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Coping with interrelatedness and fragmentation at the infrastructure/land-use interface: The potential merits of a design approach

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Abstract: Road infrastructure projects are increasingly placed in their wider land-use context because of the functional relationships they have with surrounding areas. These more inclusive area-oriented planning processes typically involve a complex of interdependent but institutionally fragmented actors. Effective operationalization of collaborative strategies therefore remains difficult. Various policies introduce spatial design efforts to the infrastructure planning processes as a strategy to deal with these issues. This paper explores experiences in the Netherlands that have placed spatial design in vital positions in the process. An exploration of literature from the fields of spatial design, planning, and geography teaches us that design approaches, in such cases, may be applied to serve as a communicative modus that fosters dialogue, creativity, and eventually an inclusive and shared story about an area's future. We interviewed designers experienced in serving that role and asked them whether and how such objectives are achieved. Consecutively, in order to come to practical lessons for exploitation of the merits indicated by the interviewees, we studied two projects that the interviewees considered best practices. We conclude that a combination of technical and relational design can effectively help a fragmented group of actors to find a shared and meaningful story and make integral choices on infrastructure projects, framed within a wider area's development. Ensuring effective iterations between technical and relational design requires institutionalization of the coordinative capacities of design, as well as the right mindset among participants. This way, the employment of such design approaches facilitates effective operationalization of collaborative governance at the infrastructure/land-use interface.

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1 Introduction

To avoid problems with timely project delivery, social cost effectiveness, stakeholder satisfaction, and support among public and political stakeholders (Flyvbjerg, Bruzelius, and Rothengatter 2003; Busscher, Tillema, and Arts 2015), western countries are increasingly concerned (or experimenting) with integrating regional and local land-use interests in the (re)development of major road infrastructure networks (Bertolini 2009). Examples of such integrated strategies are found worldwide. "Area-oriented" approaches in the Netherlands, "context-sensitive" strategies in the US (Amekudzi and Meyer 2006), the TILLUP-study by the Federation of European Highway Research Laboratories (Fehrl 2013), the "regional packages" in Sweden (Heeres, Tillema, and Arts 2012a), the Madrid Rio-project in Spain (Madrid 2011) and the "Infrastruktur in der Landschaft"experiment in Germany (BBSR 2011) are all initiatives that use major road infrastructure developments to proactively enhance the (urban) landscapes that surround the roads.

These inclusive projects and policies can be seen as attempts to cope with pressing functional interrelatedness within an institutionally fragmented planning context (see e.g., Baccarini 1996; Williams 1999; Van Bueren, Klijn, and Koppenjan 2003). Coping with this interrelatedness involves an enhanced approach of embedding road infrastructure development within a wider land-use context of the area (Neuman 2006); an approach that exceeds mitigating or compensating in situations of conflicting land-use interests. Rather, such integrated development of major road infrastructures strives to enhance national or regional economic vitality in combination with livability at the local level (Graham and Healey 1999). Such strategies imply working in coalitions of actors. However, from an institutional perspective, these actors are often strongly fragmented: Not only do they have their roots in different planning disciplines and represent different cultures, views, approaches etc., or are nested in different governmental levels (national, regional, or local), but they may also have conflicting scopes of interest (sectoral or more inclusive) (see Table 1; see also Herder et al. 2008; Neuman 2012). These conflicts of interests between the silos of line infrastructure planning and spatial planning—and planning's conventional reactive intention to avoid or mitigate them—hamper fruitful cooperation in planning at the interface of major transport infrastructures and other land uses.

Table 1: Fragmentation of planning cultures: Differences between infrastructure and land-use planning

Classic infrastructure perspective (sectoral)	Inclusive land-use perspective
Limited to directly affected site only	Involves indirectly affected site also
Technical, sectoral	Multifaceted, integral
Difficulties, risk assessment, resistance, need for mitigation, compensation	Possibilities, synergy, spin off
Defensive, win-loose, conflict avoiding	Offensive, win-win
Institutionalized	Dynamic institutional landscape of stakeholders and coalitions
Positivist ontology: Calculations, facts	Social-constructivist ontology: Opinions, values, dialogue
Dominated by specialists	Dominated by generalists
Procedural, linear	Network, organic, non-linear

To proactively accommodate such myriads of actors, interests, scales, and decisions, a reflexive, deliberative approach is regularly advocated and applied in many sectors of spatial planning (Forester 1999). Such planning approaches can be partly satisfied with a collaborative governance style (Innes and Booher 2014; Emerson, Nabatchi, and Balogh 2012). Collaborative governance approaches emerged to address decision-making issues among mutually dependent but operationally autonomous actors within such fragmented stakeholder contexts, which could not be solved by conventional hierarchical approaches (Sørensen and Torfing 2009; Van Bueren, Klijn, and Koppenjan 2003). For that purpose, collaborative governance crosses the "boundaries of public agencies, levels of government, and/or the public, private, and civic spheres" (Emerson, Nabatchi, and Balogh 2012, p.2; see also Torfing 2005).

