



Delft University of Technology

## City making in times of transition

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**Publication date**  
2024

**Document Version**  
Final published version

**Published in**  
Proceedings of the International Conference on Changing Cities VI: Spatial, Design, Landscape, Heritage & Socio-economic Dimensions

#### **Citation (APA)**

de Boer, J. J., & Cavallo, R. (2024). City making in times of transition: Sustainable, resilient, inclusive and attractive public spaces as stepping stone for a future-proof built environment. In A. Gospodini (Ed.), *Proceedings of the International Conference on Changing Cities VI: Spatial, Design, Landscape, Heritage & Socio-economic Dimensions* (pp. 624-636). University of Thessaly.

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# City making in Times of Transition – Sustainable, resilient, inclusive and attractive public spaces as stepping stone for a future-proof built environment.

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## Abstract

The paper discusses the necessary integrated approaches and design actions aimed at fostering a future-proof built environment through the (re)design, retrofitting, and transformation of public spaces into sustainable, resilient, inclusive, and attractive areas for inhabitants and visitors. It emphasizes the importance of adapting to and mitigating the effects of climate change, as well as addressing spatial advantage and quality, social well-being, and ecological balance. Can we leverage climate adaptation and the urge for the energy and mobility transition as catalysts for spatial transformation to benefit inhabitants? Can this lead to improving attractiveness and use of public space within their neighbourhood? Can design thinking, with a focus on societal values, overcome governance's preoccupation with costs?

The City x Space design study demonstrate that an integrated design approach from different perspectives and disciplines can tackle the multitude of transitions in diverse urban settings, with public space -including its subsurface- playing a pivotal role in improvement or even transformation. Six design cases in different Dutch and Flemish cities, spanning historical, post-war reconstruction, and post-industrial contexts, showcase tailored solutions that contribute significantly to creating a more attractive and inviting future-proof built environment. The combination of a more formal set-up, a clear *Research-by-Design* approach with included assessment criteria, and the involvement of multidisciplinary design teams from practice provides both directions from a policy perspective and freedom from a design viewpoint to explore and envision plausible futures for selected locations.

The main conclusion is that policy makers, architects, urban designers, and landscape architects must deal with new and shifting conditions with a focus on societal, spatial, and ecological values. For policy makers, it is relevant to translate insights from designs produced by Research-by-Design into their policy processes for developing a prospect for action. Both professional practices and education need to foster innovative and interdisciplinary design strategies in a more holistic and integrative approach within their cultural-historical architectural and urban contexts. For both current and future spatial designers, the task -but above all the opportunity- is to position themselves more as integrators and agents of change contributing to a paradigm shift that can drive tangible adaptation and improvement in our living environment at the local scale.

**Keywords:** *built environment, public space, climate change, shifting conditions, paradigm shift, holistic and integrative approaches, research by design, design actions, multidisciplinary collaboration.*

## 1. INTRODUCTION

This paper presents the results of the design study *City x Space* (Stad x Ruimte) conducted in the Netherlands and Flanders in 2021 and reflects on the effectiveness of the *Research-by-Design* approach facilitated by the initiators. The design study explored the potential of multifunctional and plural use of space for existing and future purposes and functions within the built environment [1].

This was done through an integrated design approach where public space, subsurface, and buildings were considered as a cohesive solution space by multidisciplinary design teams. The study encompassed design measures for climate adaptation, housing and social issues, and system transitions for energy, mobility, circularity, and ecology. In the Netherlands, study locations and cases were provided by the cities of Amsterdam, Maastricht, and Rotterdam, while in Flanders by Leuven, Mechelen and Oostende.

The initiative and organization for this design study were a collaboration among the Centre for Underground Construction (COB), Delft University of Technology (TU Delft), the Flemish Government (Department of Environment) and the Deltametropool Association (VDM). The urge for this study stemmed from foreseen claims on existing scarce space within dense cities due to the needs for housing, energy transition, and climate adaptation, and how this matter can be faced through a more efficient use of space. The study also encompassed the subsurface, typically regarded as *terra incognita* mainly seen as storage space for utilities such as sewers and cables or for transportation like metro systems and car parking. Concurrently, a Dutch governmental program for public space was initiated, aligning with the aims of the study. Cities presented issues and questions related to their locations, like the monofunctional use of space in an outdated inner-city sports park (Leuven), the potential of a heat-grid within a pre- or postwar neighborhood, also susceptible to flooding by excessive rainfall (Amsterdam, Maastricht), opportunities for circularity within a redevelopment harbor site (Oostende), the potential of a multifunctional landmark building as catalyzer for transformation of an inner-city post-industrial site (Mechelen), and the transformation potential of a large-scale traffic roundabout adjacent to a redevelopment port area and impoverished residential neighborhoods (Rotterdam). These were not presented as actual assignments for tendering or projects but as policy ideas aimed at better understanding how issues could be addressed through more efficient use of space.

