

CONSIDERING THE FUTURE OF INFRASTRUCTURAL HERITAGE

DOI: https://doi.org/10.18485/arh_pt.2025.10.ch73

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ABSTRACT

Keeping up with trends in techno-ecological strategies for the future development of cities, industrial archaeology reveals a new paradigm that we may not be fully aware of. Infrastructural heritage, namely railways, iron bridges, etc., as relicts of the industrial past, juxtapose two different characters. On one side, they represent glorious evidence of human progress, and on the other, evidence of the ecological degradation of the environment. Therefore, their perception as cultural heritage or, better said, the legacy they convey is contested and in question. In the spirit of the cyborg society to which we belong, burdened with a task to recreate, reuse, recuperate, remediate and reassure a sustainable environment, it is necessary to reimagine a way of looking at and understanding the future of infrastructural heritage. Instead of seeing them as mere monuments of the past, they could become active participants in the techno-ecological recovery of the urban environment. In the surroundings of the Design Studio, project research was conducted on the case study of the Old Railway Bridge in Belgrade. Together with master's students, we sought different architectural narratives that could generate hybrid naturalities in the urban environment. Architecture is understood as a tool through which biotic and abiotic merge, opening a series of broader critical themes of ecologically based design. Results offer a wide perspective of traces overlapping nature and culture, producing new complex urban-ECO-logics.

KEYWORDS _ *Cyborg society, Industrial heritage, Urban ecosystem services, Old Railway Bridge in Belgrade*

INTRODUCTION

If we are to create a maintainable future, we must change how we perceive architecture, its role and purpose. We must transform our practice, and as a prerogative, we have to change the course of education by infusing and deeply understanding both – ecology and technology. We must focus on problem-based design tasks, teach critical and reflective thinking strategies, and open our discipline towards other disciplines and out of the scalar perception. Wicked problems that occupy today's research community bridge conventional scientific and design disciplines, interlacing principles, knowledge, scales, and tools (Lönngren & Svanström 2016). They can be solved only in collaboration and through out-of-the-box thinking. To incorporate and integrate ecology and technology into design thinking and fuse their protocols, we are obliged to mirror their deep interconnections in our epistemology of design.

In light of global urbanization and climate change, and in line with the techno-ecological approach, the remnants of city structures have become a valuable field to experiment with more resilient forms of urban infrastructures. Finding new paths for a sustainable future goes through experimentation, which represents the first step to adaptation strategies. Keeping up with techno-ecological trends for the future development of cities, industrial archaeology reveals a new paradigm that we may not be fully aware of. Infrastructural heritage, namely railways, iron bridges, etc., as relics of the industrial past, juxtapose two different characters. On one side, they represent glorious evidence of human progress, and on the other, evidence of the ecological degradation of the environment. Therefore, their perception as cultural heritage, or better say, our legacy is contested and in question.

The classical approach in architectural and urban design is seen as a technological feature that conquers nature or, at its best, is embedded in it. Nature is seen as a background, a picture, and scenery, while architecture is seen as a "machine for living". The best possible example might be Mies van de Rohe Farnsworth's house – a technologically advanced, artificial creature placed in the middle of nature, naked and blunt (Rocheleau 2024). The environmental crisis can be regarded as a design crisis in the sense that the consequences of our designs, constructions, and uses ultimately affect our understanding of the environment. Design, as a manifestation of culture, is in turn based on our system of values and beliefs, thus rendering the epistemology of design incompatible with that of nature. Nature's processes are inherently scale-linked, as they are intimately dependent on the flow of energy and matter across scales. Nature's inherent qualities of generativity and scalability foster adaptability and integration. Conversely, the processes of building and constructing operate within a confined scope, constrained by predefined disciplinary languages and instruments. This results in stability within the confines of space and time, leading to degradation and singularization. To address these challenges, it is imperative to integrate human mono-scalar and uni-disciplinary practices with nature's multi-scalar and multi-disciplinary design principles. The central objective of this discourse is to explore the potential of architectural design to establish connections between nature and culture.

The article is divided into three parts. The first positions the techno-ecological approach through theories of ecological design and cyborg society. The second explains the context, process and results performed with students and analysed through a specific set of attributes that were grounded on the first theoretical background. The last part in discussing results envisions possibilities and obstacles burdening the future of architectural and urban design, giving special attention to education guidelines.