However, a collaborative style does not suffice to successfully cope with the tensions between interrelatedness and fragmentation. Collaboration tends to center around negotiation, agreement, and consensus, which can easily have a conservative stance and result in solutions that are generally acceptable but fail to exploit the complementarities between land uses in a synergetic way. It may also create conflicts and deadlocks and result in the above-mentioned problems with time, costs, and quality (Sørensen and Torfing 2009).

Spatial design is positioned here as a potential means to facilitate an innovative and integrative approach in which the constructed realities of the relevant actors are not the only factors that are important. Rather it concentrates on the joint exploration of the potentialities of a location and on combining interests in innovative and meaningful ways. It is a learning process that challenges instead of confirms the constructed realities of actors (Lawson 2006; Luck 2012; Dorst and Cross 2001). This role of spatial design has been much described in academic literature (see e.g., Madanipour 2006). Spatial design can, for example, be understood as "an argumentative and learning process [that] is very appropriate in situations that require perspectives that go beyond compromise," such as planning at the complicated infrastructure/land-use interface (De Jonge 2009; see also Throgmorton 2003; Van Dijk 2011).

For this purpose, also in road infrastructure planning, spatial design is now increasingly applied, throughout the world, to handle the above-described tension of functional interrelatedness and institutional fragmentation. Examples are the role of designers in the before-mentioned Madrid Rio-project, the involvement of designers in rebuilding flood defenses after Hurricane Sandy in the US, and the cooperation between designers and planners in the expansion of Beijing's train system. In other infrastructure fields, similar trends can de discerned. In the US, for example, following Hurricane Sandy, so-called "rebuild by design" competitions were instigated. These competitions focus on integrating flood protection infrastructures with regional spatial development solutions (Rosenzweig and Solecki 2014). The results of a similar combination of flood protection and urban or landscape development can be seen in Hamburg's Hafencity (Restemeyer, Woltjer, and Van den Brink 2015) and in the Dutch Room for the Rivers-program (Klijn et al. 2013).

The infrastructure planning sector's increasing interest in spatial design can, for example, be recognized in the Netherlands. The Dutch government has adopted policy statements on spatial design to formally emphasize the relation between infrastructure and spatial design (BZK et al. 2008; I&M 2012). Examples of policy implementation are the establishment of the "Route design" program (Van Zelm Van Eldik 2008) and the introduction of design guidelines that link design to all steps in programming, budgeting, and planning of major road infrastructure projects (RWS 2011; RWS 2012a). Also, the role of designers is increasingly institutionalized in the Netherlands with the appointment of designers as "national advisors for infrastructure and land use" (as well as for landscape and water-related issues), the involvement of chief local architects in infrastructure development, and the introduction of independent "quality teams" (in December 2013, a study identified 145 quality teams in the Netherlands: Van Assen and Van Campen 2013; see also Klijn et al. 2013).

Many of these recent initiatives are based on the expectation that spatial design will facilitate constructive interaction among interdependent but fragmented actors. Despite the more general attention to the interactive and innovation-sparking capacities of collaboratively designing spatial solutions, academic literature gives little evidence of the merits and application of design approaches for the challenges of planning at the strongly fragmented infrastructure/land-use interface.

We studied the perceived merits of spatial design in planning at the specific interface of major transport infrastructure works and other land uses. We asked two main questions: (1) What are the merits of a design approach in projects of integrated planning at the infrastructure/land-use interface; And (2) how may these merits be exploited in practice?

This article presents interview outcomes and case studies on design approaches that pay attention to the interrelatedness of infrastructure and other land uses. First, we explore theoretical views on the potential role of spatial design in complex planning situations and its purpose within the collaborative governance and planning realm (Section 2). We combine concepts from spatial design and geography to create a comprehensive conceptual perspective on the processes and content of design. Our empirical research (approach further outlined in Section 3) consists of a round of interviews with 14 Dutch experts in design at the infrastructure/land-use interface (Section 4). We complement the information from the interviews with two best practices from the Netherlands (Section 5). These cases serve to illustrate in what way spatial design potentially influences planning at the interface of infrastructure (road and water) and other land uses. The explored cases are the eastern ring road of the city of Utrecht, from the Dutch national program on infrastructure and land use (MIRT), and the construction of a bypass in the river Waal at Nijmegen, as part of the Room for the River-program (RvdR-program). In both cases, there has been much interest in spatial design as a way of dealing with conflict between fragmented actors. The Dutch water sector, and especially the RvdR-program, provides an interesting learning opportunity. In the RvdR-program, the interest in spatial design is reflected in specifically developed procedures and institutions, whereas road infrastructure planning is still searching for accommodation of design approaches (RWS 2011; RWS 2012a). The findings from the interviews and case studies are discussed in Section 6. Finally, we conclude this study by outlining theoretical and practical implications and suggesting directions for additional research (Section 7).