For COB and the Flemish partners, the study provided an opportunity to engage with and learn from the design study and a Research-by-Design approach, which was new to them. For TU Delft, it offered an opportunity to apply and to evaluate a method for characterizing and visualizing the subsurface and to assess design proposals for locations in a more methodical manner than in previous design studies. A more formal assessment of design outcomes, resulting from various Research-by-Design approaches, should receive increased attention. As approach, a significant growth is seen in the Netherlands in spatial and urban planning and urban design over the last decade, with policymakers at various governmental levels embracing its results in policy development and programs. However, there is a lack of clear definition and documentation for these approaches, and its designs inherently involve speculation. Therefore, there is a need for a better understanding of both approach and its results to enable policy and practice to appreciate its significance and potential impact in full extent. How transparent is the process to get results? And how predictable and unambiguous are these? Especially, given the uncertainties and impacts of climate change, the multitude of system transitions, and the necessary investments to make the built environment more future proof. This understanding is also crucial for education, preparing students for their future careers and roles in the spatial domain.

### **1.1 Design, research, and abduction**

Design has various definitions and application, encompassing a broad range of disciplines and professions involving in conceptualizing tangible objects, processes, or substances in the human-made world. In general, designers are viewed as creators, engineers as problem solvers, and researchers as discoverers. However, this distinction becomes artificial when considering the comprehensive learning cycle that embodies all these aspects. Within architecture, design and research are interrelated based on two separate determined or indefinite variables for an object and its context [2]. For instance, designing a station building at a planned location involves a determined object and context, with research informing aspects such as accessibility. This is defined as *research*

for design. Conversely, an old, deserted factory location could present an open-ended scenario for its future purpose. In this case design can provide insight and understanding of location's potential and alternatives. This is defined as *research by design*, characterized by an indefinite object and context. The European Association for Architectural Education (EAAE) defines *research by design* as any kind of inquiry in which design is the substantial constituent of the research process. It should lead to new insights, knowledge, practices or products which is consistent with experience in practice. Its results must be original, significant and rigorous as architectural research requires [3]. The Royal Institute of British Architects (RIBA) also refers to the same criteria that define quality for scientific research in general. These criteria address both process and output, where communication and peer review are mechanisms to assess and reflect on those criteria. The involvement of practice is seen as relevant due to its practical nature and the relationship between architectural processes, products, and performance [4].

Like these definitions, Dorst explains the notion of *abduction* and the way designers in general reason, based on the equation *WHAT (thing) x HOW (working principle) leads to VALUE (aspired)* (1), in the context of problem solving and design thinking [5]. When applied to architecture, the design and construction of a house (WHAT) to provide shelter and comfort for a family (VALUE) can benefit from archetypical designs and proven construction techniques (HOW). However, if the desired value of shelter and comfort is not for a family but for vulnerable persons who needs also care, then the WHAT would be an open question. This is defined as Abduction-1, representing traditional problem solving. In case the known working principles are strictly related to design a house or hospital, then there is also an open question for the HOW, leading to Abduction-2. This introduces two unknowns that should be resolved in parallel, requiring a novel approach due to their open and (more) complex nature. For this reason, the notion of *frame creation* is introduced, facilitating the investigation of themes related to the aspired value to discover new working principles and its application in a design which could hypothetically lead to this value.