THEORETICAL BACKGROUND

The overall message of Felix Guattari in his book *Three Ecologies* can help us situate the contemporary nature of ecology, encompassing not only environmental concerns, but also social relations and human subjectivity. His *ecosophical* approach is a base for our research emphasizing the importance of understanding the interconnectedness of environment, social relations and human subjectivity to address ecological issues effectively (Guattari 2014). If we are to understand the overall framework

of the approach, we have to go back to Christopher Alexander and his book “The Nature of Order”, connecting disciplines and scales in extraordinary living system structures that operate on various levels and adapt to a variety of contexts (Alexander 2002). If we are to understand the process of the techno-ecological perspective of process designing, we have to perceive it as Buckminster Fuller in “Synergetics: Explorations in the Geometry of Thinking”, offering a unique perspective on understanding complex systems and emphasizes the importance of holistic thinking and design science in addressing global challenges. Synergetic refers to changes in the geometry of thinking, implying new patterns of thought where interconnectedness between different elements and systems influences each other and focuses on problem-solving instead of generalizing design strategies (Fuller 1982). If we are to contextualize the connection between technology, nature and culture we have to understand the message Reynar Banham sends us in his provisional book “Los Angeles: The Architecture of four ecologies” where he argues that urban design should integrate ecological principles but also emphasising techno-ecological approach i.e. introducing advanced technology to minimize negative and enhance positive effects of urban living processes (Banham 2001).

Ecological perspective

In relating ecology and urban planning through the phenomenon of the urban environment, urban ecology emerged prioritizing the development of a unique set of urban ecological principles (Duvigneaud 1974). After Rio’s environmental agenda, urban ecology was redesigned in line with sustainability goals (Alberti 2008; Breuste et al. 1998) rendering towards sustainable urban development (Weiland and Richter 2009). The main issue was redefining the role of human activity in urban ecosystems. Instead of seeing humans as mere disruptors, they were recognized as both limiters and drivers of ecological processes (Marcotullio et al. 2003). As humans act primarily through culture (Borer et al. 2000), i.e. building and constructing, design became the primary focus of urban ecology, waving towards ecological design. Ecological design, understood as a component of urban ecology and distinctly anthropocentric in nature, presents three pivotal perspectives: conservation (exercising restraint in expenditure and recycling natural capital), regeneration (restoring ecological balance), and stewardship (promoting responsibility towards other living creatures and the landscape) (Van Der Ryn & Cowan 1995). The design proposal is explored as a living system, wherein nature, technology, and culture are intertwined creating a unique synthesis (Ecosystems and Human Well-being: Synthesis : a Report for the Millennium Ecosystem Assessment 2005).

Techno-ecological approach

Embracing an ecological perspective in architecture involves the use of various technologies and design approaches justified through the representation of sustainable places. The integration of technological innovation is logical and in line with a technologically tailored digital society. The current trend of technologization and digitalization of society is opening a whole new relationship between humans and their bodies. The lines between being a biological creature and using technology, which was once clear, are now blurred. These technologies are becoming a part of our lives in such a deep way that we don’t even notice. This has led to the creation of a fascinating new world—a *cyborg world* that seamlessly integrates the natural, the social, the technical, and the cultural, without clear boundaries, centres, or margins (Swyngedouw 2006). Nature and the city become interconnected hybrids facilitating the flow of ecological systems in-between.

The techno-ecological approach is defined as any form of technologically advanced and aware design that minimizes environmentally destructive and maximises its positive impact by integrating it with urban living processes. It is a responsible approach that places ecology in the foreground of design (reducing pollution, preserving habitat, fostering community, and enhancing health) with the help of advanced technology. Founded on the theories of Alexander, Fuller and Banham, it searches for patterns

in a spirit of well-known Wendell Berry's "*spirit of searching for patterns* where every new solution causes a ramifying series of new problems, the only limiting criterion being, apparently, that the new problems should rise beyond the purview of the expertise that produced the solution" (Berry 1981).

The techno-ecological approach follows a framework of urban ecology and is based on principles of ecological design focusing on adaptation and integration through the application of advanced technologies. It is multidisciplinary in nature, understanding technology as a support of natural processes, its remediation and recuperation support – a life support system ultimately transforming the way we think about architecture and our place in life on the Earth. It is no longer possible to meaningfully divide ecological flows and technological systems, creating a new cyborg urban infrastructure with which new urban materiality is managed (Banham 2001).

