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Innovation, green infrastructures and urban form

Towards regenerative city models

In the contemporary global context—characterized by increasing environmental pressures, demographic asymmetries, and socio-economic fragmentation and structural inequalities—the relationship between urban form, ecosystem services, and territorial innovation acquires unprecedented strategic value. This Special Issue intends to critically explore and foster a new interdisciplinary debate aimed at rethinking the urban project within a framework of regenerative and systemic transformation.

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Civic Seoul 2030: toward infrastructural renaturalization

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Abstract
Citizens play a crucial role in shaping cities, balancing rights and responsibilities in public and private spaces. The concept of civic ethics involves finding a common identity within diverse individual differences and promoting sustainable urban ecosystems. Despite economic growth and formal democracy, residents of Seoul may not yet fully embrace this civic identity. Civic ethics call for a more integrated approach to city living, emphasizing values such as autonomy, empathy, diversity, and ecological awareness. Seoul's future development will be influenced by global trends in urbanization, requiring the city to adapt and plan strategically. The Metropolitan Government of Seoul is focused on inclusive growth, developing new engines for growth, and responding to changing demographics, but simultaneously on a process of decarbonization and renaturalization. To create a vision for 'Future Seoul,' the city is analyzing successful urban strategies from around the world and considering innovative approaches like a 'Civic City Seoul' model. In the light of a series of preliminary research, a number of architects are invited for our 'Underground' and 'Superground' projects. These projects reexamine various urban systems which used to be regarded as monofunctional and with a strong characterization related to urban renaturalization processes.

Keywords
Urban regions; Green networks; Territorial innovation

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1. Metropolitan renaturalization processes

Modern cities face unprecedented challenges: climate change, biodiversity loss, pollution, and a growing demand for green spaces for the well-being of citizens. In this context, urban renaturalization emerges as a promising strategy to address these challenges and improve the quality of life in urban areas. This essay explores the concept of urban renaturalization, focusing in particular on the transformation of existing infrastructure into natural corridors and its integration with public transportation systems and slow mobility. Urban renaturalization can be defined as the process of reintroducing natural elements within the urban fabric, often through the transformation of spaces previously dedicated to gray infrastructure. This approach not only aims to improve the urban environment ecologically, but also to create multifunctional spaces that can serve as both habitats for flora and fauna, recreational areas for citizens (Pirselimoğlu Batman et al., 2024), and corridors for sustainable mobility (Artmann et al., 2017), emphasizing the importance of integrating smart city growth with green infrastructure, creating a conceptual framework for compact, green cities. Early renaturalization initiatives focused primarily on the creation of urban parks and the restoration of isolated green areas. However, the contemporary approach has evolved toward a more integrated and systemic view that considers the city as an interconnected ecosystem (Pincetl, 2017), in fact, analyzing this historical evolution, highlighting how current urban renaturalization strategies are the result of a process of learning and adapting to emerging environmental challenges.

Fig.1 Strategic structure of the Civic Seoul renaturation project plan

The paper aims to retrace the choices made by the city of Seoul following the renaturalization of the Cheonggyecheon River, with the 'Civic Seoul' project (Fig.1) and the 'Superground' consultation and 'Underground' competition, projects in which the authors were variously involved. The very Cheonggyecheon River renaturalization project in Seoul, South Korea, completed in 2005, was a globally significant point of the

concept of renaturalization possibilities. This project involved the demolition of an elevated highway and the restoration of the river below, creating a linear green corridor in the heart of the city. The success of this intervention has inspired numerous similar projects around the world, demonstrating the potential of large-scale urban renaturalization.

Cities like New York, Paris, and Singapore have undertaken similar projects, each with unique local adaptations. For instance, the High Line in New York City has transformed an abandoned elevated railway into a public park, while Singapore's Park Connector Network offers a series walkways linking various parks and green spaces. These projects demonstrate the potential of elevated spaces to create new urban ecosystems, improve air quality, and provide residents with opportunities for recreation and social interaction. As cities continue to grow and evolve, renaturalization spaces are likely to become an increasingly common feature of the urban landscape. By learning from the experiences of cities like Seoul, New York, and Singapore, urban planners and designers can create more sustainable, resilient, and equitable cities.

