Urban landscape infrastructures

Designing operative landscape structures for the built environment

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Abstract

This paper explores infrastructure as a type of landscape and landscape as a type of infrastructure. The hybridisation of the two concepts, landscape and infrastructure, seeks to redefine infrastructure beyond its strictly utilitarian definition, while allowing design disciplines to gain operative force in territorial transformation processes. This paper aims to put forward urban landscape infrastructures as a design concept, considering them as armatures for urban development and for facilitating functional, social and ecological interactions. It seeks to redefine infrastructural design as an interdisciplinary design effort to establish a local identity through tangible relationships to a place or region. Urban landscape infrastructures can thereby be used as a vehicle to re-establish the role of design as an integrating practice. This paper positions urban landscape infrastructure design in the contemporary discourse on landscape infrastructures. The space of flows, as opposed to the space of places, is introduced as an impetus to develop the concept of landscape infrastructure into a more comprehensive form of urban landscape architecture. Furthermore, this paper outlines a set of principles typical for urban landscape infrastructure design and suggests three potential fields of operation: transport, green and water landscape infrastructure. The design of these operative landscape structures is a crosscutting field that involves multiple disciplines in which the role of designers is essential.

KEYWORDS

landscape infrastructure; flowscapes; design; urbanism; transport; green infrastructure; infrastructural urbanism; landscape architecture; systems thinking; architecture; regional design; infrastructure

1. INTRODUCTION

Urbanisation, ecological crisis and climate change are several of the contemporary challenges of our society, which are demanding a fundamental review of the planning and design of our landscapes, in particular in relation to environmental issues and sustainability. While the technical challenges may be considerable, the spatial and cultural challenges are by far the largest. In this era known as the Antropocene, a human-dominated geological epoch (Crutzen, 2002; Sijmons, 2014a), the architecture of the urban landscape has evolved into a complex system, extending far into the hinterland and deep into environmental systems, beyond any individual's understanding or direct influence. Infrastructures, by virtue of their scale, ubiquity and inability to be hidden, are an essential component of the urban landscape (Strang, 1996). Infrastructure has been in service of the conquest of nature, whereby the environment has been denied its natural dynamism in favour of colonisation that relies on more controlled and static systems. From the nineteenth century onwards, complete river systems became controlled by man in favour of economic growth (e.g. Cioc, 2002; Disco, 2008). Rail, road and energy infrastructures were constructed to integrate and control nations (e.g. Badenoch & Fickers, 2010; Guldi, 2012). Natural landscapes have been transformed into urban, logistic, industrial and waste landscapes (e.g. Meyer & Nijhuis, 2014; Waldheim & Berger, 2008; Prossek et al., 2009; Berger, 2006) (figure 1).



Figure 1: The Maasvlakte Rotterdam, the Netherlands, as an example of a logistical landscape (photo: Ben ter Mull, 2014)

Though often successful in geopolitical and economical terms, the tendency to engineer infrastructures for 'single purpose' often resulted in disrupted landscapes, defaced retrofitted constructions and buildings, and erasure of cultural and natural values (Strang, 1996). However, widespread

insights into the potentially irreversible harm such single purpose-design has done to natural systems resulted in a growing awareness to strive for more harmonious forms of urban landscape architecture. This leads to large-scale economical commitment of national, international, European and global collaborations. Today infrastructure projects play a key role in global policy. Infrastructure is considered the primary field of investment of public authorities (European Commission, 2011, 2012). It is regarded as a backbone in which the increasingly privately financed urbanisation can be grafted (Shannon & Smets, 2010). As such, infrastructural design emerges as an important way to steer urbanisation. Yet the responsibility for infrastructural design is diffused, falling piecemeal to disciplines such as civil engineering, architecture, urban design, landscape architecture, agriculture and landscape ecology (cf. Strang, 1996). The unravelling of the dialectic between landscape and infrastructure, and the relationship between processes and formal aspects, is at the core of contemporary criticism and debate among the disciplines of landscape architecture, urban design, civil engineering and architecture. Though there are interesting examples of multi- and interdisciplinary design-related research on the infrastructural landscapes themselves, the potentials of infrastructure for performing the additional task of shaping urban landscapes is largely unexploited.

This paper aims to put forward urban landscape infrastructures as design concept considering them as armatures for the development of urban systems and which facilitate social and ecological interactions. It seeks to redefine infrastructural design as interdisciplinary design effort to establish a local identity that has tangible relationships to the region. Urban landscape infrastructures can thereby be used as a vehicle to re-establish the role of design as integrating practice. The paper elaborates on the hybridisation of the concepts of landscape and infrastructure and positions urban landscape infrastructure design in the contemporary discourse on landscape infrastructures. The space of flows is introduced as an impetus to develop the concept of landscape infrastructure into a more comprehensive form of urban landscape architecture. Furthermore the paper outlines a set of principles typical for urban landscape infrastructure design and suggests three potential fields of operation.

2. FROM INFRASTRUCTURE AS LANDSCAPE TO LANDSCAPE AS INFRASTRUCTURE

Infrastructure design was an essential feature of territorial planning and city development. As exemplified by Cronon (1991) for Chicago, Picon (2005, 2009) and Barles (2007) for Paris, and Van Acker (2014) for the Campine Region in Belgium, major hydraulic and transport infrastructures exert great

influence on the possibilities for economic and spatial development of urban landscapes. Infrastructures make things possible. In the eighteenth century Paris for instance, urban canals were used for transportation and to power mills and workshops. Consequently a complex set of manufacturing activities developed along the river banks (Picon, 2005). In the beginning of the twentieth century the sewer system of Paris was not only employed for the removal of human excreta to improve urban hygiene, but also aimed to produce the fertilizers needed in rural surroundings (Barles, 2007). The sewer system steered and facilitated the development of sewage farms, which played an important role in the food production for the city (figure 2). Though infrastructures were important technological utilitarian features in the urban landscape they were usually not imbued with a landscape connotation. However, appropriating infrastructure as landscape has the potential to gain operative force in territorial transformation processes and to explore the dynamic between structure and process.

