage directly with real-world challenges such as the adaptive transformation of urban voids, brownfield sites, and heritage contexts. Concurrently, the Online Training Course amplifies the project's pedagogical reach, fostering interdisciplinary exchange and enhancing professional competencies across a broader spectrum of built-environment disciplines. The outcomes of these interlinked components reveal the transformative potential of embedding hyper-consciousness—a critical awareness of the complex interdependencies between material flows, energy systems, cultural heritage, and socio-ecological contexts—within the architect's skillset. Such an approach cultivates practitioners capable of designing interventions that transcend mere mitigation and instead contribute positively to ecological and cultural regeneration.

Ultimately, INCEPT provides a replicable and scalable blueprint for integrating adaptive reuse and circularity into architectural education. It argues persuasively that future architects must be equipped not only with technical expertise but also with the capacity for strategic, systemic thinking that aligns design practice with the imperatives of climate neutrality, cultural continuity, and socio-ecological resilience. In doing so, the project positions architectural education as a critical agent in Europe's broader transition toward a sustainable, decarbonized, and regenerative built environment.

Acknowledgements.

The authors gratefully acknowledge the support of the Erasmus+ Programme of the European Union, which funded the INCEPT project - Align architectural education with the paramount energy and climate goals of the green transition in Europe. This research and educational initiative was made possible through the collaborative efforts of the consortium partners — the New Bulgarian University, the University of Architecture and Urbanism "Ion Mincu" Bucharest, and the University of Zagreb — whose shared commitment to advancing sustainable architectural education has been central to the project's success. The views expressed in this publication are those of the authors and do not necessarily reflect the official position of the European Union or the Erasmus+ Programme.

References.

1. Cole, R.J., M. Valdebenito, J. (2013). The importation of building environmental certification systems: international usages of BREEAM and LEED. Building Research & Information, 41(6): p. 662-676.

2. Eastman, C., Teicholz, P., Sacks, R. & Liston, K. (2008). BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons.

3. Hărmănescu, M, Coccolo, S., Naboni, E., Hansen, P. (2018). Rethinking Sustainability Towards a Regenerative Economy within an Adaptive Neighbourhood Design. In: PLEA 2018: Smart and Healthy Within the Two-Degree Limit Proceedings of the 34th International Conference on Passive and Low Energy Architecture; Hong Kong, China, Vol.2, eds. Edward Ng, Square Fong, Chao Ren, p. 591-597.

4. Lucon, O. Urge-Vorsatz, A.; Zain Ahmed, A.; Akbari, H.; Bertoldi, P.; Cabeza, L.; Eyre, N.; Gadgil, A.; Harvey, L.; Jaing, Y. Buildings. Chapter 9. In Climate Change 2014: Mitigation of Climate Change; Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel; The Intergovernmental Panel: Cambridge, UK; New York, NY, USA, 2014; pp. 678–679.

5. Olgyay V., Olgyay A., Lyndon D. (2015). Design with climate: bioclimatic approach to architectural regionalism (New and expanded). Princeton University Press.

6. Richarz, C., Schulz, Ch. (2013). Energy Efficiency Refurbishment - Principles, Details, Examples. Detail Green Books.

7. Stan, A., Harmanescu, M (2021). Abandoned lands in small and medium sized cities situated on Southern and Lower Danube's urban fronts, as opportunity to enhance the river urban green infrastructure (UGI) in Urban Services to Ecosystems: Green Infrastructure Benefits from the Landscape to the Urban Scale, Catalano, C., Andreucci, M.B., Guarino, R., Bretzel, F., Leone, M., Pasta, S. (Eds.), Springer: Nature.

8. Wang, H., Chen, X., Jia, F., & Cheng, X. (2023). Digital twin-supported smart city: Status, challenges and future research directions, Springer.

9. Waldheim, C. (2016). Landscape as urbanism: A general theory, Princeton

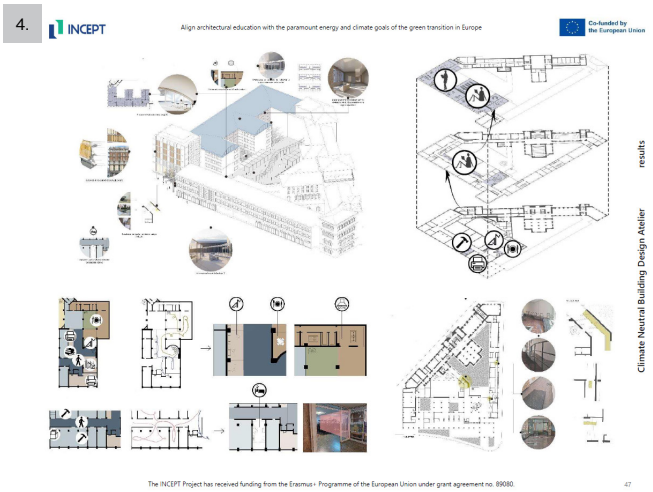
Figures.