2 Toward a conceptual view on design in infrastructure planning

2.1 Merits of design in planning

The concept of "design" has a very specific meaning in the context of planning, which we shall explain in this section. Two typical understandings of spatial design can be distinguished. From an architectural perspective, spatial design is often understood as a product, with a strong focus on the content of plans and designs. This contrasts with views that consider spatial design from a planning perspective, which sees it as a way to manage a wider creative process of arriving at decisions and action (Madanipour 2006). In practice, where planning and designing are often part of the same trajectories, these views are closely related to each other.

We argue to make the complementarity of design as a product and design as a process explicit in what has been called "Design Thinking" (De Lille, Roscam Abbing, and Kleinsmann 2013) a "designerly approach" (Luck 2012) or a "planning-as-design" perspective (Van Assche et al. 2012). Some call it "mundane designing" to distinguish it from highbrow design (Luck 2012; McDonnell 2009). It is a cluster of paradigms (Stumpf and McDonnell 2002; Dorst 1997) that have in common that they are ways of treating each problem-solving process as a mindset or as a process of inventing alternatives (Boland and Collopy 2004). Other similarities are that they empathize with multiple kinds of people using and owning the site by visually imagining problems and preliminary solutions where words alone would not convince (Batterbee and Koskine 2005; Utterback et al. 2006; Evans 2011). Designers employ their skills in a continuous creative dialogue (Gloppen 2009). Seen in this way, a design approach helps prevent communication in planning being reduced to abstract policy talk and avoids polarization as conflicting discourses become self-referential and stakeholders can no longer make sense of what others are trying to say, or why.

Design (as a process) is inevitably a part of planning processes, alternatives (the designed options) from which to choose before each decision has to be generated. We take the position that the range of alternatives is never self evident. Participants in a planning process need to actively explore the "solution space" (Rittel and Webber 1973; Forester 1989). Conventional models of design suggested that design problems are fixed. Therefore, the search for potential solutions is defined by a general set of design requirements. Currently, underpinning much of the research on design thinking is a co-evolutionary model of design (Dorst and Cross 2001). This multidimensional thinking and exploration is perhaps among the most significant contribution to knowledge to arise from design studies (Wiltsching et al. 2013). Dorst and Cross (2001) showed that creative design concepts are developed through an iterative process, in which design problems and potential solutions co-evolve. When perceived this way, design involves exploring two conceptual spaces: A problem space and a solution space, with developments in each space informing the other. This co-evolution of problems and solutions has been observed in design meetings (Wiltsching, Christensen, and Ball 2013). It appears that participants indeed go through a learning process.

Designing is thus about conceiving and discussing imaginary futures. An important question is how the act of designing is done in practice: How elaborate or narrow, and how interactive or isolated? The next sections elaborate more on these issues, from an infrastructure planning perspective. Although in the day-to-day practice of planning, content and process are, in fact, deeply intertwined concepts, and for purposes of clarity in analysis and discussion, we treat these concepts separately.

2.2 Content of design: Acknowledging interrelatedness

Turning these merits to good use in planning at the infrastructure/land-use interface requires a profound understanding of the specific nature of planning at this interface, especially in relation to its contents and interactive processes. Concerning the content of design, Throgmorton (2003) (see also Eckstein and Throgmorton 2003) and Healey (2007) argue that, in essence, spatial designs are narratives that seek to influence the "flow of future action." The capacity to cope with functional interrelatedness strongly depends on the ideas about the relation between spatial functions that underlie these narratives. These ideas are constructed by perceptions of what space, place, and scale essentially are.

Regarding these perceptions, the academic debate on structuralist and post-structuralist ideas about geography proposes two relevant understandings of space (Figure 1). Within a conventional "territorial" understanding of space, spatial scales are considered "relatively stable, nested geographical arenas" (Brenner 1998). Places subsequently derive their identity from their position within these cascaded spatial containers (Brenner 2003; Bulkeley 2005). However, in the rise of post-structuralist thinking, geographers have arrived at the conclusion that places derive their identity not merely form their nested position in geographical scales, but rather from "engagements" with other places (Murdoch 2006). Following this argumentation, spaces and places do not have singular identities but can have multiple identities, derived from their relations with other places (Amin 2004; Bulkeley 2005). Within such a "relational" perspective, spatial elements, such as places or areas, become articulated nodes in webs of relations, connecting various spatial scales (Graham and Healey 1999; Allen et al. 2002). Places thus derive their identity from the various networks—including infrastructures for communication and transportation, but also, e.g., social, ecological, and economic networks with local, regional, or national widths—that overlap in a place (Castells 2000).