The primary focus of the design study and its collaborating partners also extends to the public domain. Design and design thinking are recognized concepts within the realm of public administration and public policy [6]. In the early stages of this field, it was also characterized as a design discipline, with policy interventions aiming at problem solving for societal issues. However, as challenges such as climate change and migration become more complex, alongside the involvement of multiple stakeholders with diverse needs and interests, questions arise about the effectiveness of traditional policy development methods for addressing these complex, wicked, and ill-structured problems. There is a growing need for novel approaches that align with core values of public administration, including accountability, legal certainty, and predictability. Design thinking, which prioritizes societal values over mere problem identification and intervention, is increasingly seen by policy experts as a solution to the current state of policy development. In general three directions are recognized: 1) Design as optimization, as a continuation of the problem solving approach by experts for well-defined issues while considering societal impact and involving stakeholders; 2) Design as exploration, searching for creative and innovative solutions for more open issues and stimulating human-centered design thinking; 3) Design as co-creation, engaging affected actors for the definition of problems and solutions in order to learn collectively and to enlarge commitment. However, contemporary design approaches, particularly those aligned with exploration and co-creation, often raise concerns regarding effectiveness and innovativeness of resulting policies and relevant conditions. Their meaning lies more in policy definition, aiming to create a better understanding rather than improving decision-making, based on a balance of analytic rigour and societal relevance.

## **1.2 Research-by-Design for the built environment**

When reflecting on [2], [5] and [6], a closer examination of the variables for context and value is warranted. In relation to the built environment, an object is inherently connected to a multi-actor

setting beyond its physical context, with various needs and interests addressed by policies and regulations. These are undeniably linked to the desired value(s) of these actors, whether users or clients, driven by their purposes and objectives. These latter factors represent *steering*, with value as their *outcome*. When purpose is interpreted as the (working) hypothesis stemming from the analytic and inductive exercise -by the creation of a new frame on basis of the desired value and novel working principles- then a design will not yield a binary result like false or true, as with a theory. Instead, the design process is deductive, akin to justifying a hypothesis in research, yet it is qualitative and hard to justify as the sole and righteous answer. Moreover, the design process is iterative, a facet overlooked by equation (1), next to its omission of context. The extent to which the desired value would be realized through several iterations remains uncertain, further emphasizing the distinction between design and scientific research. The latter is binary in its justification, confirming predictability and facilitating the accumulation of knowledge. In case of design, we can assess and determine to what extent the value is delivered according to its purpose.

When reconsidering aforementioned reasoning within the built environment domain, it could be formulated as follows: *PURPOSE (objectives) steers WHAT (object) x CONTEXT (plural) x HOW (working principle) leads to VALUE (outcome)* (2). Main assumption is that the purpose is hypothetical and explicitly stated, originating from many sources: via the analysis of the values and working principles, as an idea from a single thought, as a position, or as an actual issue. The purpose may be ambiguous, open, and complex. The plural context may include physical and social, governmental, economical, financial, technological, legal, cultural, historical, and ecological aspects. Concerning the variables, the degree of abduction is higher with an additional variable, making the equation more complex as it reflects reality. In any case, for equations (1) and (2) there is no guarantee that both the analysis as inductive activity, as well as the design as deductive activity, will be appropriately and transparently executed. Scientific research has its protocols and extended review systems, alongside the developed attitudes and competences of researchers through education and training. As noted before, analytic rigour is necessary to become transparent and effective. To achieve this, a sound and clear organizational and process set-up should be in place for the execution of analytic and design activities to instill confidence in the plausibility of a design and its assumed value.

### **1.3 Research questions and objectives**

The design study City x Space is the latest instalment in a series of design studies initially co-initiated and co-organized by the Dutch Architect Association (BNA) and TU Delft. These studies focused on exploring opportunities for the use of space at various locations considering societal and technological developments, as well the potential impact of climate change and related system transitions in energy, mobility, circularity, and ecology. The locations included station areas [7], areas adjacent to urban highways [8], potential (re)development sites [9], and social housing neighborhoods [10]. COB, comprising members from engineering firms specialized in infrastructure, water, and construction domains, was particularly interested in how spatial designers perceive the subsurface from a design perspective, and how they address issues using a Research-by-Design approach. The Flemish government also expressed interest in exploring the potential of the subsurface for functions and program beyond utilities, as well as understanding how a Research-by-Design approach could be instrumental for getting more insights in spatial related issues. As outcome of discussions among the initiators, the following central question was formulated: *How could an integrated and multifunctional use of space, with a focus on public space, subsurface and buildings in a dense urban environment, create space and added value which contribute to an attractive and future proof living environment?* This main question pertains to the how, what, context and value. The purpose stems from the interests, policies, and position of the initiators and collaborators, where the integrated and multifunctional use of space serves as the key hypothetical working principle for designing an attractive and future proof living environment, representing its aspired value.