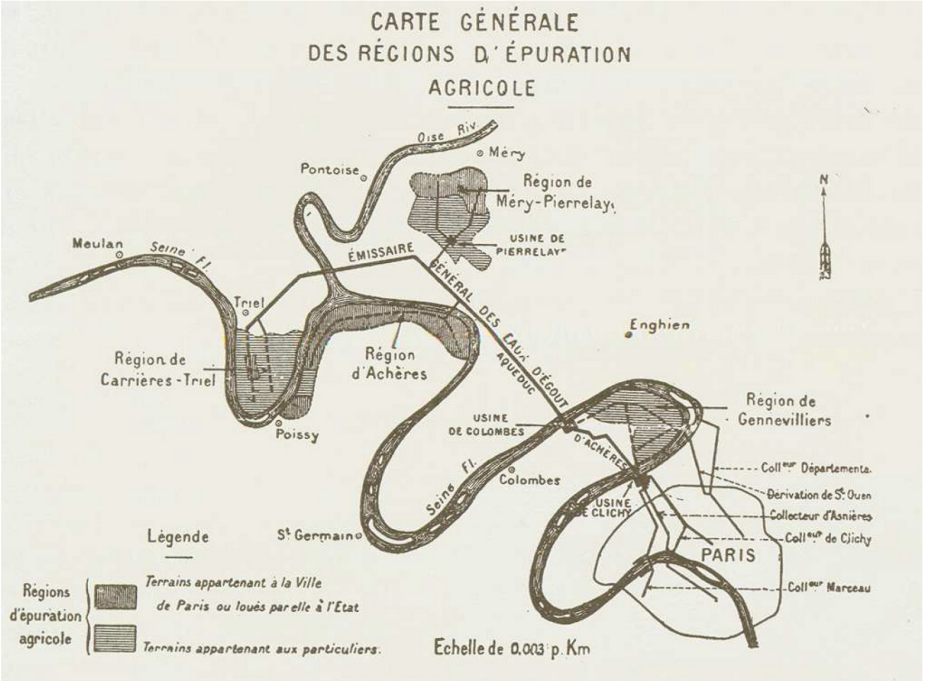

Figure 2: Infrastructure as condition for urban development exemplified by Paris (France) at the beginning of the 20th century. The sewer system steered and facilitated the development of sewage farms which played an important role in the food production for the city. Map by E. Gerards, 1907 (image from Barles, 2007)

Infrastructures can be defined as *"constructed facilities and natural features that shelter and support most human activities – buildings of all types, communications, energy generation and distribution, green spaces, transportation of all modes, water resources, and waste treatment and management"* (PERSI, 2006). Landscape on the other hand is defined as *"an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors"* (Council of Europe, 2000). As such, the current understanding describes infrastructure as the human impetus to alter the natural environment, while landscape is described as the inadvertent result. However, their combination offers an opportunity to redefine both notions into a more integral design brief where goals and means converge, resulting in operative landscape structures that serve multiple ends. In this perspective landscape and infrastructure merge and are the vessels of collective life, and must function, fit and be acceptable in order to enhance the quality of the landscape (Shannon & Smets, 2010). Hence, conceiving infrastructure as landscape enriches infrastructure with generating architecture, constructing landscapes and living environments; it engages social and imaginative dimensions as much as engineering (Shannon & Smets, 2010). This implies that infrastructures no longer belong to the realm of single disciplines like civil engineering, architecture or landscape architecture, but to a crosscutting field that involves multiple disciplines and in which the role of designers is essential (Shannon & Smets, 2011; Bélanger, 2010).

2.1 Infrastructure as landscape

The idea to conceive infrastructure as landscape or landscape as infrastructure is not new. From the second half of the eighteenth century infrastructure was regarded an integral part of the landscape by landscape designers. At this time they were involved in the design and scenography of routes in the English landscape garden. In the nineteenth century, during the industrial revolution in Europe, parks were regarded as important infrastructure for healthy cities (Hennebo & Schmidt, [1975]; Chadwick, 1966). The increasing use of automobiles and the vast urbanisation in Northern America at the end of the nineteenth century initiated the development of metropolitan parks and parkways (Schuyler, 1986; Zapatka, 1995; Dalby, 2002). Green spaces were considered green infrastructures for the city and routes as 'flow landscapes' were travelling was connected to the scenic experience of the natural environment. In the beginning of the twentieth century these ideas exerted great influence on metropolitan park planning and highway design in Northwest Europe (e.g. Dümpelmann, 2005; Zeller, 2002; Van Winden, 2015). From the 1940s onwards landscape architects and urban designers became also involved in design and transformation of infrastructures for electricity generation and flood control, but also brownfields (former industrial areas),

highways, or urban agriculture. Nowadays it is common practice for design disciplines to look at infrastructure as a type of landscape and they have developed particular specialisations (e.g. Berger, 2006; Hölzer et al., 2008; Shannon & Smets, 2010; Sijmons, 2014b; Braae, 2015) (figure 3).



Figure 3: The design of Landschaftspark Duisburg-Nord (Germany) in 1991 by Latz + Partner can be considered a benchmark for the redevelopment of former industrial brownfields into mixed-use use complexes where ecological and socio-cultural objectives blend (photo: Carschten, 2010, CC BY-SA 3.0 DE)

Considering infrastructure as landscape can be characterised as an object-oriented approach, where the infrastructure is the object, which is treated as an interdisciplinary landscape design brief with emphasis on the 'scapes'. It is possible to identify at least four discourses of infrastructural design, which approach infrastructure as landscape from a spatial, ecological, technical, or social perspective. In practice these discourses usually overlap but differ in their main objectives. The spatial approach employs expert, phenomenological and psychological principles to allocate and design infrastructures, such as roads, dykes, and wind turbines, based on formal-architectural characteristics and spatio-visual experience (e.g. McClusky, 1979; Thayer, 1994; Shöbel, 2012). The ecological approach employs nature and environmental based techniques as operative instruments to create green infrastructures (also called greenways, ecological corridors, etc.) which are constellations of open space, woodlands, wildlife habitat, parks and other natural areas, sustaining clean air, water, and natural resources for sustainable cities (e.g. Hough, 2004; Rouse & Bunster-Ossa, 2013; Czechowski et al., 2015). In technical oriented approaches civil and agricultural techniques are the basis for the design of infrastructure as landscape. Examples can be found in for instance route design and design of flood control and urban agriculture (e.g. Snow, 1959; Prominski et al., 2012; Viljoen, 2005). The social approach is

characterised by a human-centred perspective which employs participatory or anthropometric design strategies, for instance via involving people in the development of infrastructures or the design of public space for reasons of social engineering and healthcare (e.g. Carr et al., 1992; Woolley, 2003; North, 2013).