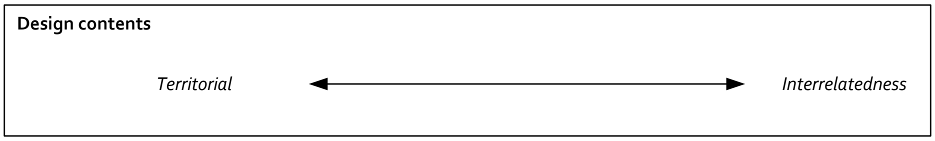

Figure 1: A functional-spatial spectrum of design: Territorially vs. relationally driven design

Conventional infrastructure planning struggles with such views. The jurisdictions of planning authorities and their plans often mismatch the scopes and scales of the issues of day-to-day practice (Bertolini 2009). A striking example is the development of national road transport networks that are, simultaneously, embedded in national, regional, and local scales. The imposed geo-political boundaries of territorial planning jurisdictions compromise the ability to address the full interrelatedness of these infrastructures and other land uses in planning. Whereas, dealing with the interrelatedness of functions that overlap in places requires planning that considers "relations and processes rather than objects and forms" (Graham and Healey 1999). Allmendinger and Haughton (2009), therefore, argue that relationally driven planning approaches are more appropriate than conventional territorially inspired strategies, when the creation of synergies between interrelated land uses is an objective.

2.3 The process of design

Referring to the "persuasive properties of visioning" (Throgmorton 2003), Hajer, Sijmons, and Feddes (2006), Rauws and Van Dijk (2013), and De Jonge (2009) point at another side of design in planning, i.e., its interactive capacity. Spatial design can help with bridging the gap between fragmented visions by presenting a place as a coherent system of interrelated various land uses and by emphasizing complementarities. By drawing attention to such a perspective, spatial design challenges hierarchical governance attitudes that are exercised by fragmented public actors at the infrastructure/land-use interface (Kaufman and Smith 1999; Healey 2007).

The capacity of spatial design to strike a balance between complementary interests depends on the nature of the design process (Madanipour 2006). Dobbins (2011) distinguishes two kinds of spatial design processes: Solution-driven design and problem-driven design (Figure 2). Solution-driven processes are characterized by the assumption that problems are well-defined and stable. Subsequently, such processes focus on developing grand design solutions to the assumed problem. In problem-driven design, the problem is assumed to be much less clear and stable. Such processes rather focus on collaborative exploration of the problem. As a result, problem-driven design processes are much more open and explorative in nature. This focus on "designing as making sense together" seems to better fit the challenges raised by the institutional fragmentation at the infrastructure/land-use interface (Forester 1989).

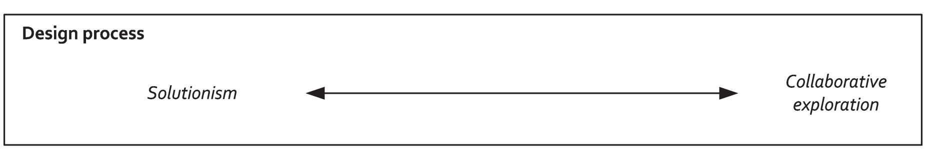

Figure 2: Two extremes concerning design processes: Between solutionism and collaborative exploration

A similar ambiguity can be recognized in the positions taken by designers who have central positions in spatial design processes. In a first possible role, designers are seen as omniscient experts that are hired for drafting grand designs, while in a second possible role, the designer maintains a central position but focuses on facilitating the interactions among participating stakeholders (Vos 2014). The second role, in particular, seems relevant for facilitating deliberation in fragmented contexts (De Jonge and Van der Windt 2007; Roggema 2014). Innes (1992) indicates that a lack of professional facilitation may prevent "the participants from working constructively on their differences." Therefore, this role comprises setting ideal conditions by framing problems, analyzing, warning participants, calling attention to issues, preventing participants from manipulating the process, etc. (Innes 1996). Nevertheless, designers' expert knowledge, as meant in the first role, remains relevant. Designers can facilitate interactive processes by their creative capability to articulate, combine, and visualize potential solutions that are brought to the table.

2.4 Synthesis

Section 2.1 illustrated the potential of a design approach in land-use planning. On the basis of this literature study, it may be expected that the involvement of design approaches has merit for planning at this interrelated but strongly fragmented interface. Sections 2.2 and 2.3 explored two perspectives of spatial design (its content and its processes). This exploration of academic literature leads to four (extreme) examples of how approach could be set up (Figure 3).