Additional questions provide more direction and detail: 1) How could the (re)design of a strategic location contribute to spatial advantage, improving the living environment and strengthening resilience to climate change of a city?; 2) Which combinations of functions are desirable and favorable for a location considering societal needs and environmental conditions?; 3) How to integrate an object in an innovative way at system level and at a larger scale?; 4) How to create economical, societal, and ecological benefits by combinations of functions and spatial efficiency?; 5) How to incorporate different system transitions, flexibility, and resilience?; 6) How could an intervention for a location also contribute to area development or creating new conditions for this?; 7) Which future images, scenario's, design principles, innovations and approaches could be developed and useful for policy and practice? These questions also introduce a multitude of contexts and value related themes for frame development alongside the key hypothetical working principle.

## **2. METHODOLOGY**

The accumulation of issues and variety of contexts reveal an open and complex situation for each study case, justifying an explorative Research-by-Design approach instead of a traditional design approach with defined variables. From a methodical perspective, the diversity of cases is relevant for comparing and understanding the relationship between the hypothetical working principle and associated design interventions, their value contributions, and conditional differences. This also provides insights into the potential for broader application and generic lessons. With its typological characterization of study cases and methodological intention on testing and analyzing the relationship between purpose and open variables, this study differs from the aforementioned design studies. It aims not only to produce future images but also to seek a better understanding of the conditions under which a Research-by-Design approach can yield plausible and explainable results based on a transparent process from a methodological viewpoint and within an urban planning and policy context.

### **2.1 Operationalization**

The values derived from the main question were operationalized into the following main criteria: 1) Spatial advantage, 2) Environmental quality, and 3) Future proofing. The potential to realize these values was operationalized through the main criterion of 4) Realization.

This operationalization emerged from discussions among the organizers, the interpretations of case descriptions provided by the cities, and from relevant Dutch and Flemish national policies [11]. Each criterion has specific sub-criteria, like spatial efficiency, health, resiliency, etc. The criteria serve as the core of an assessment framework integrated into the process set-up (Figure 1). The operationalization process, occurring within the social context of various actors and criteria which entail a plural context, makes clear that an explicit attention for values and their origin is critical to find common ground and room for them. From a stakeholder perspective, this establishes a collaborative baseline and guides the design purpose, where values and derived criteria, along with the key hypothetical working principle, constitute a *starting frame* for designers. This provides organizers and cities the opportunity to evaluate the extent to which design proposals contribute to the desired values. The criteria are not quantitative performance indicators which is not problematic considering the purpose and nature of the design study, characterized by an open, ambiguous, and complex main question. Furthermore, the low-level of detail in the designs limits the opportunity to assess in full extent. As an ex-ante assessment, it implies a priori and fictitious contribution of design interventions, necessitating qualitative assessment from a multidisciplinary expert perspective.

### **2.2 Study set-up**

The organizers of the design study issued an open call for participation via Dutch and Flemish architect, urbanism and spatial planner associations and networks. The study's intentions, cases,