2.2 Landscape as infrastructure

Parallel to the notion of infrastructure as landscape the idea of landscape as infrastructure evolved. Conceiving landscape as infrastructure can be characterised as a goal-oriented approach, where landscape is treated as an operative field that defines and sustains the urban development and ecological and economic processes are employed as formative design tools. Pioneering writings in that respect include Strang (1996), who coined the idea of landscape as infrastructure, and Allen (1999) who identified the field of infrastructural urbanism. Recently Bélanger (2009, 2010, 2013) and The Infrastructure Research Initiative at SWA (2011) introduced the term landscape infrastructure to redefine infrastructure as an integrated alternative for improving mass transit, enhancing public accessibility and ecological performance, while remaining economically sound. Landscape as such becomes the medium through which to formulate and articulate solutions for integration of infrastructure with viable programming that can address many pressing issues facing many cities all over the world (SWA, 2011) (figure 4). In this conception the landscape is often reduced to a set of essential systems that support cities and regions. It focuses on the 'hardware' – the systems of transport, water, production and commerce – and is largely disconnected from socio-cultural or biophysical functions (Duany & Talen, 2013; Carlson, 2013). However, the potential of considering landscape as infrastructure is put forward by Waldheim (2011, p. 4): *"By postponing the question of urban form, these proponents of a landscape infrastructural approach to the architecture of the city suggest that a focus on performance criteria, operational imperatives and contemporary flows might allow us to reengage with social and environmental subject."*

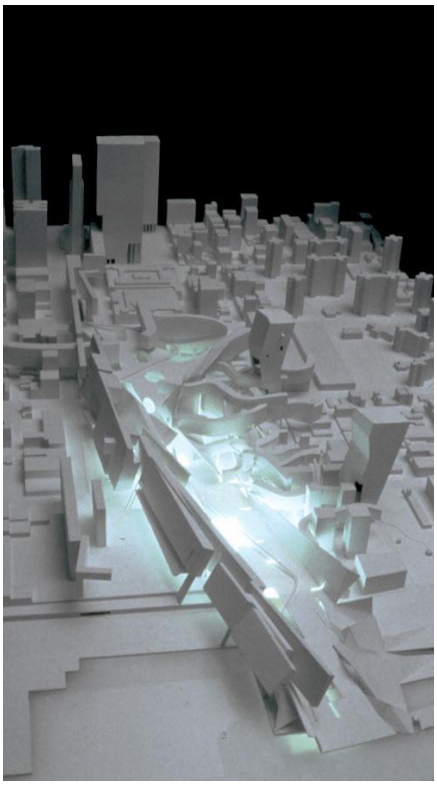

Figure 4: The work of Morphosis Architects in the New City Park competition for Manhattan (New York, USA) in 2009 considers the park as public armature of core programs and infrastructure; landscape as infrastructure (image courtesy: Morphosis Architects)

Among design disciplines, in particular in the field of urbanism as interdisciplinary planning and design activity towards the built environment, there is a recognisable tendency to consider landscape as infrastructure exemplified by the emergence of several 'urbanisms'. Examples of emergent urbanisms in this respect are: infrastructural urbanism (Hauck et al., 2011), ecological urbanism (Mostafavi & Doherthy, 2010; Reed & Lister, 2014), agrarian urbanism (Waldheim, 2010), water urbanism (De Meulder & Shannon, 2008), metabolic urbanism (Baccini & Brunner, 2012; Ferrao & Fernandez, 2013), combinatory urbanism (Mayne, 2011) and landscape urbanism (Waldheim, 2002, 2006; Mostafavi & Najle, 2003). Though there are authors who strive for a more inclusive view (e.g. Tjallingi, 1995; Pollalis, et al., 2012; Hagan, 2015), several novel approaches to urbanism express a thematic, utilitarian lens towards landscape as infrastructure. Others emphasise the involvement of natural processes and hardly address socio-cultural aspects. The emphasis is in most cases on processes as open-ended steering devices, rather than a more form-oriented architectural approach, neglecting the biophysical landscape

as a condition for organising space and its material substance. This type of binary thinking ('this' vs 'that': 'ecology' vs 'sociology; 'process' vs 'form') tends to blind design disciplines to see complex webs of relationships which constitutes the urban landscape (cf. Meyer, 1997). Yet, design is about putting things together rather than taking them apart, integration rather than reduction: it is about relations between things and not the things alone (Meyer, 1997; Sijmons, 2012). Planning and design operations should focus on the interaction between landscape processes and formal-aesthetic aspects and facilitate a multitude of relationships between natural and human systems (Nijhuis, 2013). This type of thinking addresses the integral nature of the urban landscape as a holistic and complex multi-scalar system and the mutual relationship between structure and process (figure 5).