2. Challenges for a social and re-nature Seoul metropolis

Throughout history, cities have grappled with urbanization. Seoul, like many others, underwent rapid growth since the 1960s, but has now reached a turning point. This presents an exciting opportunity to embrace the city's existing natural beauty, integrating historic development patterns with fresh approaches.

Moving past rapid expansion, Seoul, alongside other established cities, prioritizes human-centered urban regeneration. This strategy seeks to resolve past growth challenges while fostering organic development suited to the present. Additionally, Seoul faces the impact of transportation advancements, a changing demographic, and increased tourism – unprecedented issues requiring innovative solutions.

As cities mature, traditional urban planning approaches may reach their limits. Seoul is exploring architectural solutions as a lens to evaluate its future goals. This approach emphasizes the role of architecture within a broader urban design framework, recognizing buildings as interconnected with the city's fabric.

Citizens are individuals who possess both rights and responsibilities. As cities are spaces that serve both personal and public needs, citizens play a dual role as both inhabitants and contributors to the city's vitality.

The public realm exists between the private and social spheres. This means that public spaces require a balance of individual rights and collective responsibilities. Citizens must navigate this tension, embracing both personal interests and a sense of civic duty. As urban dwellers, citizens seek safety and security within their homes while also recognizing the need for compromise and cooperation with others. This involves balancing individual desires with the collective good. Citizens are expected to participate actively in their communities, communicate effectively, and work together to achieve shared goals. However, this often requires harmonizing seemingly contradictory demands, such as individuality and community, autonomy and cooperation. However, citizens come to establish a common identity within their respective identities as they accept and respond to such contradictory demands, and such a civic identity forms the center of the commonality, complexity, diversity, and organicity of urban spatial systems and prompts cities to function as immense and complex ecosystems. Of course, here also is the issue of the individual differentiation of various factors stemming from differences among individual citizens in class, gender, culture, education, experience, and geography. In addition, the differentiation of such individual differences and such complexity in themselves comprise the heart of urban ecosystems. These ecosystems signify the urban systems for survival, and efforts for the preservation and sustainability of urban ecosystems therefore become minimal morals indispensable to the maintenance of cities. They can also be termed an ethics that citizens must hold as the subjects of cities, and it is precisely here, too, that urban discipline meets civic ethics.

Despite a process of advanced economic growth and the establishment of formal democracy, it is difficult to say that the residents of Seoul as a megacity have sufficiently recognized or been trained in an ethics as co-subjects living together in common space. In general, citizens hitherto have tended to remain either capitalist

persons who pursue economic rationality and clearly recognize and claim private ownership or institutional subjects of formal democracy as represented by a sense of legal rights and political franchise, and these two identities have been divided or partly integrated according to the circumstances. Civic ethics signifies a more active and natural integration of these two identities, and such integration request citizens to grow into more creative and mature beings by rejecting and overcoming these two characteristics, which they currently harbor. Civic identity rejected as urban subjects signifies: thinking about Seoul not as an aggregate of fragmented individuals' efforts to survive without support but as a community of 'co-beings' living in common space (Bocca, 2021); pondering on what lies between the private sphere and the of social sphere; harboring humanistic values based on common identity including intellect, autonomy, coexistence, empathy, consideration, sense of responsibility, diversity, openness, and an ecological perspective; and having respect for the democratic values of engagement, communication, cooperation, solidarity, sharing, organicity, and peace. In addition, this implies the paradigms of urban planning for 'Future Seoul' beyond Seoul as a city of advanced growth based on economic rationality and Seoul's current identity as a symbol of square democracy (democracy prompted by demonstrations in open squares). Paradigms of 'Civic City Seoul' as well (Hae-Won et al., 2018). In the background of the task pursued by the Metropolitan Government of Seoul under the title of 'Future Seoul Tasks' lie the comprehensive awareness and long-term vision that the excavation of future leading projects and policy tasks for Seoul's sustainable growth is directly linked to the safety and prosperity of the Republic of Korea. The City of Seoul understands future tasks largely on the levels of inclusive growth, development of new growth engines, sustainable resilience (Shirgir et al., 2019; Palermo et al., 2024), responses to population changes and are creating related detailed execution plans. Consequently, the Basic Survey for the Urban Visions of Civic City Seoul presents specific strategies for urban spaces: grasping the complexity of the spaces encompassed by Seoul; analyzing the visions of major cities worldwide; deriving universal paradigms; and then proceeding toward 'Civic City Seoul' based on the zeitgeists of 'Civic Communities,' 'Condensed-sharing City,' and 'Ecological-humanistic City.'

