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INTRODUCTION

Societies in densely populated deltaic areas rely heavily on transport and water infrastructure of diverse types and scales, such as roads, bridges, railways, stations, waterways, dikes, navigation locks, (sea)ports, and airports. From the earliest stages, human activities have been enabled by infrastructure as foundation and precondition for prosperity and safety.

Yet, continuous expansion is neither feasible nor sustainable within planetary boundaries, considering the developments society is facing, like population growth, environmental pressure and liveability, loss of biodiversity, geopolitical developments, resource depletion, and climate change.

At the same time, a large part of the current infrastructure is at the end of its technical lifetime, since much was constructed after World War II. This situation raises critical questions about the current state and use of infrastructure as well as its future availability and suitability. The loss of critical infrastructure could disrupt human activities when accessibility of locations becomes problematic or that our preparation for the effects of climate change, like sea level rise, excessive rainfall, or freshwater scarcity, is inadequate. Moreover, it is unclear what the systemic relations are and to what extent existing systems can be adapted or that system change and transition are necessary, as is the case for energy and raw materials. There is great uncertainty about how developments will unfold and whether there are sufficient time and resources available to provide an appropriate human response. These conditions create a decision-making impasse.

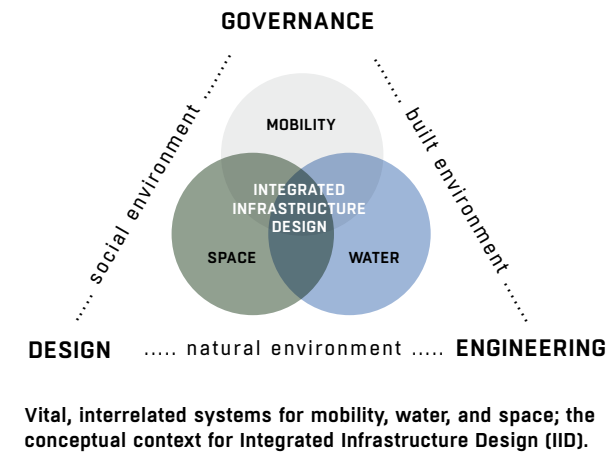
The key challenge is whether policy makers, designers, engineers, and constructors can jointly find solutions that reduce path dependency and avoid lock-ins for future responses under shifting conditions. Governmental infrastructure owners and its users, like business and residents, should not adopt a postponing or indifferent attitude, but act proactively, with a focus on value creation in a sustainable and balanced manner for people, planet, and profit. Mobilising creativity and innovation in practice and education is necessary to find answers. Integrated infrastructure design, the subject of this design guide, can contribute to this challenge.

WHY THIS DESIGN GUIDE? – The focus on integrated infrastructure design at TU Delft started in 2012, when a discussion took place among a small group of leading scientists from the architectural, urban, water and transport fields. The central question was why design, and engineering had drifted so far apart regarding knowledge development and educational practice, while at the same time socio-economic and infrastructure-related issues became more complex. Therefore, the need for collaboration was clear to all. The ongoing specialisation and fragmentation had to be mitigated somehow. To find an answer, an expert meeting was organised with practitioners from the design, engineering, and construction world. This resulted in a research and education agenda, which led to several interfaculty and interdisciplinary education programmes, studios, courses, concepts, and methods related to the vital systems for mobility, water and space and its integrated design (see figure).

Now, it is time to assemble the knowledge and experience of the involved scientists and experts from practice, based on more than ten years of interdisciplinary design education within a transdisciplinary context of social issues and infrastructure, and on an array of design studies for a future-proof built environment and its infrastructure, in close collaboration with practice. This design guide is a proposition to share insights with a broader academic and professional audience, and anyone who has interest in infrastructure and its meaning for people, planet, and profit.

This design guide shows inspirational and already realised designs and offers students and practitioners theoretical and practical insights from a vast array of firsthand approaches. A typical Dutch point of view on integrated infrastructure design is taken as starting point, with a focus on mobility, water, and space. As a low country in the delta of three rivers ending in the North Sea, the Netherlands face unique challenges that require specific solutions due to its geographical, cultural, and institutional contexts. However, content-wise, many of the discussed topics and methods, techniques, and strategies are also relevant for students and practitioners in other countries. The design guide

covers a range of disciplines and fields from policy, planning, design, engineering, economics, and social sciences. All these play a role in the development of integrated infrastructure as a common good, that have an undisputable impact on societies and their living environments.



HOW TO USE THIS DESIGN GUIDE? – The large variety of contributions in this design guide is structured by three main sections, matching the plan, analyse, and synthesise aspects of infrastructure design. Within each main section, further insight is offered by several thematic and case-based contributions, each of which ends with lessons that be deduced from these case studies. The related subsections on methods, techniques, and strategies offer a concise introduction of methodologies that may be of use to the reader. All main sections contain featured designs which are inspirational due to their integrative nature and the values they create. The closing section contains conclusions drawn in the making of

this design guide. This section offers further outreach to practice, education, and research in order to disseminate the proposed paradigms for the practice of infrastructure development and management.

THE PLAN SECTION focuses on the ‘front-end’ of infrastructure development. This is a decisive phase for problem definition, the purpose and direction of further development, and the extent to which stakeholders’ viewpoints, aspired values, and interests are considered. Thematic contributions cover the setting of political and governmental agendas, decision-making for a long-time span, the meaning of infrastructure for land value, urban and (inter)regional development, and stakeholder participation. The methods, techniques, and strategies discussed here are mostly supportive to planning, policy, and management processes.

THE ANALYSE SECTION provides insights and supports as to how to assess stakeholder expectations for an infrastructural intervention, as well as the boundary conditions and related risks. Apart from turning unknowns into knowns, the exploration of opportunities can reveal more value than initially aimed for. The thematic contributions discuss how spatial and engineering design can contribute to this. The methods, techniques, and strategies are mostly supportive to analysis and evaluation.

THE SYNTHESISE SECTION aligns stakeholders’ expectations with reality. Will a realised design contribute in a sustainable and balanced manner to people, planet, and profit? The thematic contributions dive into various approaches and designs for flood protection and water management, ecological restoration, regional connectivity, local urban development, and public space. The methods, techniques, and strategies discussed here are supportive to design processes for diverse types of infrastructure and for design in itself.

WHAT IS NEXT? Looking at the whole picture, the cases and lessons from the thematic contributions and the featured designs indicate the contours and characteristics of an upcoming practice for infrastructure development and management, but this is not yet fully crystallised. This section offers an outlook on how to pin down, validate, disseminate, internalise, and institutionalise Integrated Infrastructure Design in practice, education, and research.

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Backcover: Harderwijk, Gelderland: Aqueduct Veluwemeer crossing the N302 motorway. [© Sébastien Nagy]

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