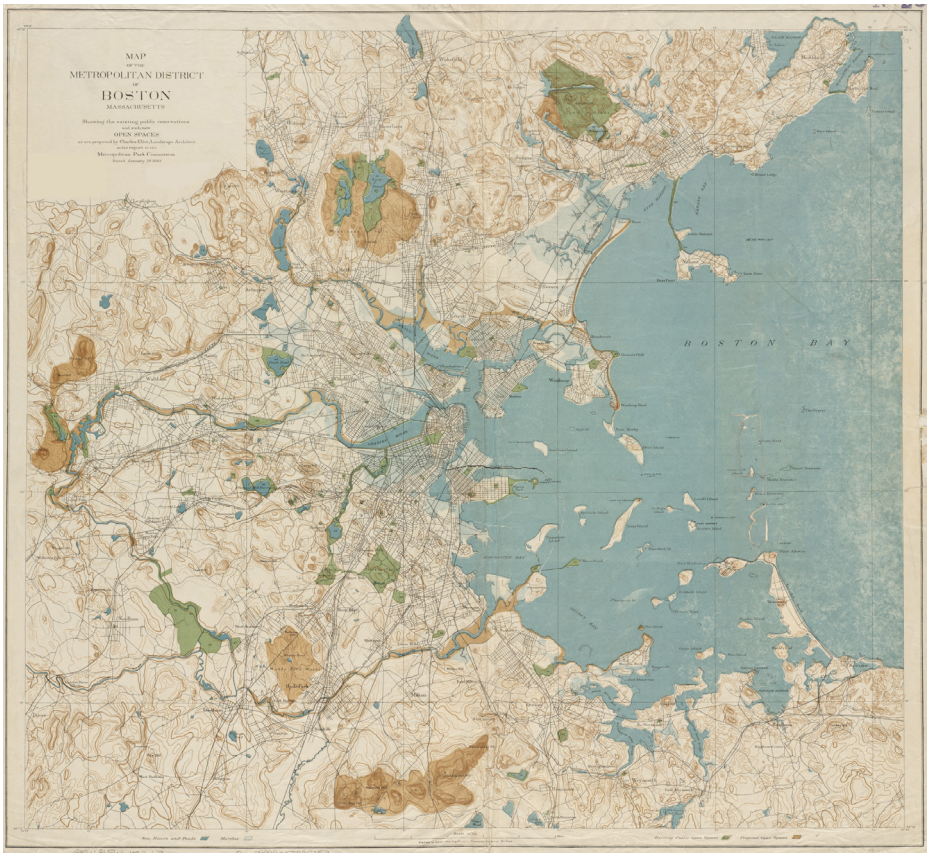

Figure 5: The Boston Metropolitan Park System as proposed by Sylvester Baxter and Charles Eliot in 1893 offered a new vison of how a green-bleu system could function as an armature for the rapidly expanding metropolitan area of Boston (Massachusetts, USA). The plan exemplifies the potential to shape urban and architectural form while employing social and ecological processes to establish a local identity that has tangible relationships to the region (image source: personal archive S. Nijhuis)

Considering urban landscapes as systems could provide a strong countervailing force. Design disciplines need to re-establish the role of design as synthesising activity (cf. Sijmons, 2012) and stimulate an interdisciplinary discourse where architects, urban designers, landscape architects and civil engineers work together on a more comprehensive form of urban landscape infrastructure design.

3. URBAN LANDSCAPE INFRASTRUCTURE DESIGN

Urban landscapes can be understood as complex systems composed of subsystems each with their own dynamics and speed of change (Otto, 2011; Portugali et al., 2012; Batty, 2013). In this perspective the urban landscape is considered a system where different processes and systems influence each other and have a different dynamic of change (Braudel, 1966). Systems are organised entities that are composed of elements and their interaction, and consist of structures and processes (Benyus, 2011; Batty, 2013). The urban landscape as system is a constellation of networks and locations with multiple levels of organisation (Doxiadis, 1968; Otto, 2011; Batty, 2013). Networks are important for interactions, communications and relationships. Locations are the result of the synthesis of interactions. The spatial dimension of networks and locations can be referred to as the *space of flows* and the *space of places* (Castells, 2000). The space of flows can be defined as the formal expression of structures for the (1) provision of food, energy, and fresh water; (2) support for transportation, production, nutrient cycling; (3) social services such as recreation, health, arts; and (4) regulation of climate, floods and waste water (figure 6). The space of places can be defined as the spatial expression of a locale whose form, function, and meaning are a result of social, ecological and economical processes. Though the relationship between the space of flows and the space of places is not pre-determined in its outcome, the space of flows is becoming more dominant as a spatial manifestation of power and function in our society (Castells, 2000). This shift implies that design disciplines should not only focus on the space of places but also on the space of flows because they have the potential to gain operative force in territorial transformation processes. The space of flows emerges as a new field of inquiry for design disciplines and opens up opportunities for shaping architectural and urban form to establish local identity with tangible relations to the region.

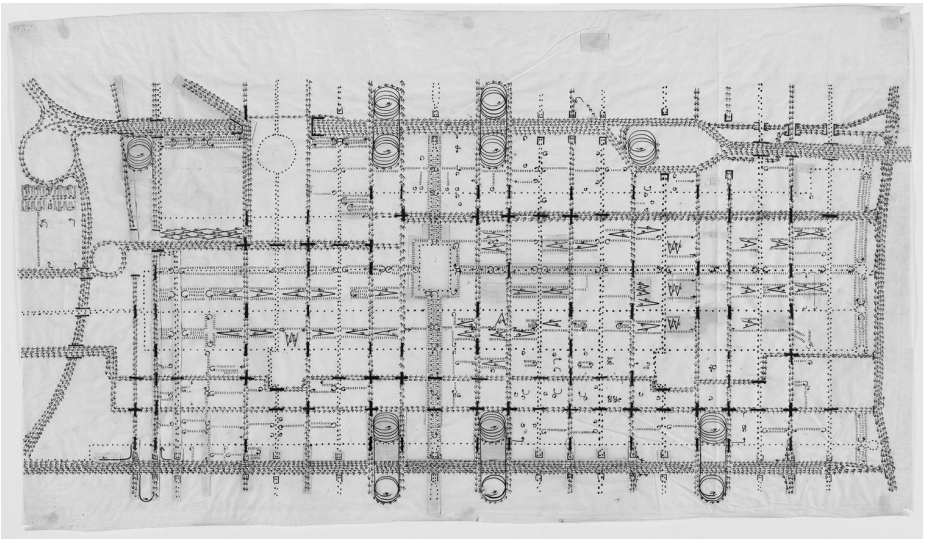

Figure 6: Understanding the space of flows as an formal expression of processes of interaction. Traffic Study project for Philadelphia (Pennsylvania, USA) by the architect Louis Kahn, 1951-1953 (image courtesy: Museum of Modern Art, New York)

3.1 Flowscapes: designing operative landscape structures

The notion of the space of flows or flowscapes could serve as an impetus to develop the concept of landscape infrastructure into a more comprehensive form of urban landscape architecture which addresses the complex webs of relationships constituting the urban landscape. These flowscapes can be regarded as operative landscape structures. They are operative because they direct and facilitate urban development, stimulate social and ecological interaction and establish the relation between process and form, between 'flows' and 'scapes'. The resulting formal framework is a landscape design, which organises the space of places and its material substance. In that respect successful landscape design establishes a characteristic relationship between form and content throughout the scales.