According to studies forecasting the future of cities, cities in the future will encounter a reconfiguration of spatial, environmental, and social conditions that is utterly different from what has hitherto been experienced. In a situation where such changes in paradigms of urban development are accelerating, Seoul needs to overcome existing practices, to establish new perspectives on the strategic direction of urban and architectural policies reflecting changes in social structures, and to plan tasks accordingly.

Indispensable to preemptive discussions on the strategic direction of the urban and architectural policies of 'Future Seoul' is the advance construction of the basic data. In addition, it is necessary to examine urban strategies pursued from long-term perspectives in places including London, New York City, Paris, Catalunya, and Brussels as well, to look at the problems and strategies of cities worldwide together with Seoul's problems from multiple angles, to investigate advanced cases, derive new perspectives through active exchange, and to construct competitive basic data through discussions on international levels. Accordingly, the direction of future tasks will be established by analyzing the factors of change in urban environments that will affect 'Future Seoul' through the comprehensive collection and survey of the basic data on the internal and external elements surrounding 'Future Seoul' and the architectural strategies of major cities abroad and deriving future visions that will lead exploratory visions of mid- and long-term urban management policies and the transformation of urban policy paradigms.

2.1 Civic Seoul. Looking for n-scenarios

The next generation of urban planners will be challenged to find solutions to complex problems related to population, energy, environment, food, water, security, housing, health, and transportation. But also, to a rational land-use, a sustainable growth and infrastructural development, a new kind of conception of the public space, etc. Its challenge will be to provide new strategic scenarios no longer productive or reproductive but

'co-productive', capable of generating open and intelligent models, orientated and co-participated at a time, from which address, that talk about the new main global topics, substantial in the contemporary cities approach.

Fig.2 Schematization of all 10 paradigms of the Civic Seoul project in one scenario

The contemporary urban landscape is undergoing a profound transformation, marked by several key trends. One such trend is the emergence of new territorial articulations, leading to a renewed emphasis on re-naturalization, landscape valorization, and sustainable land-use practices. Simultaneously, public spaces are evolving into dynamic, interactive environments. The proliferation of sensors and real-time data applications is reshaping public interfaces, fostering new forms of civic engagement and participation. The concept of mobility is also being reimagined, with a focus on efficiency, speed, and slower, more contemplative modes of transportation. This shift is accompanied by a rethinking of infrastructure, leading to the development of integrated and sustainable models. Urban recycling and the reuse of existing structures are gaining prominence as strategies to reduce environmental impact and promote sustainable development. Moreover, there is a growing emphasis on mixed-use development, which involves the integration of various functions and programs within a single building or urban block.

Sustainable agendas, including energy self-sufficiency and resource management, are driving the development of eco-habitats and resilient urban systems. Cities are increasingly adopting flexible and adaptable strategies to withstand future challenges and ensure long-term sustainability. Coastal and riverfront areas are recognized as valuable assets, and their revitalization is seen as a key driver of urban regeneration. The tourism industry is also experiencing significant growth, driven by the increasing demand for leisure and cultural experiences.

Finally, the intersection of culture, innovation, heritage, and creativity is emerging as a powerful force in shaping the future of cities. By fostering these elements, cities can attract talent, investment, and visitors, and enhance their overall quality of life.

The Civic City Seoul urban spatial strategy (Fig.2) comes from the combination of the city urban system analyzed in the spatial resources section of the city. In principle, Seoul should be classified according to urban system classification in city area / natural area / infrastructure area / watershed area, and strategy appropriate to each area of unnatural territories (Canessa, 2021) should be applied. Urban spatial strategy defines the type of site or type of implementation as four single strategies:

- Central District | Target: It is a strategy that can be implemented intensively in the high-density area of Seoul. It aims to connect urban spaces of diverse character and lead new vitality and practice (Fig.3);
- Nature | Border: The goal is to create a city filled with vivid scenery, where urban elements and natural elements are intertwined by a strategy that can be implemented in the boundaries of Seoul and the surrounding countryside, or the boundary of Seoul and the city (Fig.4);
- Infrastructure | Clip: It aims to link various city infrastructure facilities such as bridges, transit, passage, park, and square in the fragmented city of Seoul, and to have an organic context at the whole city level (Fig.5);
- Water | Platform: The platform aims to extend and overcome Seoul's limitations through the transformation of perceptions of waterfront areas. Rather than introducing one functional element at the facility level, the platform sees the watershed as an alternative expansion of urban functions and plays a role of the integrated function of the city (Fig.6).