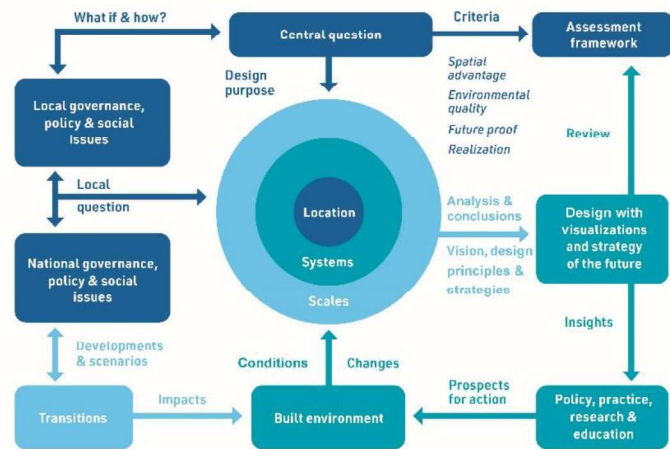


method, and set-up were presented at a well attended information meeting, where attendees were encouraged to join as multidisciplinary design teams for specific cases. Selection criteria included motivation for the study, vision for the preferred case and method, the disciplinary composition and experience of the team, and willingness to contribute based on a fixed fee. The selection for a particular case was made by the respective city. In addition to the professional design teams, student teams from the architecture and urbanism departments of TU Delft were also involved within a curricular studio setting. Prior to commencing the design activities, three masterclasses were organized by the organizers, featuring topics and state of the art insights by scientists, policy advisors, technical experts, and designers. The first masterclass focused on spatial planning and transitions for climate adaptation, energy, and mobility. The second masterclass delved into design approaches and technical aspects related to the subsurface. The third masterclass addressed business cases involving the subsurface use of space and stakeholder approaches. These masterclasses aimed to establish a common knowledge base and provide updates for the design teams, with extra attention for the subsurface, which may be not the primary focus for spatial designers.

The applied framework for the Research-by-Design approach shows the relationship between the central question, which incorporates the design purpose for value creation, and the specific issues from the cities, represented by the local question for a strategic location (Figure 1). The design purpose functions as the *starting and reference frame* for the multidisciplinary design teams, focusing on the integrated and multifunctional use of space as the hypothetical key working principle, along with the generic values as operationalized for the assessment framework. The local question specifies the unique issues and values for the location within a local and, eventually, national policy and social context. Next to these the current

conditions of a location which may already be affected by the impact of climate change and one or more transitions. The local question was discussed between city representatives and members of a design team during the first local workshop and site visit held for each location of the design study. The *what if* notion refers to the exploratory nature of the central question, its aspired values, and to the potential and uncertain impact of a multitude of transitions on the built environment and location, along with its subsequent scales and systems.

At the level of the design study, two fixed plenary meetings were scheduled for all participants. The first was dedicated to the analysis by the design teams of their case and the conclusions drawn from the inputs and location analysis. Some teams already provided a direction for further development of a vision on *what* and *how* for their location. Due to its plenary character, there was an exchange between cases and design teams, with a panel of external experts providing reflections from different perspectives. Between the first and second plenary session -for the elaborated vision and design- local workshops were planned for a more in-depth discussion involving city representatives, design teams, and in some cases, other invited actors related to the location. The second plenary meeting served as the final event where the designs and future images of the locations were presented to all involved participants. This included a strategy to connect the vision with subsequent steps or phases for interventions within a time window. Once again, city representatives and an external panel reflected



**Figure 22.** Framework for a set-up of a Research-by-Design approach, integrating research, design, and assessment.

on the designs for the locations. A dedicated final event was organized for the student work and teams due to the curricular schedule not aligning with the design study schedule. Representatives of the cities joined this event to reflect on student's visions and designs and for its takeaway.

The subsequent phase for documentation and interpretation by the organizers and invited experts marked the conclusion of the design study. In addition, to local meetings held to inform a broader audience about the design proposals and to facilitate discussions for potential collaboration, the interpretation process followed a two-tier approach. Firstly, relevant themes were defined, experts were invited to and deepen their perspectives on these themes, which also served as a reference for assessing the designs. Secondly, the designs were assessed according to the criteria derived from the central question. The chosen themes and perspectives included integration, subsurface data and representation, urban and architectural concepts and approaches, investments and finance, spatial cohesiveness, urban value, change and steering. For the assessment according to Figure 1, design teams were requested to do a self-assessment of the extent to which their designs contributed to the main criteria through an ordinal score, supported by the interventions in their designs. Conclusions from both approaches formed the basis for fourteen generic lessons (3. Results, Table 1).

The study did not include a methodological inquiry into the extent to which cities continued with the results as part of some prospect of action for actual change related to their strategic locations.

### **2.3 Applied techniques**

Expert sessions dedicated to the subsurface were organized by TU Delft for design teams and local experts. To assess its occupation and conditions, the System Exploration Environment and Subsurface table (SEES) was introduced [12]. This table differentiates several layers such as buildings, infrastructures, public space, and subsurface, and covers topics like civil constructions, water, energy, and subsoil. Available data about sewage pipes, heat-grids, power and data cables, foundations, constructions, water reservoirs, soil composition and condition could be categorized and be classified as dynamic or static. A completed table was translated into a visual representation through a set of plan-view and cross-section drawings prepared by TU Delft. These drawings informed design teams about the present spatial condition of the subsurface at a location, aiding them in considering for their interventions. During the analysis and design activities carried out by the design teams, a wide variety of methods and techniques were employed. Examples of these are functional and system analysis, a layer approach, a circular and flow approach, a parametric approach, and a sustainability capitals approach. The framework of Figure 1 offered designers full freedom to apply methods and techniques with which they were familiar.