Perhaps it is better to speak of urban landscape infrastructures since they facilitate and frame flows of people, living organisms, materials and information. Urban landscape infrastructures are not only support structures that direct, facilitate and create conditions for urban development, but also have spatial, ecological and socio-cultural qualities themselves. In the words of Habraken (1972, p. 72) they *"cultivate the garden in such a way that the conditions for the growth of a living culture are set up."* As such urban landscape structures are considered armatures for urban and rural development, and facilitate interactions between natural and human systems. The urban landscape infrastructure is a mediator between nature and society, based on a material

space that exists as a structure of man-made patterns as well as an ecological system, and is independent of perception.

Urban landscape infrastructures can be used as a vehicle to re-establish the role of design as integrating activity in contemporary urban development and transformation. This implies that multi-functionality, connectivity, integration, long term strategies, ecology, social-inclusive and interdisciplinary design processes are at the core of spatial design. It aims to create landscapes from a perspective of sustainable development, so as to guide and shape changes which are brought about by socio-economic and environmental processes. Thinking in terms of urban landscape infrastructure design suggests more innovative and integral forms of planning and design. But what is the particular nature of urban landscape infrastructure design? The presumption is that the answer can be found in a particular repertoire of principles, building on grounds prepared by Habraken (1972), Allen (1999) and Kriken (2010).

Urban landscape infrastructure design is about construction of landscapes itself and not about specific technical constructions in a landscape. It is about creating conditions for future development. Here the concept of the longue durée is crucial: understanding the landscape as a long-term structure, which is changing rather slowly. Sustainable development in its original definition as planning for future generations (WCED, 1987) is inherent to this approach. Urban landscape infrastructure design works through the scales from regional to local, from general to specific, and maintains overall continuity as well as facilitates local contingency. The urban landscape infrastructures establish ways of balancing out services and qualities between parts of a territory (Busquets & Correa, 2006). Though they are static in and of themselves they guide and facilitate flows, movement and exchange. In that respect the urban landscape infrastructures are artificial ecologies, managing flows of energy and resources on a site and directing the density and distribution of natural or human habitats (Allen, 1999). Urban landscape infrastructure design is about the creation of robust and adaptive systems, which are open to change. Robustness refers to the persistence of certain characteristics under conditions of uncertainty. Openness is the degree to which the urban landscape infrastructure can adapt within distinct boundaries (Gharajedaghi, 2011). Thus in order to grow and develop urban landscape infrastructures both must persist and adapt; their organisational structures are sufficiently adaptive to withstand challenges, while also supple enough to morph and reorganise (Corner, 2004). Urban landscape infrastructure design recognises the collective nature of the urban tissue and allows for the participation of multiple authors. Urban landscape infrastructure creates a directed field where different participants can contribute (Allen, 1999). Urban landscape architecture design is an interdisciplinary effort where specialisations in engineering and ecology blend with spatial design thinking.

3.2 Potential fields for urban landscape infrastructure design

The concept of urban landscape infrastructure offers a renewed understanding of the landscape as infrastructure, which needs to be explored on its opportunities and possibilities for strategic regional design and local interventions. It stimulates design disciplines like architecture, urban planning and landscape architecture to cooperate and review the agency of design giving shape to the built environment, and establishes relationships between ecology and socio-cultural aspects, between process and form, between the space of flows and the space of places. Urban landscape infrastructure design employs civil-, agriculture-, nature-, and environment-based techniques as operative instruments, which implies cooperation with disciplines like civil engineering, hydraulic engineering and landscape ecology as well. There are at least three potential fields for urban landscape infrastructure design, which emerge from practices which employ the principles as described above:

(1) Transport landscape infrastructures

The first field is the design of urban landscape infrastructures that facilitate different modes of transportation, energy supply, waste treatment and information dissemination (e.g. telecommunications). This category includes the spatial design of vehicular, rail, and air systems, as well as ports and waterways. Energy systems (e.g. oil, gas, nuclear, wind), their transformation to produce energy, and their distribution are also important elements (e.g. power lines, pipelines). When considering these utilitarian systems as urban landscape infrastructures they become entities of multiple-use and integration where technical, aesthetic and social values blend. These multi-modal transportation systems shape conditions for urban development and offer opportunities for new types of public space. Typical design operations in this context are the planning and design of transit landscapes, shared spaces (traffic/public space), multimodal nodes and their environments, transit-oriented development, harbour and brownfield transformation and the development of energy landscapes (figure 7).



Figure 7 Transport landscape infrastructures as armature for urban development. Design study by Venhoeven CS Architecture & Urbanism and others of transit oriented development in Heerhugowaard (Metropolitan Region Amsterdam, the Netherlands). Development of a multi-nodal hub (1), a multi-functional park strip with new urban program connected to it (2), urban densification in a park like setting (3), and transformation of urban tissue in the transport corridor (4) (image source: De Boer et al., 2015)

(2) Green landscape infrastructures

The second field is the design of urban landscape infrastructures that maintain and develop natural ecosystem values and provide associated social, economic and aesthetic benefits to humans as a set of interconnected green space networks. Useful for planning and design is the concept of land mosaics consisting of green patches, corridors and matrices. Much of the foundation of this field draws on the planning principles of regional metropolitan park systems of the nineteenth century. Green space structures can act as organisational structures for sprawling metropolitan areas, providing space for nature development, leisure/recreation and cultural heritage. Food production and energy supply are becoming increasingly important as urban landscape infrastructures. Typical design operations include the planning and design of metropolitan park structures, development of agricultural urban landscapes, urban ecology and protection of heritage landscapes (figure 8).