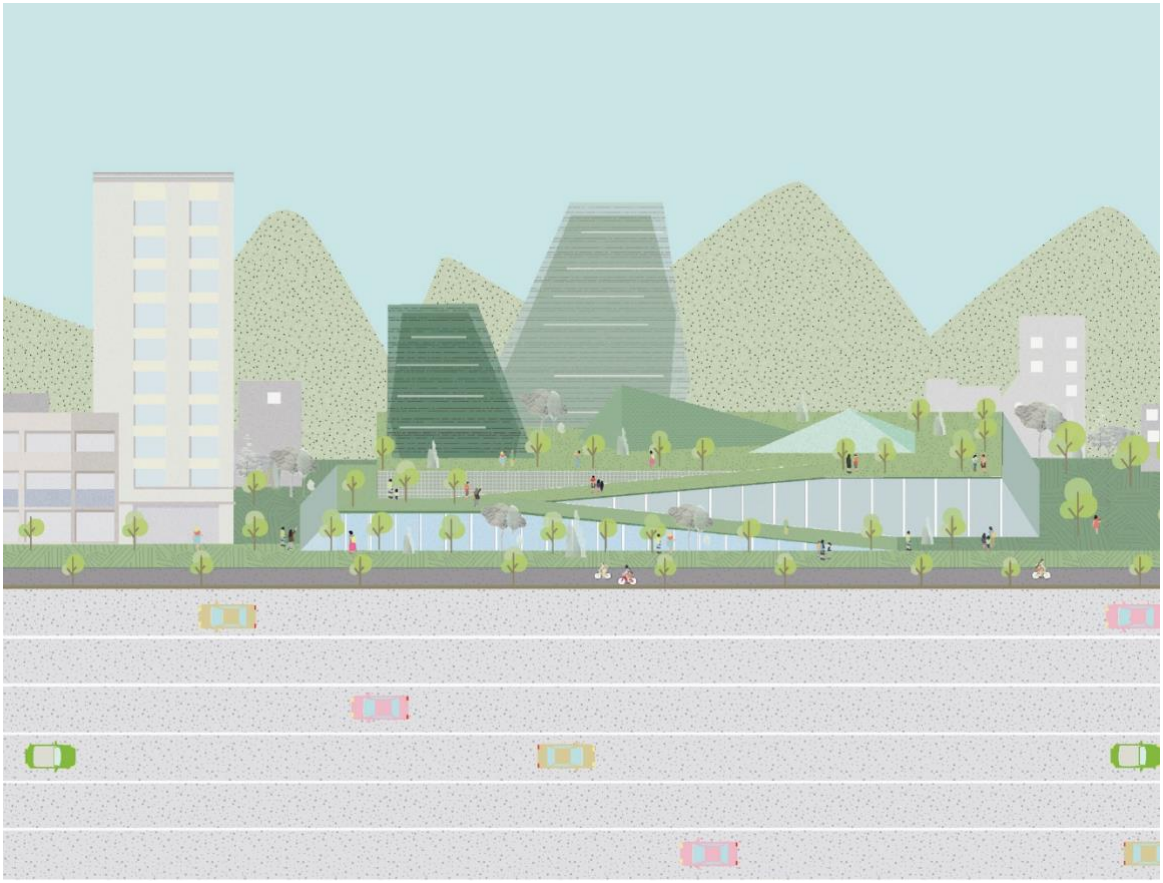

Fig.3 Central District. Simulation of a Target intervention

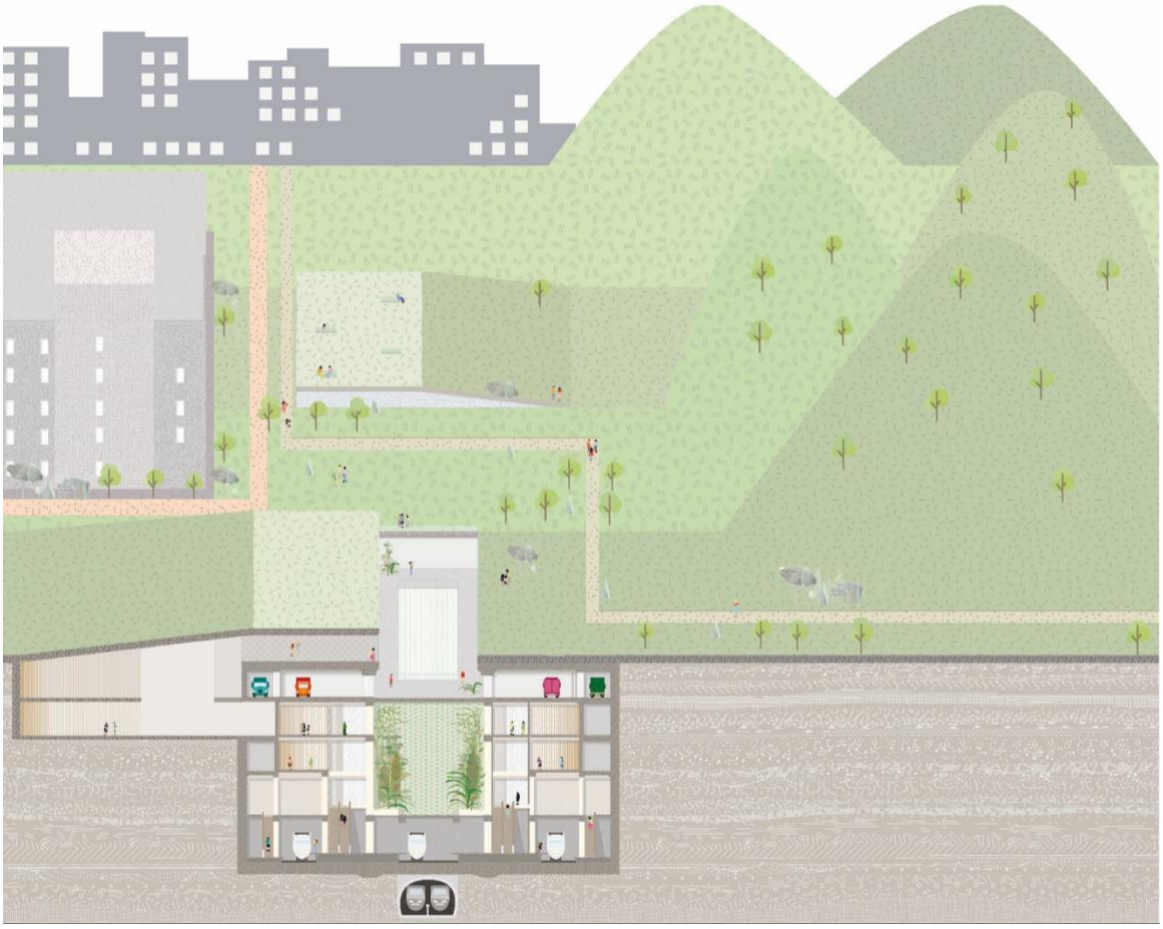

Fig.4 Nature. Simulation of a Border intervention

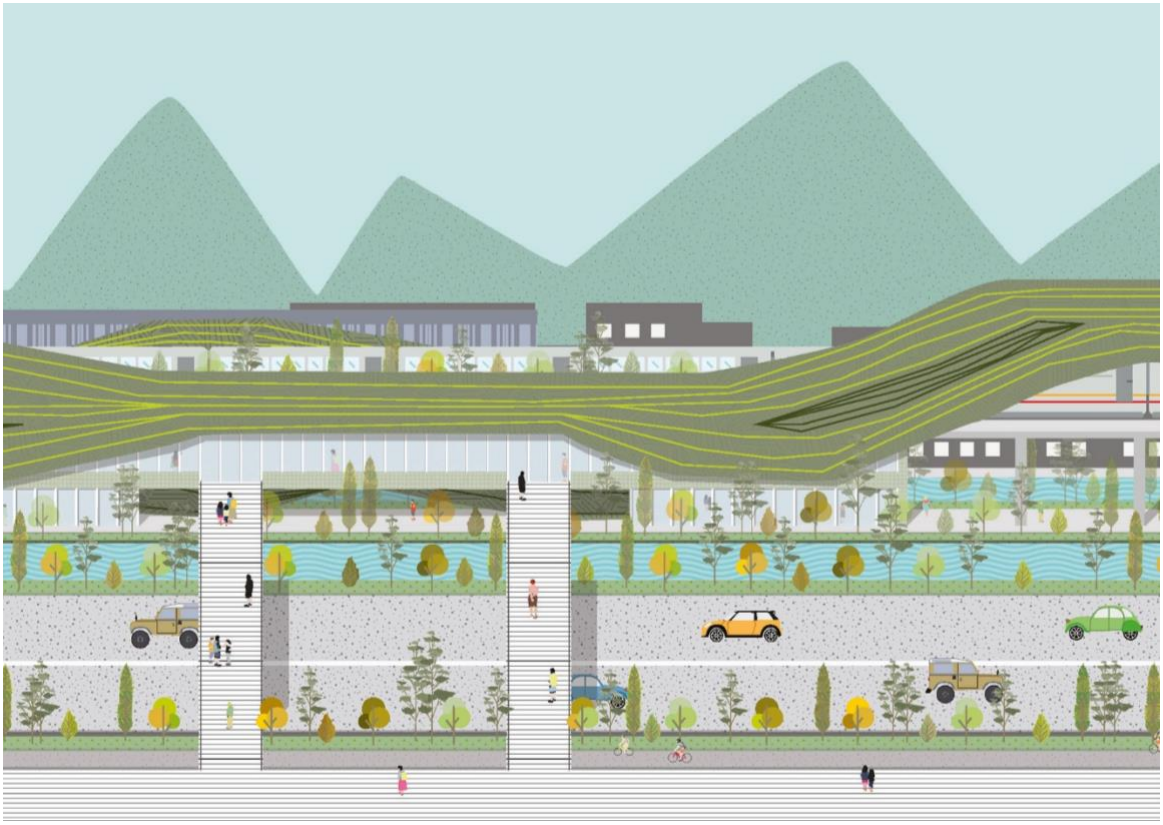

Fig.5 Infrastructure. Clip intervention simulation

Fig.6 Water. Simulation of a Platform intervention

2.2 Civic Seoul. Looking for n-scenarios

The 'Civic City Seoul - Ten Paradigms', which emerged from the study of the major cities in the world, are the local interpretation of various specific conditions that make up the identity of Seoul. These paradigms can be a basic principle of urban planning that can be applied to make Seoul a civic city, where the concepts of civic citizenship and renaturalization are forced into the context of a multi-scalar city like Seoul.

The last few decades have confirmed the evidence of a spectacular change of scale -and thinking- in the definition of our spaces of exchange and sociability -of our own habitats- to