## **3. RESULTS**

The results of the design study revolve around the designs for the locations. Their potential contribution to the values was assessed by the organizers, as defined by the central question, and operationalized by the criteria. Some exemplary values and aspects are illustrated by one of the many visualizations delivered by the design teams. Additionally, the designs were scrutinized from various perspectives by experts to discern and characterize defining aspects. This all has led to fourteen lessons learned, which could be valuable for cities that have ideas or facing open, complex, and ambiguous issues concerning a location, and for designers in practice, as well for architecture and urbanism students (Table 1). The effectiveness of the applied Research-by-Design approach will be addressed in the conclusion chapter.



### 3.1 Addressing spatial advantage, environmental quality, and futureproofing in an integrated manner

Several designs show the opportunities that the energy transition could provide for integrating measures for climate adaptation, prioritizing pedestrians, and cyclists, and creating attractive public spaces. They address: 1) spatial advantage through the combination of mobility and energy functions, and use of the subsurface; 2) environmental quality through removing parking spaces, adding green, and providing value and usability for inhabitants; 3) future proofing through the introduction of a heat-grid, and enhancement of the resiliency of public space to heat-stress and flooding by increasing water infiltration and retention. For dense neighborhoods, a heat-grid may be the preferred system from a financial perspective, but it also opens the opportunity for a redesign of public space (Amsterdam). Similarly, less dense neighborhoods like those in Maastricht, Leuven, and Oostende, could also benefit from these combined measures achieving cost reduction. Also, the need to replace old sewage systems, as seen in Amsterdam and Maastricht, could provide an opportunity for an integrated approach. The introduction of flexible structures and the combination of functions shows potential for spatial advantages and mid- and long-term business viability (Amsterdam, Mechelen and Leuven). Moreover, novel function combinations, as part of transport and flood defense infrastructure interventions, also demonstrate potential for spatial advantages and business cases related to additional real estate (Rotterdam). The designs illustrate the relationship between public space, the subsurface, and buildings, emphasizing the need for an integrated approach to all spaces.



**Figure 2.** Maastricht: ‘Energy boulevard’ as carrier for an attractive and future proof public space [13].



**Figure 3.** Rotterdam: *Dike Park* with integrated water retention and utility space [14].

### 3.2 Assessment of technical and architectural concept

Several designs introduced new concepts for interweaving ground and subsurface level, removing the hard distinction between the upper- and underworld. This was done through the use of interconnected layers of public space (Rotterdam, Leuven, Mechelen). The use of an open casco construction for subsurface or building spaces offers flexibility for present and future functions, enhancing the designs’ futureproofing and cost-benefit ratio (Amsterdam, Leuven, Mechelen). Regarding spatial cohesiveness and urban value, most designs primarily impact the immediate location. However, some designs have influence to surrounding neighborhoods by introducing complementary functions and programs such as housing, jobs, and amenities (Rotterdam, Oostende), or by establishing an ecological and utility framework (Leuven).



**Figure 4.** Amsterdam: modular and flexible subsurface blocks and redesigned public space [15].

#### Proceedings

of the International Conference on **Changing Cities VI:**  
Spatial, Design, Landscape, Heritage & Socio-economic Dimensions  
Rhodes Island, Greece • June 24-28, 2024  
ISSN: 2654-0460  
ISBN: 978-618-5765-02-6



**Figure 5 and 6.** Leuven: *Climate joints* connect sport park and surroundings, and integrate eco-system services, and utilities. Cross-section of a Climate joint with integrated cycle route [16].