Figure 8: Green landscape infrastructures as armature for urban development. The Emscherpark is conceived as an interconnected green space network structuring the fragmented 'Zwischenstadt' or 'Middle landscape' in the Ruhr area (Germany) and provides space for nature development, leisure/ recreation and cultural heritage. Top: section of the regional masterplan Emscher Landschaftspark (image source: Projekt Ruhr GmbH 2005). Below: a local design intervention, the Gleisboulevard in Zollverein Park (photo: Thomas Mayer, 2008)

(3) Water landscape infrastructures

The third field is the design of landscape infrastructures that focus on water management and riparian zones. Important issues here are coast and river management – including river modifications, seawalls and floodgates – as well as the use of beach nourishment, sand dune stabilisation, development of flood forests and coastal/estuarine wetlands to create new multifunctional landscapes. It includes the planning and design of land reclamations, major flood control systems (dikes, levees, major pumping stations and floodgates), drainage systems (storm sewers, ditches), major irrigation systems (fresh water reservoirs, irrigation canals), and also sewage collection and disposal of wastewater beyond their utilitarian use. Other important operations are planning and design of multifunctional flood defence structures, river landscape modifications, aquatic landscape development, fresh water storage and supply landscape infrastructures, water fronts, waste water treatment plants, and adaptive water protection measures (figure 9).

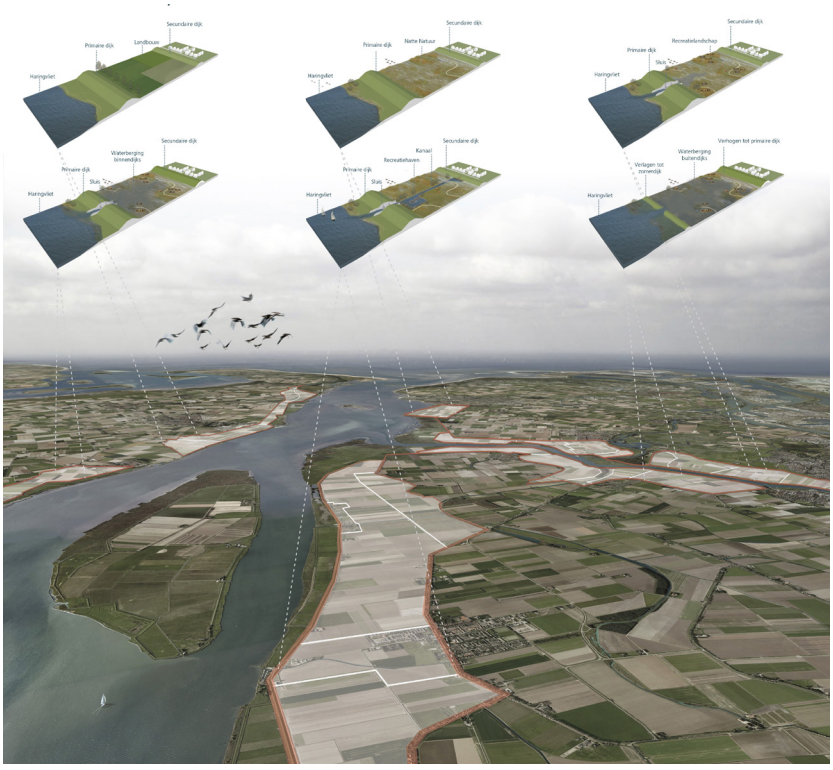

Figure 9: Water landscape infrastructures as armature for urban development. A robust adaptive framework as alternative water protection measure in the Southwest Delta of the Netherlands. The sections show the multiple possibilities for multifunctional development of the zones between the primary and secondary dikes in the rural areas south of Rotterdam (image source: Meyer et al., 2014)

These fields of urban landscape infrastructure design provide lenses to a more comprehensive form of urban landscape architecture and need to be explored and further developed in an interdisciplinary setting. Here research by design can be regarded as a powerful synthesising journey of discovery. The design is the vehicle to draw up hypotheses of possible spatial futures and to test their local and regional consequences. Through interdisciplinary design-based case studies at different spatial scale-levels designers can seek for a better understanding of the dynamic between social and ecological processes and typo-morphological aspects. These inquiries into urban landscape infrastructures should reconcile the desire for economic growth with efforts to create a built environment, which is more sustainable, and socially and ecologically balanced.

4. CONCLUDING REMARKS

In order to redeem control over the processes that shape the built environment and its contemporary landscapes, a fundamental review of the agency infrastructural design is needed. This paper has put forward urban landscape infrastructure design to gain operative force in territorial transformation processes while establishing local identity and tangible regional relationships through connecting ecological and social processes and urban and architectural form. The design of these operative landscape structures is a crosscutting field that involves multiple disciplines and in this field the role of designers as integrators is essential. The ability to interrelate systems in design becomes increasingly important, as the complex interconnection of different systems and their formal expression is a fundamental aspect of contemporary design tasks. The concept of urban landscape infrastructure focuses on the design of the space of flows, which can be characterised as transportation, green and water landscape infrastructures. While acknowledged in the differences amongst the three fields of urban landscape infrastructure design, it is important to understand their relationships and to address them integrally as armatures for urban development. With flows and movement at the core, urban landscape infrastructures facilitate functional, social and ecological relationships between natural and human systems and provide conditions for spatial development. Here the landscape is not considered as something stable, localised and qualified by its own site, but as the product of operations that are structured through a network of transmissions in a regional perspective. To study the urban landscape as a system of dynamic actions, and as a system of the interaction of space and process, opens up new perspectives of interdisciplinary spatial intervention, more in accordance with a society in perpetual transformation, a society in which the user feels more involved, committed, and in harmony with the environment. Urban landscape infrastructures as such have always a social and ecological

vocation, given that they have been conceived to facilitate society as an operative landscape structure for sustainable urban landscape architecture.