do with the exponential increase in mobility, (hyper)connectivity and long-distance communication, the delocalization of exchanges, and the capacity for technological and material transformation of our environment. But also, with the capacity to process and interact complex and digital parameters of information. Not yet, working 'from' complexity in order to simplify its effects, but working 'with' complexity in order to celebrate its potentials. Today, we are present at a change of paradigms in architectural thinking: from an architecture based on a static logic we have moved -or are moving- towards an architecture based on a dynamic and 'irregular' logic-one that is more impure, irregular and definitively interactive-in interaction with an environment, a context, a society and a creative and scientific culture permanently attentive to the diversity and complexity of a definitively informational space-time. Transversal and multi-scalar. The contemporary interest in tackling transverse fields involving urbanism, architecture and landscape responds to the interest in moving between boundaries, logics and scales (to recognize and to transgress them) but also to understanding architecture as a relational environment rather than a mere formal or functional object, with all that this implies in terms of constructional and interpretative, planning and (why not?) narrative interaction in and with the environment. Intersecting settings in which authenticity does not reside, then, in some kind of essentialist basis but in that open-ended process of interchange and interaction intended to work, at the same time with synthetic registers more than

with analytical layout n-scenarios (Fig.7): Urban and Natural Multi-Habitat; Participatory Civic City; Multi-centered Communicative Infrastructures; Sustainable Spatial Ecosystems; Reviving the City; Condensed – Common City; Resilient Urban Environment; Multilayered Boarder; Citizen-centered Tourism; Dynamic Cultural Heritage.