### 3.3 Design clues for realization

All designs provide clues for potential financial benefits, opposite to the costs of interventions which is pertinent for developing a business case. The design for Leuven offers eco-system services and a flexible utility structure that reduce costs for connecting neighborhoods and maintenance while the renovation of the sport park should be covered by additional space for new functions and program. Long-term benefits could be derived by exploiters from the heat and cold storage system integrated into the climate joints. The design for Mechelen presents open and transformative spaces in their park building, potentially yielding future exploitation benefits if integrated into the business case for investments. The design team for Oostende has developed action cards for stakeholders, showcasing design interventions from a catalogue of solutions related to circular flows of water, materials, biodiversity, energy, and program. These could be instrumental in forming a coalition of relevant stakeholders to tackle the redevelopment of the port area. The designs for Rotterdam focus on the addition of real estate for housing and amenities opposite to the large investments for infrastructure. Since a dike is central for flood protection, this could give a clue for investments from the Dutch national governance. For both Amsterdam as well as Maastricht, the renewal of utilities and addition of a heat-grid are large investments with long-term benefits. Existing maintenance budgets should cover the renewal and could help to reduce costs for the heat-grid concerning opening and digging in streets and its hindrance for a lengthy period. The improvement of public space by green, water infiltration and retention could be also part of maintenance budgets or financed from climate adaptation funds in case these are available from governmental bodies.

### 3.4 Lessons learned

From the assessment of the designs, fourteen lessons were formulated by the organizers for an integrated and multifunctional use of space in the context of climate change and related system transitions. Clustered into three steps, these lessons offer a different direction than traditional problem solving. The equation (2) contains too many uncertain variables, whereby the challenges question the present way systems are organized and perform, while realized projects are in their infancy phase before they could become best practices or even paradigms. The eventual realization of designs as presented in this study is complex and time-consuming, as urban design and area development generally are. However, the lessons show that there are answers that could serve a broader academic and professional audience than only those involved in this Dutch and Flemish study.

**Table 1.** Lessons learned based on the designs and their assessment.

<b>14 lessons for integrated and multifunctional use of space</b>
<b><i>Take a different perspective</i></b>
er the cross-section of subsurface, public space and building as a new paradigm for integrated multifunctional use of space.
er the subsurface as a valuable building block to improve the quality of the living environment the ground.
3. Have an eye for the larger scale and systems.
4. Look beyond the traditional land and real estate development cycle.
<b><i>Change one's mind</i></b>
5. Focus and steer based on values.
6. Design for change.
7. Make use of planned interventions in the subsurface.
8. Define an integrated business case.
<b><i>Act differently</i></b>
by Research-by-Design for exploration, idea development or the definition of plural issues by context, conditions and impact are uncertain for the mid- and long-term.
11. Use storytelling and future images for communication with stakeholders.
12. Research-by-Design is not without engagement.
13. Subsurface data should be available and updated.
14. Consider how investors structure and assess costs and benefits.

#### 4. CONCLUSIONS AND DISCUSSION

The designs show the potential for multifunctional and plural use of space for both existing and future purposes and functions within the built environment, offering a broad variety of approaches and solutions for various locations. Their potential contributions to the central question reveal similarities as indicated by the main criteria of spatial advantage, environmental quality, futureproofing, and realization. Despite the difference of visions, applied design principles and strategies, and the actual designs they all have a comparable contribution to the values. The use of a clear central question and derived criteria represents a steering force that is detached from a location's character, allowing for fresh and creative approaches with tailor-made solutions. This top-down focus on values does not hinder bottom-up inspiration and innovation.

##### 4.1 The significance of the designs and lessons

The significance of the designs is twofold: 1) providing insight for involved cities into given issues and their translation into potential value for their location by the design; and 2) serving as study cases that lay the foundation for generic lessons for a broader audience, including policy makers, design professionals from practice, architecture and urbanism students, and scientists. A broader application of the designs is limited to similar locations and conditions which in general is unlikely. As such, the designs are not templates for reproduction due to the specificity of issues, policies, actors, and other contextual conditions. They serve more as inspiration, illustrating that the integration of functional and spatial measures can lead to cohesive and insightful designs. The lessons are more generic, with the applied visions, design principles, and strategies inspiring practitioners to consider and apply them for other locations, while informing students to expand their design toolbox. The lessons emphasize the necessity to take another look on issues, systems, and space as a first step in rethinking existing practices and approaches. Internalizing these lessons could lead to new directions in practice that develop and apply approaches contributing to a future-proof built environment.