MATERIALS AND METHODS

Rather than questioning the overall problem of the city in crisis, this paper understands a world in constant flux. Crisis and change are inevitable resilient processes where individuals, communities and cities simply have to fit in and adapt. This neoliberal framework is probably needed if experimentation is in question. Non-equilibrium is a new complexity in which non-linear balance follows this techno-ecological perspective creating a cyborg creature, a subject that simultaneously pertains biotic and abiotic elements, emphasising resilience and adaptive learning to urban sustainability in the face of ecological crisis and climate change agenda. Abandoning the modernist dream of total control, this paper discusses the possibility of small-scale experimentation having a large-scale benefit for the city and society, i.e., the unplannable and unpredictable future nature of cities.

In the spirit of the cyborg society to which we belong, burdened with a task to recreate, reuse, recuperate, remediate and reassure a sustainable environment, it is necessary to reimagine a way of looking at and understanding a future of infrastructural heritage. Instead of seeing them as monuments of the past, they could become active participants offering a window on the role and scope of placemaking through REuse strategies in the field of cultural heritage management. Within the context of protection and reuse of infrastructural heritage, novel techno-ecological design is supposed to prompt radical transitions testing out different logics (Hodson and Marvin 2007), through the concept of parasite and prosthesis, networking bodies and environments, unstable in form and function, whose membrane enables simultaneous merging of architecture and nature. It is in the immediate relation to environmental conditions – an Environmental Support System (Nikezić 2022).

In the surroundings of the Design Studio, the project research was conducted on the case study of the Old Railway Bridge in Belgrade. Together with master's students, we sought different architectural narratives that could generate hybrid naturalities in the urban environment. Architecture is understood as a tool through which the present is questioned, and the future is built, opening a series of broader critical themes of ecologically based design, touching on the city's economic, ethical, societal, and other values and practices of hybrid natures in which biotic and abiotic merge.

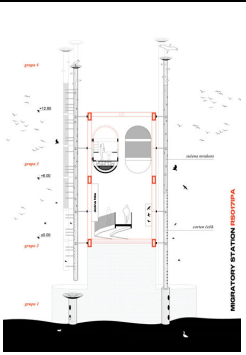
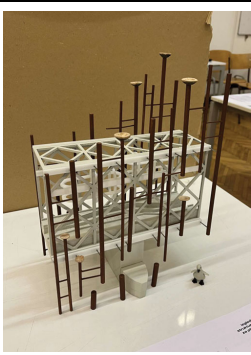
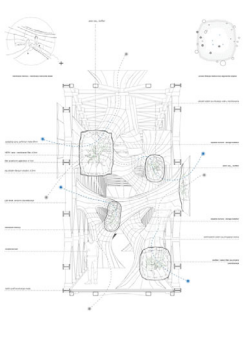
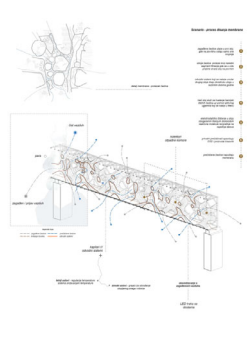
Old Railway Bridge in Belgrade

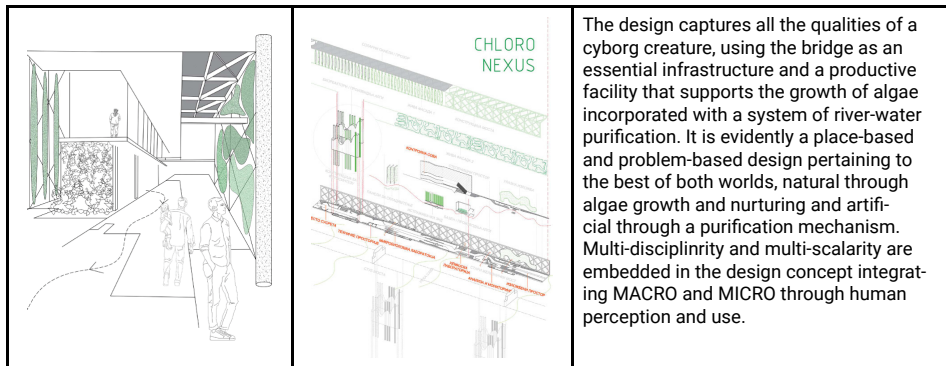
Along the path of the Orient Express, a road toward a developed Europe, the Old Railway Bridge in Belgrade was built in 1884 (Most koji je Srbiju šinama spojio s Evropom [The Bridge That Connected Serbia to Europe by Rails], 2019). The dimensions of this urban landmark that has persisted for over 140 years on the Sava River are approximately 377 meters in length, featuring a single railway track and a height of around 12 meters. However grand structure is not the main characteristic that gives meaning to this urban spot. The broader context of historical, cultural, social, and geopolitical frameworks certainly defines the bridge as a significant heritage asset. It belongs to the category of industrial heritage as part of Industrial Archaeology—the branches of science that explore human

modernization, progress, and social development in the more recent past from the era of the Industrial Revolution. This bridge was demolished and reconstructed multiple times due to the circumstances of the world wars, so we can say that this history of discontinuity and revival represents the cyclical life of the mega-structure. The aim of the student project proposals precisely goes in the direction of emphasizing its resilience and ongoing transformation, giving new life to this object in the contemporary realm.