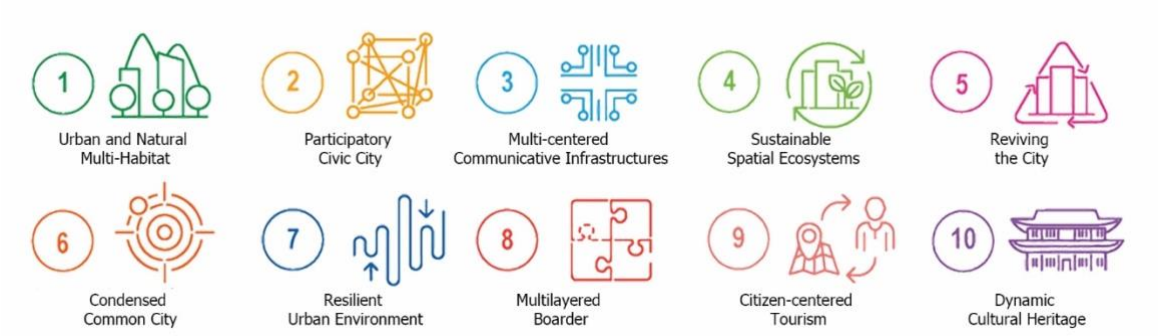

Fig.7 The 10 paradigms of the Civic Seoul project

2.3 Superground vs Underground

There exist indispensable infrastructures for a city to work properly. Currently, these infrastructures exist only to fulfill their functional purposes and are occupying huge areas in Seoul. Also, most of them are bringing isolation or disconnection to their neighborhood. However, today's advanced technology is helping them to explore possibilities for integration, complexation and going underground, and they have come to discover potential as a place to study new urban values. This research project has selected 20 sites for architectural and urban experiments to make Seoul into a city of people for the 21st century (Gausa, Joon, 2020). Some of these were assigned to teams of architects[1] to experiment with specific solutions and others were submitted to competitions such as the one won by Dominique Perrault Architecture to design the Gangnam International Transit Center.

In the light of a series of preliminary research, a number of architects are invited for our 'Underground' and 'Superground' projects. These projects reexamine various urban systems which used to be regarded as monofunctional. They look into underground spaces and infrastructures which were isolated from urban structures, with an aim to complement existing urban systems and prepare for the future. Though their discussions are around specific sites in Seoul, the ultimate goal is to find a universal solution applicable to other cities around the world.

The selected 20 sites can be classified into various categories such as size (XL, L, M, S), shape (Strip, Spot, Node) and type (Rail, Road, Water, Green, Waste).

The projects for each site are expected to be combination of following factors: Paradigm and Program. Among 10 paradigms for 'Civic City Seoul', some more than one, even all the 10 paradigms must be condensed in every site, evaluating the different degree of a percentage by each participant. In the same way each participant must evaluate the percentage to be attributed to each of the 4 Programs (Living Spaces, Convivial Spaces, Production and Exchange, Knowledge and Leisure).

Is easily recognizable a game of transitions, made by transits by and from 'territory to city to place and then to project': from the exploration of new types of evolutionary devices called to combine information and conditions, programming and formulations, into new maps of analysis and synthesis at the same time. The goal of this 'strategic-expressive' methodology is to re-evaluate urban reality analyzed, re-activating it from its

[1] AZPML, Eduardo Arroyo — NO.MAD, Chanjoong Kim, Eun Young Yi, Studio Fuksas (Massimiliano and Doriana Fuksas) + Ramon Prat Homs, Go—Up Architects, Haewon Shin, Alejandro Haiek Coll, Minsuk Cho – Mass Studies, Willy Müller – WMA, NL Architects, Seung H-Sang, IROJE architects & planners, Francis Soler, It's, Michel Desvigne, Federico Soriano and Dolores Palacios — S&Aa, Topotek 1, Yoshiharu Tsukamoto — Atelier Bow-Wow + Tokyo Tech. Tsukamoto Lab, Charles Waldheim + Office for Urbanization, Yoon Gyoo Jang — Unsangdong Architects Cooperation.

own articulated potential, that is, from its own resources and active elements. (re-evaluating its dynamic impulses and its structural matrices and, at the same time, revalorizing its space models that are potentially more qualitative).