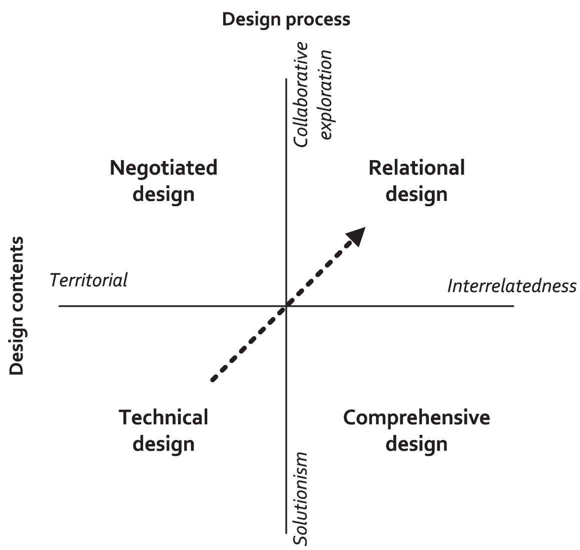

Figure 3: A conceptual model visualizing four (extreme) design strategies for the planning of major infrastructure works

From these possible design approaches, "technical design" reflects the conventional approach to infrastructure planning. Such approaches typically have a more inward orientation toward optimizing territorial solutions. "Comprehensive design" recognizes the need for taking into account interrelatedness of land uses. Nevertheless, the design process remains unchanged and the interactive capacities of a design process remain unused, for example, because the designing is done by a single dominant, omniscient designer. "Negotiated design" sees designing as a way to operationalize a more collaborative approach to finding acceptable planning solutions. It emphasizes the interactive capacities of a design process. Yet it neglects to proactively include other land uses within the infrastructure/land-use system into the design process. This leads to a process with a lot of negotiation but with very few possibilities to actually meet the needs of other land-use interests. The "relational" design approach combines both perspectives. It involves a focus on the interrelatedness of space, and is characterized by collaborative exploration of problems and potential solutions. This combination provides relational design approaches with the capacity to deal with interrelatedness and fragmentation simultaneously. It makes the relational approach a promising alternative to technical approaches in the pursuit of viable plans at the infrastructure/land-use interface and also for overcoming the identified issue with collaborative governance forms.

3 Research approach

In the empirical part of this paper, we seek to gain more insight in the practical merits of the growing number of design approaches (see Section 1) in dealing with the tensions of interrelatedness and fragmentation in major infrastructure development. To provide directions for planning of major line infrastructures, we explore how such merits could be exploited in such situations. Design approaches are defined as the deliberate involvement of spatial designers (e.g., an urban designer or a landscape) architect) in a central position in a project, for the purpose of steering the project's content and interactive processes.

3.1 Geographical limitation

We focused our study on design approaches within the Dutch infrastructure-planning sector. The Netherlands makes an interesting example. Due to a very dense land-use pattern, interrelatedness between road infrastructure and other land uses in the Netherlands is high. At the same time, Dutch infrastructure development is organized in a strong, separate planning sector with a strong focus on the national level (Heeres, Tillema, and Arts 2012b; Hartman et al. 2012). To deal with this complex situation, a transformation is taking place in the Netherlands from conventional trade-offs—with a focus on mitigation and compensation—to more integrated trade-offs focusing on the creation of synergies between land uses (Peek and Louw 2008). As part of this transformation, planning for major infrastructure works in the Netherlands has begun to pay attention to design approaches as a means to facilitate interaction between actors. Various evaluation reports point at these efforts' positive contributions and encourage the further deployment of spatial design as a planning tool (De Jonge and Van der Windt 2007; VROM 2007; CRA 2011; Hulsker et al. 2011).

3.2 Expert interviews

For information about the practical merit of design at the specific infrastructure/land-use interface, we interviewed design experts as a first step in our fieldwork. The experts were selected based on their project experience and prominent advisory roles in spatial design at the infrastructure/land-use interface. First, several designers were approached based on references found in key policy documents. In turn, these design experts were asked to recommend other experienced designers. In the end, we interviewed 14 design professionals who have all been active in projects integrating major road infrastructure issues and land uses with a regional or local character in the Netherlands (see Table 2). All experts have professional experience with spatial design (both design processes and design concepts) as an explicit means to deal with tensions from interrelatedness and fragmentation.

In interviews, we explored what the experts experience to be the merits of a design approach in infrastructure projects. We applied an open interview format. Each interviewee was prompted by the question: "Why were you appointed as the designer in process X?" Later they were asked: "How did the process evolve?" To be able to differentiate between content and process of design, the experts were asked to reflect on the relationship between infrastructure and other land uses in these projects. Additionally, we asked for their ideas about the role of designers in planning processes. We refrained from biased questions such as "Did you succeed?" and "What did you achieve?" To be able to categorize the experts' statements and to point out essential factors, the interviews were transcribed and labeled. Section 4 presents the merits of the design approaches we found for design contents and design processes.