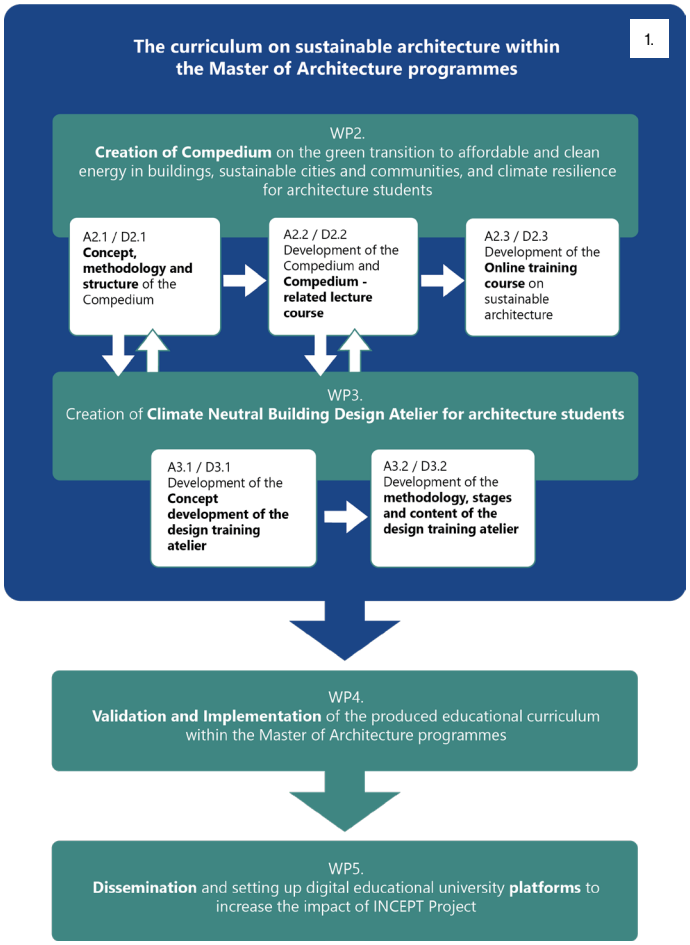
Figure 1- Overview of the INCEPT curriculum main components.

Figure 2- Objectives of the Climate Neutral Building Design Atelier. Source: Report on the concept of the design training atelier within INCEPT project, report author: Mia Roth Čerina, University of Zagreb.

Figure 3- Thematic focus aligned with tutor profiles. Source: Report on the concept of the design training atelier within INCEPT project, report author: Mia Roth Čerina, University of Zagreb.

Figure 4- From the urban context (U), through the entire space at the architectural object scale (A) and up to the scale of the technical details (T), students from the 3 universities created sustainable solutions on the studied cases. Source: The broshure of the Climate Neutral Building Design Atelier, exemple of a student project developed on the study-case of the Ion Mincu University, Bucharest, 2023-2024.

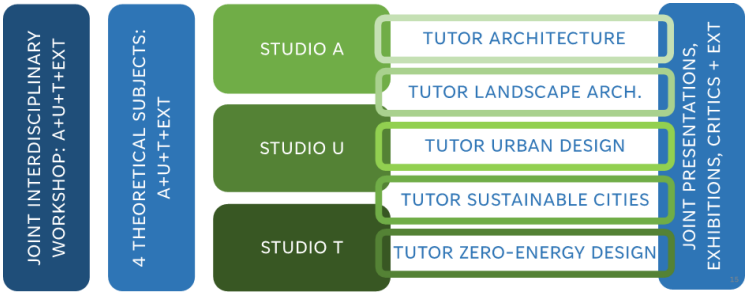




2.

alignment to INCEPT project objectives and current global policies	• gaining knowledge about energy efficiency and circularity principles of the source of materials, the entire life cycle of buildings, inclusive design, and sustainable urban planning
alignment to INCEPT project objectives and current global policies	• creating an interdisciplinary studio where the content, design principles, solutions and development test the achievement of UN sustainable development goals, New European Bauhaus principles and green redesign of cities
alignment to INCEPT project objectives and current global policies	• matching the semestral structure, content and processes to the existing master programmes and local contexts of partners
alignment to INCEPT project objectives and current global policies	• creating a clear, repeatable and adaptable method of teaching which improves design studio teaching within existing educational contexts
alignment to INCEPT project objectives and current global policies	• developing a foundation of interdisciplinary collaboration for future practitioners in architecture

3.