Results and discussion

Leaning on the theoretical background, designs were analyzed through a set of attributes following the techno-ecological perspective. Leaning on fundamental principles of ecological design, multi-disciplinarity and multi-scalarity emerge as major important principles. Place-based and problem-based design approach has to be followed with regard to socio-ecological benefits (conservation, regeneration, or stewardship) and the application of advanced technology. Designs have to be adaptive, engaging, and resilient, proposing integration in the overall context with an emphasis on the inherited structure and the enhancement of ecological but also urban processes.

Migratory Station (student: Aleksa Vučković) The bridge is considered as a temporary habitat for migratory birds, along the annual migration.		
 		The design demonstrates a highly developed concept in the ecological sphere, also carrying a high level of cultural wealth, educating people on bird species passing through the city. The bridge is both a bird's habitat and an observation platform. In connecting architecture, ornithology and ecosystem services agenda multi-disciplinarity is achieved. In providing simultaneous presence for a variety of bird species and visitors, multi-scalarity is assured. It is a place-based and problem-based design based on researching routes and resting places for birds in wider and narrower areas. It is adaptive, offering an infrastructure for birds' nesting and resembling their natural habitat.
Membrane memory (student: Sladjana Lukić) The bridge becomes a massive filter membrane operating on the principles of Bernoulli's tube.		
 		Design pinpoints pollution problems, and is interesting from the perspective of technological advancement, as a form of 'cyborgization' of cultural heritage. On the premise of being positioned on natural wind currents, the bridge becomes a system that purifies polluted urban air. In addition, it holds the aesthetic and sculptural value of a new urban landmark. In this way, the concept is multi-disciplinary in terms of connecting engineering, ecology and architecture, multi-scalar in providing ecosystem services in various scales and adaptive and resilient, focusing on a diversity of capturing, stimulating wind flows through geometry/shape and materiality.
CHLORO NEXUS (student: Emanuela Ilić) The bridge is envisioned as a cyborg factory producing algae and purifying river water.		



In the group of 12 students, results offer a wide perspective of traces overlapping nature and culture, producing new complex urban-ECO-logics. From those offering experimental platforms for the improvement of ecological services of the place to those focusing on wider socio-ecological problems of awareness, responsibility and understanding towards both ecological and built legacies of the place. It is interesting to note that it was almost impossible to target ecological and cultural agendas at the same time. One will always prevail in speaking in favour of the fact that it is difficult to change the geometry of thinking. We have decided to present the most successful examples that put the idea of a cyborg creature at the forefront of the concept.

DISCUSSION and CONCLUSION

Provided design illustrations demonstrate the necessity of experimentation in architecture as a foundation for a design that incorporates elements of the environment and addresses contemporary urban problems. Multi-disciplinarity serves as a unifying principle in design, emphasizing the value of sustainability and ensuring multi-scalarity, which facilitates systematic observation of the city as a living organism rather than as a static landscape. In this context, resilience is not merely a development goal in itself, but rather, it is manifested in the process of addressing individual problems through small-scale projects. The techno-ecological approach fosters an environment conducive to problem-based learning, where analytical design and creative thinking are interlaced, and where critical thinking is prioritized within an interdisciplinary design framework.

This approach enables students to comprehend the dynamic role of heritage in shaping our environment. Their relationship to heritage transcended mere observation, delving into the domain of understanding heritage as a subject of environmental change. The role of architectural practice as a mediator of the ecological system and its services has instilled a sense of responsibility in students, who, in turn, have become cognizant of their potential role in creating a better society.

Reused infrastructure, a technological creature supporting ecological services, can communicate between the city and society, between man and the environment, mediating everydayness and targeting ecosystem problems. It is flexible, movable, changeable and adaptable, a sort of environmentally responsible and socially aware assistant house. In terms of organization, it is an interactive network of things, spaces and people enabled, a sort of soft-smart house. In terms of culture, it is a supervised digital life-support system, a sort of healer organism that fuses technological and biological parts into a unique urban ECO-logic.

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