Table 2: Overview of interviewed design experts (In chronological order; middle column indicates the case the experts reflected on, if applicable: a. Nijmegen; b. Utrecht)

Nr.	Function		Relevant expertise
1	Landscape architect	(b)	Road infrastructure and spatial quality
2	Architect	(b)	Former national policy advisor for infrastructure
3	Architect	(a)	Former national policy advisor for infrastructure
4	Landscape architect		Spatial quality design and research
5	Landscape architect		Coordination of quality-improvement programs
6	Spatial quality expert	(a)	Spatial quality coordination Room for the River-program
7	Planning consultant		Strategic spatial planning and infrastructure design
8	Landscape architect	(a)	Waterway infrastructure
9	Landscape architect	(b)	Regional road infrastructure and spatial quality
10	Land-use planner	(b)	Regional road infrastructure and spatial quality
11	Landscape architect		National road infrastructure and spatial quality
12	Landscape architect		National road infrastructure and spatial quality
13	Urban designer		Strategic spatial and infrastructure design
14	Urban designer	(a)	Road infrastructure and spatial quality

3.3 Case studies

Although based on rich experiences, the potential merits brought forward by the design experts need to become more telling if they are to be of interest to planning practice. First, this asks for an insight into the effects of applied design approaches. Second, it requires the identification of concrete lessons about the application of design approaches within infrastructure planning's challenging contemporary context. Therefore, Section 5 explores two cases involving design approaches at the infrastructure/land-use interface that were mentioned by several interviewees as particularly successful projects in terms of identified merits. We explored and highlighted the problems that were experienced, the design approach and the subsequent nature of the process, and the merits of design. We conclude the case description by reflecting on the influence of the design approach on concrete parameters such as project progress, budget, stakeholder satisfaction, and public support. These parameters are much used in the infrastructure planning sector to refer to a development's success. These issues are where the contemporary issues of the infrastructure planning sector with interrelatedness and fragmentation become tangible.

Two case studies were carried out: A water infrastructure case from the Room for the River-program (Nijmegen) and a motorway infrastructure project (the Utrecht Ring Road). Both projects encompassed a complex of interrelated challenges at the infrastructure/land-use interface and explicitly integrated design approaches to overcome these cumbersome issues. Moreover, both projects involved designers in their processes at moments when planning was especially cumbersome due to conflict between institutionally fragmented actors.

Although in both projects the responsibility for the infrastructural works is with the executive agency of the national Ministry of Transport and Environment (Rijkswaterstaat, RWS), the cases show some notable differences. The first case is part of the RvdR-program, which has attracted worldwide attention as an effective planning approach to contemporary problems with water safety in highly urbanized delta environments (RvdR 2012). Its approach has been acknowledged as robust and successful (OECD 2014), and it has been well evaluated (Hulsker et al. 2011; Van Twist et al. 2011). The RvdR-program pursues two integrated objectives: (1) improvement of water safety and (2) local area quality. As the instrumentation of the program's second objective, spatial design is strongly embedded in the program's procedures (Klijn et al. 2013; Rijke et al. 2012; RvdR 2006; RvdR 2007; TK 2007).

The second case is a national motorway infrastructure project. Dutch infrastructure policy aims to structure road infrastructure investments by applying integrated development visions and integration as a strategy for the most complex planning issues (V&W 2012). Spatial design is increasingly advocated as a helpful instrument to facilitate such integration. However, unlike the institutionalization and operationalization of attention to quality and design in the RvdR-program, spatial design is not yet institutionalized in road infrastructure development.

The case studies involved a study of relevant documentation and interviews with planners from the organizations involved in the projects. Additionally, some of the interviewed design experts also reflected on the explored cases (Table 2).

4 Findings from the expert interviews

4.1 Process-related merits

In general, the interviewed experts recognize the conceptualized capacities of design as an activity that may facilitate interactions among the fragmented actors at the infrastructure/land-use interface. The experts brought forward several aspects on which processes that explicitly involve design are better equipped for this purpose compared to processes that do not explicitly include design. For scientific transparency, the numbers in the text below indicate which of the interviewee(s) made a certain statement.

First, the design approach at the infrastructure/land-use interface is a powerful instrument because of its "permanent iterations. A proper design process must be seen as a spiral, in which all relevant interests are taken into account at every step" (#2). These iterations alternately diverge from and converge around the problem and switch between various perspectives and levels of scale (#1 and #4). This generates well-informed perspectives on interrelations between elements of the problem and on the context of the issue that the interviewees considered typical for a design approach.

Second, in the operationalization of this iterative activity, several experts we interviewed see merit in the combined effort of "calculation and depiction" that design may stimulate (#5). This visual mode of communicating introduces a new sort of dialogue. It prevents the kind of communication problems that could follow from difficulties to understand the various professional languages that are used around the table. "When interests and plans are depicted in a single design, participants are forced to start developing a common language" (#1). Moreover, "drawing in collaborative sessions is an invitation. It invites stakeholders to actively participate and start an open discussion about aims" (#8). But proper design is not only an open-ended conversation about interests and aims. Infrastructure projects always contain a number of "highly inflexible preconditions" (#13), preconditions that relate to effectiveness and feasibility, such as the strength of a bridge, the capacity of a waterway, or safety restrictions (also #7). Design is therefore not only about making highly aesthetic grand designs (#3, #10), but realistic and meaningful design that meets these preconditions also applies the best knowledge available to critically evaluate whether effects work out efficiently and acceptably. "Working out integrative ideas needs hard, quantitative substantiation of ambitions and effectiveness of interventions," claims one interviewee (#5). This implies that engineers also have a role in viable design approaches, in addition to the creative minds of designers (#1, #8). Other interviewed experts plea to also involve cost experts, economists, and legal experts from an early stage onward to avoid wasting time, energy, and money on infeasible alternatives and to avoid disappointment (#1, #7, #12, #13).