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REFERENCES

Allen, S. (1999) 'Infrastructural urbanism', in: idem, *Points + Lines. Diagrams and Projects for the City*. New York, Princeton Architectural Press, pp. 46-59

Baccini, P. & P. Brunner (2012) *Metabolism of the Anthroposphere. Analysis, evaluation, design*. Cambridge (Mass.), The MIT Press.

Badenoch, A. and A. Fickers (eds.) (2010) *Materializing Europe: Transnational Infrastructures and the Project of Europe*. London, Palgrave

Barles, S. (2007) Urban metabolism and river systems: an historical perspective – Paris and the Seine, 1790-1970. *Hydrology and Earth System Sciences* 11: 1757-1769

Batty, M. (2013) *The new science of cities.* Cambridge (Mass.), The MIT Press

Bélanger, P. (2009) Landscape as Infrastructure. *Landscape Journal* 28(1): 79-95

Bélanger, P. (2010) 'Redefining infrastructure', in: Mostafavi, M. & G. Doherthy (eds.) *Ecological urbanism*. Baden, Lars Müller Publishers, pp. 332-349

Bélanger, P. (2013) *Landscape infrastructure. Urbanism beyond engineering*. Wageningen, Wageningen University.

Benyus, J. (2011) *A Biomimicry Primer*

Berger, A. (2006) *Drosscape. Wasting land in urban America*. New York, Princeton Architectural Press.

Braae, E. (2015) *Beauty Redeemed. Recycling Post-Industrial Landscapes*. Basel, etc., Birkhäuser

Braudel, F. (1966) *La Medtiterranee: La part du milieu.* Paris, Librairie Armand Colin

Busquets, J. & F. Correa (eds.) (2006) *Cities X Lines. Approaches to City and Open Territory Design*. Nicolodi Editore

Carlson, D. (2013) The Humanity of Infrastructure. Landscape as Operative Ground. *Scenario journal* 3 (http://scenariojournal.com/article/humanity-of-infrastructure/, accessed April 2015)

Carr, S. et al. (1992) *Public space*. Cambridge (Mass.), Cambridge University Press

Castells, M. (2000) *The rise of the network society* (The information age: economy, society and culture, volume 1). London, Blackwell publishing

Chadwick, G.F. (1966) *Park and town*. London, Architectural Press

Cioc, M. (2002) *The Rhine: An Eco-Biography (1815-2000).* University of Washington Press

Corner, J. (2004) Not unlike life itself. Landscape strategy now. *Harvard Design Magazine* 21: 31-34

Council of Europe (2000) *European Landscape Convention*. Florence (European Treaty Series 176)

Cronon, W. (1991) *Nature's metropolis. Chicago and the Great West*. New York & London, W.W. Norton & Company

Crutzen, P. (2002) Geology of mankind. *Nature* 415: 23

Czechowski, D., T. Hauck and G. Hausladen (eds.) (2015) *Revising green infrastructure. Concepts between nature and design.* London, etc., CRC Press

Dalby, M. (2002) *Regional Visionaries and Metropolitan Boosters. Decentralization, regional planning and park-*

way during the interwar years. Boston, Kluwer Academic Publishers

De Boer, H., et al. (2015) *Onder weg. Vijftien ontwerpen voor Transit Oriented Development (TOD) aan de Zaancorridor*. S.l., BNA Onderzoek

De Meulder, B. & K. Shannon (2008) *Water urbanisms.* Amsterdam, SUN Architecture

Disco, C. (2008) 'Taming the Rhine: Economic Connection and Urban Competition', in: Hard, M. & T.J. Misa (eds.) *Urban machinery: inside modern European cities*. Cambridge (Mass.), The MIT Press

Doxiadis, C.A. (1968) *Ekistics. An introduction to the science of human settlements.* New York, Oxford University Press

Duany, A. & E. Talen (2013) *Landscape urbanism and its discontents. Dissimulating the sustainable city*. S.l., New society publishers

Dümpelmann, S. (2005) The park international: park system planning as an international phenomenon at the beginning of the twentieth century, *GHI bulletin* 37: 75-86

European Commission (2011) *A growth package for integrated European infrastructures.* Brussels

European Commission (2012) *TEN-T: Transport infrastructure.* Brussels

Ferrao, P. & J. Fernandez (2013) *Sustainable metabolism*. Cambridge (Mass.), The MIT Press.

Gharajedaghi, J. (2011) *Systems thinking. Managing chaos and complexity*. Amsterdam, etc., Morgan Kaufmann

Guldi, J. (2012) *Roads to power. Britain invents the infrastructure state*. Cambridge (Mass.), Harvard University Press

Habraken, N.J. (1972) *Supports. An alternative to mass housing*. New York, Praeger publishers

Hagan, S. (2015) *Ecological Urbanism: The Nature of the City*. London, Routledge

Hauck, T., R. Keller & V. Kleinekort (eds.) (2011) *Infrastructural design. Addressing the in-between*. Berlin, DOM publishers

Hennebo, D. & E. Schmidt [1975] *Entwicklung des stadtgrüns in England* (Geschichte des stadtgrüns, band III), Hannover, Patzer Verlag

Hölzer, C. et al. (eds.) (2008) *Riverscapes. Designing Urban Embankments*. Basel, etc., Birkhäuser

Hough, M. (2004) *Cities and Natural Process: A Basis for Sustainability*. London, Routledge

Kriken. J.L. (2010) *City building. Nine planning principles for the twenty-first century*. New York, Princeton Architectural Press

Mayne, T. (2011) *Combinatory urbanism. The complex behaviour of collective form*. Culver City, Stray Dog Café

McClusky, J. (1979) *Road form and townscape*. London, Architectural Press

Meyer, E.K. (1997) 'The expanding field of landscape architecture', in: Thompson, G.F. & F.R. Steiner (eds.) *Ecological Design and Planning*. New York, Wiley, pp. 45-79

Meyer, H., S. Nijhuis, S. & R. Broesi (2014) 'Rhine-Meuse-Scheldt Delta, Netherlands', in: Meyer, H & S. Nijhuis (eds.) Urbanized deltas in transition. Amsterdam, Techne Press, pp. 41-50