Design studies like these are more grassroots initiatives that highlight the inadequacy of present sectoral approaches in addressing the challenges and issues we face. New intersectoral and interdisciplinary approaches and collaboration are needed to develop best practices that convince policy makers to join the effort. Actual realizations, however small can serve as references or catalysts when pioneering policy makers manage to overcome organizational hurdles. For practice, this presents an opportunity to develop new business and competences. For education of spatial designers, it offers the chance to prepare students for a new practice that requires a broad understanding of various systems and values, as well as competences in system and design thinking. When policy, practice, and academia engage themselves more effectively and collaboratively with the challenges facing the built environment, a growing community can develop and embrace novel approaches, methods, and strategies, ultimately contributing to a paradigm shift in the long run [17].

#### **4.2 Research-by-Design as a transparent process for plausible outcomes**

From a methodological perspective, the design study and its outcomes show that adopting a more procedural set-up to a Research-by-Design approach enhances transparency and credibility in both its process and results. This approach clarifies both the potential and limitations of what can be expected from this way of working. The scheme of Figure 1 represents a steering model primarily guided by key issues and policies, in which the central question and its values are the main steering mechanisms through the design purpose and assessment criteria. The resulting designs undergo review and reflection by experts and practitioners already during the process, aligning with the mechanisms of architectural research mentioned by the EAAE and RIBA. The assessment against the criteria encompasses both methodologically and qualitative aspects. The insights gained can inform feedback loops via intermediate structures and processes in policy, practice, education, and research. In the context of the procedural set-up and reformulated equation (2), the PURPOSE is filled-in by the central question, WHAT by the location's designs, CONTEXT by the policies, actors, systems, scales, and conditions, HOW by the visions, design principles and strategies, and VALUE by the potential contributions of the designs to the desired values within the central question. The inclusion of the context variable is evident for architecture and urban design considering the built environment, as De Jong discussed design and related research. It is also pertinent in product design, as Dorst, originating from this background, initially introduced equation (1). This broader perspective reveals complexities often overlooked when designers solely focus on the object as a *pure artefact* to design. The designs and approaches of the design teams show that there is no fixed content for the variables leading to a single answer. Different content yields different outcomes, which is not problematic if the objectives and results are recognized and appreciated by the problem owner. This is not only about its originality and significance as EAAE and RIBA have pointed out but also in its potential to be put on a policy agenda. This underscores the need for transparency and plausibility through rigorous analysis, as also noted by Van Buuren. The presented procedural set-up can ensure these qualities while enabling clients to provide guidance through defined values and maintain control over the process without interfering with the required creativity and imagination of designers.

#### **4.3 Future research topics**

The effectiveness of the applied Research-by-Design approach lies in providing insights into issues, solutions, and values related to climate change and inherent system transitions, particularly for cities in their specific locations. They must translate these insights in actionable prospects, using design as starting point for dialogue with relevant actors within their policy context. However, this design study cannot definitively determine the extent to which the designs have been or will be effective for policy development, planning, or actual change in near future. Conducted between 2021-2022, the study and its documentation occurred within a relatively brief period in the context of policy processes. For Oostende, the city commissioned the design team for further investigation aligned with their design.



COB has developed a toolbox for spatial and adaptive planning and design, including subsurface and flexible structures, along with a serious game for value determination of spatial ambitions [18]. The Flemish government communicates the environmental qualities for public space to a broad audience. The Dutch Minister of Housing and Spatial Planning employs Research by Design as an approach in general for exploratory research into spatial issues within the context of climate change and inherent system transitions. However, dedicated research is required to better understand the effectiveness of the different Research by Design approaches in driving actual change.

Another area for research is understanding the built environment through paradigms, recognizable architectural and urbanism manifestations, and data within the notion of shifting conditions as set by climate change. A framework that can detect change in the context of climate change and related system transitions could be valuable for identifying and classifying actual realizations as reference projects, informing further development toward a future-proof and attractive built environment [19]. Public space, including its subsurface, could serve as a tangible steppingstone, addressing challenges, leveraging opportunities, and embodying values. Categorizing widespread manifestations could yield a catalogue of novel and dedicated interventions within their cultural-historical architectural and urban context. When combined with open data and open-source parametric computational tools, it could enhance the rigour of analysis activities. Integrating data-driven and parametric methods and techniques into a formal Research-by-Design approach could improve transparency and plausibility.

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