Third, several experts refer to creating room for learning as an important merit (#2, #4, #5, #8, #9). Learning is considered essential in generating a shared understanding of the underlying issues that are at stake and in developing a sense for the wider interests that are involved (#8). "To be able to work out viable alternatives, it is important to know what other stakeholders find important. […] This must be explored from early stages onward, otherwise plans will have matured too much in the separate minds of planners. […],” an expert explains regarding the importance of learning (#4). Design has this learning function, another expert illustrates:

> Design is a means of communication […]; it makes participants understand each other. Actors may seemingly understand each other in words but loose each other in real practice. The moment you try to depict the reality in a design, people will understand its implications much sooner.

Summarizing, it may be said that independently from one another, the interviewed experts indicate that the merits of a design approach are (1) a non-linear process with repeated iterations that produces a robust and rich outcome, and (2) that this is operationalized through a combined effort of calculation and depiction. This process (3) bridges divides and effectively connects relevant parties through learning and open and complete discussion on content, not blurred by lingos and formal standpoints. The use of terms such as iterations, combination, and bridging hints at a duality in each of these merits. This duality points out that a relational perspective is an addition to technical design approaches, rather than a replacement.

Although the experts generally have positive views of the merits that a design approach can have for planning of major infrastructure works, an important caution is also made. Several experts indicate that there must be a willingness among actors to expand the scope of a project and to engage in design processes (#2, #3, #13). One expert regards an “open attitude” and the capacity to look beyond the scope of one’s own interest as an important precondition (#13), while another expert refers to the “ambition to look broader” and the mindset that is needed for that purpose (#3). A third expert goes a step further and pleas for a “collective public initiative” (#2) as a compelling point of departure for the design process.

When this precondition is met, the involvement of designers is regarded as worthwhile. The interviewees especially value the role of designers as communicative intermediaries between involved planners in addressing the tension between fragmented but interdependent institutions and cultures (#5). First of all, designers are capable of recognizing and pointing out fruitful strategic linkages between interests (#10). To do so, designers must be “multidisciplinary generalists” (#5) who are able to observe issues from multiple perspectives (#2). Second, for that purpose, designers need to stay away from an over focus on grand aesthetics and comprehensive design (#10). Rather, the strong creative and visual capacities of designers must be applied to persuade participants about the implications of plans and designs (#1): “Experiencing is key. […] With merely words on paper, participants will not be convinced about other interests” (#8, also #4). This communication is not limited to the actors who are involved in plan development, but it also entails communication to the general public (#13). The mediating role needs to be combined with the specialist spatial expertise. The mediator needs to understand the project site’s unused potentials and the ways the actors work and think. Designers embody these two roles (Van Dijk and Ubels 2015).

4.2 Merits relating to the content of designs

According to various interviewees, an important capacity of a design approach is to bring together various interrelated land uses in viable plans. “An essential attitude [for planning at the infrastructure/land-use interface] is to look beyond sectoral boundaries and to explore what relations must be established to comes to viable solutions. And that is the power of [a design approach],” an interviewee states

(#4). Another designer goes on (#5): "Designing brings together various interests into a meaningful new whole." The interviewed designers bring forward various kinds of relations that design can help to establish in the practical search for opportunities for a more coherent planning approach to complementary, but conflicting interests.

First, several interviewees indicate that since "all land-use functions eventually claim a certain amount of space," design at the interface of major road infrastructure and other land uses needs to focus on "finding spatial solutions in which physically adjacent land uses strengthen each other, or at least are not in each other's way" (#1, also recognized by #2, #3, #4, #5). Second, to make appropriate trade-offs between complementarities and conflicts, an interviewee stresses, "In designs, the aim should always be to balance strategic and operational aspects of planning" (#1). On the one hand, the effects of complementarity in infrastructure planning are often only achieved in the longer term, via "discussions about the structure of areas" in the strategic domain (#4). On the other hand, the operational domain, where practical realization of infrastructures takes place, is much more concerned with a trade-off between positive and negative effects and avoiding conflict in the short term. Third, integrated road infrastructure designs inevitably cross the boundaries of institutionally separated areas. Interviewees claim that a design approach propagates a fluid interpretation of institutional scales to achieve real synergetic designs at the interface of road infrastructure and interrelated land uses (#2, #4, #8).

It is important to note that sometimes the conflict between interests in a location may be too strong to find starting points for creating a valuable new whole (#3). In the end, when there are too many inflexible preconditions, the space for creating a shared new story for an area becomes too small. Although the described capacities of design may enlighten innovative combinations of interests, design cannot change the inflexible preconditions that actors set. These conditions may eventually become "deal breakers."