Meyer, H. & S. Nijhuis (eds.) (2014) *Urbanizing deltas in transition*. Amsterdam, Techne press

Mostafavi, M. & C. Najle, (eds.) (2003) *Landscape Urbanism. A Manual for the Machinic Landscape*. London, Architectural Association

Mostafavi, M. & G. Doherthy (eds.) (2010) *Ecological urbanism*. Baden, Lars Müller Publishers

Nijhuis, S. (2013) 'Principles of landscape architecture', in: Farina, E. & S. Nijhuis (eds.) *Flowscapes. Exploring landscape infrastructures*. Madrid, Mairea Libros Publishers, pp. 52-61

Nijhuis, S. & Jauslin, D. (2013) 'Flowscapes. Design studio for landscape infrastructures', *Atlantis* 23(3): 60-62

North, A. (2013) *Operative landscapes. Building communities through public space*. Basel, etc., Birkhäuser

Otto, F. (2011) *Occupying and connecting. Thoughts on territories and spheres of influence with particular reference to human settlement*. S.l., Edition Axel Menges

PERSI Technical Committee (2006) *Proposed plan for the assessment of knowledge and practice for sustainable infrastructure*. S.l.: Practice, Education and Research for Sustainable Infrastructure (PERSI)

Picon, A. (2005) 'Constructing landscape by engineering water', in: Institute for landscape architecture (ed.)

Landscape architecture in mutation. Zurich, Gta Velag, pp. 99-115

Picon, A. (2009) *French Architects and Engineers in the Age of Enlightenment* (Cambridge Studies in the History of Architecture). Cambridge (Mass.), Cambridge University Press

Pollalis, S. et al. (eds.) (2012) *Infrastructure, sustainability and design*. London, Routledge

Portugali, J., et al. (eds.) (2012) *Complexity theories of cities have come of age. An overview with implications to urban planning and design*. Berlin, Springer

Prominski, M. et al. (2012) *River. Space. Design. Planning strategies, methods and projects for urban rivers*. Basel, etc., Birkhäuser

Prossek, A. et al. (2009) *Atlas der Metropole Ruhr. Vielfalt und wandel des Ruhrgebietes im kartbild*. S.l., H.J. Emons Verlag

Reed, C. & N.M. Lister (eds.) (2014) *Projective ecologies*. S.l., Actar

Rouse, D.C. & I.F. Bunster-Ossa (2013) *Green infrastructure: a landscape approach*. APA

Schuyler, D. (1986) *The new urban landscape. The redefinition of city form in nineteenth-century America*. Baltimore, The Johns Hopkins University Press

Shannon, K. & M. Smets (2010) *The Landscape of Contemporary Infrastructure*. Rotterdam, NAi Publishers

Shannon, K. & M. Smets (2011) Towards integrating infrastructure and landscape. *Topos* 74: 64-71

Shöbel, S. (2012) *Windenergie & landschaftsästhetik. Zur landschaftsgerechten anordnung von windfarmen*. Berlin, Jovis verlag

Sijmons, D. (2012) 'Simple rules. Emerging order? A designer's curiosity about complexity theories', in: J. Portugali et al. (eds.) *Complexity theories of cities have come of age. An overview with implications to urban planning and design*. Berlin, Springer, pp. 281-309

Sijmons, D. (2014a) 'Waking up in the Antropocene', in: Brugmans. G. & J. Strien (eds.) *Urban by Nature. Catalogue IABR 2014*. Rotterdam, NAi publishers, pp. 12-20

Sijmons, D. (2014b) *Landscape and energy. Designing transition*. Rotterdam, NAi Publishers

Snow, W.B. (1959) *The highway and the landscape.* New Brunswick, Rutgers University Press

Strang, G.L. (1996) Infrastructure as Landscape [Infrastructure as Landscape, Landscape as Infrastructure]. *Places*, 10(3): 8

SWA (eds.) (2011) *Landscape Infrastructure: Case Studies by SWA*. Basel, etc., Birkhäuser

Thayer, R. (1994) *Gray world, green heart. Technology, nature and the sustainable landscape*. New York, etc., Wiley

Tjallingi, S. (1995) *Ecopolis. Strategies for Ecologically Sound Urban Development*. Leiden, Backhuys Publishers

Van Acker, M. (2014) *From flux to frame. Designing infrastructure and shaping urbanization in Belgium*. Leuven, Leuven University Press

Van Winden, W. (2015). The diabolic highway. On the tradition of the beautiful road in the Dutch landscape and the appetite for the magnificent highway in the big city. *Research In Urbanism Series* 3(1), doi:10.7480/rius.3.835

Viljoen, A. (ed.) (2005) *CPULS. Continuous productive urban landscapes. Designing urban agriculture for sustainable cities.* London, Routledge

Waldheim, C. (2002) Landscape urbanism. A geneology. *Praxis* (4): 10

Waldheim, C. (ed.) (2006) *The Landscape Urbanism Reader*. New York, Princeton Architectural Press

Waldheim, C. (2010) 'Notes Toward a History of Agrarian Urbanism', in: White, M. & M. Przybylsk (eds.) *Bracket 1: On Farming*. S.l., Actar

Waldheim, C. (2011) 'Urbanism after form', in: Infranet Lab/Lateral office (eds.) *Coupling. Strategies for infrastructural opportunism* (Pamphlet architecture 30). New York, Princeton University Press

Waldheim, C. & A. Berger (2008) Logistics Landscape. *Landscape Journal* 27(2): 219-246

WCED - World Commission on Environment and Development (1987) *Our common future*. United Nations

Woolley, H. (2003) *Urban open spaces*. London, Spon Press

Zapatka, C. (1995) *The American landscape*. New York, Princeton Architectural Press

Zeller, T. (2002) *Straße, Bahn, Panorama: Verkehrswege und Landschaftsveränderung in Deutschland von 1930 bis 1990* (Beiträge zur Historischen Verkehrsforschung des Deutschen Museums). S.l., Campus Verlag