DESIGNING FOR THE FUTURE: SUSTAINABILITY AS A CORE EDUCATIONAL PRINCIPLE/

Bogdan IONIȚĂ, Alexandra Diana DUNEL, Maria POPA, Iulia Marta ȘTEFĂNESCU- *University of Architecture and Urbanism 'Ion Mincu' Bucharest.*

Email: atelier.design.an2@gmail.com

Abstract. This article explores the integration of sustainable practices within the university-level product design education, positioning sustainability as an essential, holistic method in the teaching process, deeply connected to the principles of design thinking. The focus is on embedding sustainability throughout the entire design journey – from concept and technical solutions to packaging and transportation – encouraging students to adopt a systems-thinking mindset. Given the current environmental and economic challenges, it is crucial to guide emerging designers to think and act sustainably across all project phases. Sustainability must become an organically embedded principle in product design, not a secondary consideration.

The problem – the fundamental driver behind the creation of a design object as a solution – is today inseparable from sustainability considerations. This article examines both the pedagogical methods which have proven effective in fostering sustainable thinking and the challenges encountered during studio-based project work. It further offers a critical reflection on how sustainability is not merely an additive component of the design process, but an inherent and inseparable dimension of contemporary product design practice. Within the educational context, the student-designer is guided to discover the integral role of sustainability as a value-generating element that shapes and informs the entire design process. Rather than being introduced as an optional or external principle, sustainability is revealed as a fundamental aspect of a holistic design approach.

As part of its methodology, the article proposes a re-evaluation of selected student design solutions, analysed in the context of this research through the lens of three key indicators: (1) student receptiveness to the holistic design process, (2) the degree to which those solutions reflect the process, and (3) the extent to which students internalized sustainable practices and later applied them autonomously in subsequent projects.

By employing this framework, the study aims to identify non-invasive pathways for integrating sustainability into studio projects – approaches that enrich rather than inhibit the design process. The theoretical foundation of this inquiry is supported by a series of selected case studies drawn from second- and third-year design studio projects, providing insight into the evolving relationship between sustainability and design education.

This article also examines both the successes and challenges encountered in implementing these principles within the design studio. Among the obstacles, the most prominent include resistance to change, limited resources for prototyping sustainable solutions, and a lack of awareness or confidence in balancing environmental responsibility with creative freedom. On the positive side, effective methods, such as project-based learning with real-world constraints, interdisciplinary collaboration, and critical reflection sessions proved particularly valuable in reinforcing sustainable thinking.

Furthermore, the analysis reveals gaps and shortcomings which persists throughout the academic year, stemming both from students and educators. Students often struggle to maintain sustainable considerations beyond the conceptual phase, while educators face the challenge of balancing free-creative leeway and inducing a certain sustainable solution. Addressing these gaps requires a cultural and curricular shift toward treating sustainability not as an external constraint but as an inherent design opportunity, one that enhances rather than limit creativity and innovation.

Introduction. The profession of product design is currently undergoing a profound transformation, and this transformation is directly influenced by the way in which design education shapes its students. For instance, the history of design, as it is traditionally taught, often privileges iconic objects of modernity, many of which were conceived in a context where sustainable thinking was not a central principle. This aspect often generates a first level of confusion among students, who tend to idealize historical models and aspire to reproduce them *"at any cost,"* without realizing that, under current conditions, the *"cost"* can be a significant ecological one. In light of these tensions, it is necessary to reevaluate the premises of initial design training so that the values perpetuated through education reflect contemporary realities and responsibilities.

This article starts precisely from this discrepancy between the disciplinary tradition and the demands of the present, proposing an analysis of how sustainability can be organically integrated into educational practice. The approach investigates the impact that pedagogical structures—workshop projects, formative assessments, case studies, and exposure to current industry examples—have on how students internalize sustainable thinking.

Instead of introducing sustainability as an external criterion, applied belatedly or forcibly, the article argues that it should be understood as a fundamental principle of the design process, present in all stages: from problem definition to concept, prototyping, materiality, production, use, and end-of-life scenario. From this perspective, education becomes the privileged space where future designers can learn to combine creativity with ecological responsibility, without perceiving the two dimensions as antagonistic (but rather as part of the same whole).

In this sense, the article examines both the effective pedagogical methods implemented in university product design programs and the recurring challenges that prevent a deep integration of sustainability: from the tendency of students to limit sustainability to the choice of recycled materials, to the lack of technical resources, time, or updated cultural references. The analysis proposes a series of directions for strengthening an educational culture in which sustainability becomes a permanent cognitive filter and a critical evaluation criterion. At the same time, by reconstructing these formative practices, the possibility of rewriting a part of design history emerges — not by denying the iconic objects of the past, but by reinterpreting them in relation to contemporary imperatives and by training a new generation of designers capable of producing the *"iconicity"*