The process is developed in a sequence of steps that begin with the 'Questioning the city and the territory', proposing (recording, expressing, displaying) big latent questions - explicit or implied - associated with datas (information documents) and evolutive informations (processes), creating a systems that is able to stimulate possible criteria (answers), associated with those resources and latent elements (potential) to which we must give impulse and orientation, and so, to possible urban horizons (objectives) and the resulting challenges. Objectives that would, in turn, suggest urba-bets, and possible future scenarios and, therefore, intentional vectorization (strategies); objectives that would be declining and formulating themselves - in an inductive / or activating way - as concrete proposals and which, involving key spaces and programming (situations) would lead to concrete operations. These interpretative keys of reading, condensed into synthetic visions, and articulated process leed to express new relational frameworks for the city: local and global, global and local, at the same time.

3. Conclusion

The 'Civic Seoul' project and the 'Superground' and 'Underground' consultations, move toward a sometimes extreme re-naturalization, where only a megacity like Seoul can think of playing a decisive role today by imagining changing course by phasing out cars, burying its infrastructure, and giving back space to nature and citizens in a social condition of exponential population growth that would seem completely at odds with this trend, but perhaps it really is a forward-looking and perhaps viable solution with great cohesion between public and private investment.

Despite the many benefits, implementing urban renaturation projects presents several challenges. Cost is often a significant obstacle, as the transformation of existing infrastructure can require considerable investment, both for implementation and long-term maintenance (Kabisch et al., 2016), with the need to develop innovative financing models to overcome these barriers. Renaturation can conflict with other urban land uses, requiring a careful balancing of different needs (Haase et al., 2017) with the need to adopt integrated planning approaches to maximize the benefits of urban renaturation. Integrating natural elements with existing infrastructure requires interdisciplinary expertise and can present significant technical challenges (Ahern, 2013), combining ecological, urban planning, and engineering knowledge. Some interventions may face community resistance, especially if perceived as a threat to established habits (Buijs et al., 2016), increasing the importance of involving citizens in decision-making and transformation processes. However, these challenges are accompanied by numerous opportunities. Technological innovation is making renaturalization projects more feasible and effective. The development of new technologies, such as bioengineering systems and permeable materials, is expanding the possibilities for interventions (Zölch et al., 2017; Papa et al., 2021), including through the application of nature-based solutions for climate change adaptation in cities. The economic benefits of urban renaturation represent another important opportunity. The creation of nature corridors can lead to increased property values in surrounding areas and create new economic opportunities related to tourism and recreation, where urban green spaces can act as catalysts for social interaction and community engagement.

Urban areas are facing unprecedented challenges, including climate change, population growth, and infrastructure aging. To address these issues effectively, cities must adopt innovative strategies that leverage technology. Digital twins, virtual representations of physical assets or systems, have emerged as a powerful tool for urban planning and management (Weil et al., 2023). By creating a digital replica of a city, planners and decision-makers can gain valuable insights into urban systems, enabling them to make data-driven decisions and optimize resource allocation.

Digital twins offer several advantages for urban planning. First, they enable real-time monitoring of urban systems, allowing planners to track changes in traffic patterns, energy consumption, and environmental conditions. This data can be used to identify potential problems and inform timely interventions. Second, digital twins can support predictive analytics, enabling planners to forecast future trends and assess the impact of different policy scenarios. This capability is particularly valuable for addressing challenges such as climate change and population growth. Third, digital twins can facilitate optimized resource allocation by identifying inefficiencies in urban systems. For example, a digital twin can be used to optimize the location of public services, such as schools and hospitals, to improve accessibility and reduce travel time.

Digital twins represent a paradigm shift in urban planning. By providing a virtual replica of a city, digital twins enable planners to make more informed decisions, improve infrastructure management, and foster sustainable development. As cities continue to grow and become more complex, digital twins will play an increasingly important role in shaping the future of urban environments.

Finally, urban renaturalization offers important synergies with other urban policies. Renaturation interventions can support other urban policy goals, such as regenerating blighted areas and promoting sustainable mobility (Raymond et al., 2017), all co-benefits of nature-based solutions in cities. To maximize the success of urban renaturation projects, a strategic and integrated approach is essential. Long-term planning is critical for renaturalization, which should, as with Seoul, be strategically designed for the long term, considering future projections of urban growth and climate change.

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Image Sources

Fig.1-7: Images accompanying the Civic Seoul project by the paper's authors.

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