Thus, from their wide experience with integrated perspectives on infrastructure development, the people we interviewed distinguish three ways in which a design approach can add a focus on interrelatedness to a conventional territorial perspective. The advocated relational design approach encompasses 1) cross-functional relations, 2) cross-domain relations, and 3) cross-scalar relations.

5 Two design approaches in integrated infrastructure projects

To be of practical value to the road infrastructure planning sector, the merits of a design approach, as identified in Section 4, need further clarification. This section presents two infrastructure projects in which design has taken a prominent role. Several interviewees actively mentioned the selected projects as clear examples of how productive such approaches can be for dealing with the challenges of functional interrelatedness and institutional fragmentation. The two cases are examined to show how the unique properties of the design approaches applied are recognizable in practice (Table 3). Subsequently, we shortly reflect on concrete indicators (time, budget, stakeholder satisfaction, and public support, as mentioned in the Introduction) to see how these approaches influenced the projects' outcomes (Table 4). As we have seen in the Introduction, the struggle of infrastructure planning to deal with the tensions between interrelatedness and fragmentation are often reflected by these indicators.

Table 3: Examples illustrating the practical merit of design per case

Types of design	Merits	Nijmegen Room for the River	Utrecht Ring Road
Design process	Iterative process	During development of a multidisciplinary vision on the area, detailed visualizations were helpful to create a clear and shared understanding. This was repeated at different levels of abstraction.	Vision (ambitions and development of the area and relations in the area) and detail (design of the traffic system) were explored iteratively.
	Calculation and depiction	In the design of the vision for the area, the effects of the proposed interventions were considered from the perspective of technical water-safety ambitions as well as a general area vision.	The design of the traffic system (important for local spatial development) comprised detailed calculations of costs and traffic effects. Certain effects (nuisance) were hard to take into account at an early stage.
	Learning	Interactive sessions and professionals with open mindsets. Local residents and planners accompanied each other on fieldtrips.	Dedicated sessions to learn about each other's referential frames and fundamental conceptions were needed to secure effective interaction between designer and the project team.
	Designer capacities	Two tracks: (a) Independent authorities with substantial knowledge and monitoring capacities and (b) central position of design among disciplines and among stakeholders.	Designers are independent authorities, in between disciplines, strong communicators, with ample creative capacity and area knowledge.
Design content	Cross-functional relations	Multifunctional ambitions and design: Waterway, water safety, housing and recreation.	Ambitions and design serve multifunctional interests: Transport, housing, office locations, education, healthcare, recreation and nature.
	Cross-domain relations	The strategic and operational planning domains were linked in various designs tasks, such as the hydrological capacities of the secondary channel and the aesthetics of the bridges that were connected to the overall strategic vision for the area.	The abandonment of the dogma for symmetric traffic solutions is an optimization that follows from relating strategic ambitions (indirect, long-term) and operational implementation issues (direct, short term).
	Cross-scalar relations	National water safety ambitions and local area quality.	Positive influences on national motorway network and local area. Influences are not left for other scales.

Table 4: Examples of the impact of the applied design approaches on aspects of project implementation

	Nijmegen Room for the River	Utrecht Ring Road
Time	Indirect influence, through positive attitude/support of stakeholders, general public and residents.	Indirect influence: Acceptation of the project among the public by taking away concerns.
Budget	Project stayed within budget.	a) Selected solution for the traffic system (induced by Q-team) is cheaper; b) Cheaper options selected for motorway underpasses.
Quality (stakeholder satisfaction)	Improvements to overall spatial quality of the area/region and aesthetic quality of the bridges in the project area.	a) Introduction of asymmetric solution for the traffic system leaves more room for local ambitions; b) Modification of the open tunnel offers chances to redress earlier mistakes.
Public support	Support of several key residents.	Improved understanding with administrative board and general public.

5.1 Room for the River: Nijmegen

Nijmegen is situated on the banks of the river Waal, close to the Dutch-German border. The river Waal is the main branch of the Rhine in the Netherlands and one of the busiest waterways in Europe. To cope with increasing water volumes, the discharge of the river Rhine will be enlarged from 15.000 m3 to 16.000 m3 per second in 2015. At the same time, a lowering of the water level by 0.27 m is aspired to. The waterway forms a bottleneck at the city of Nijmegen, going from 1500 m between dikes up the river to 350 m at Nijmegen (RvdR 2015). To accommodate for increased capacities at this location, the dike is being relocated inland and a 200-meter wide secondary channel is being constructed.

The initial design for the construction of the secondary channel, by the Dutch infrastructure-planning agency, was merely driven by water-safety ambitions and showed little concern for other interests in the area. However, the city of Nijmegen is a dynamic, rapidly expanding, medium-sized city. Soon after a project to achieve the water-safety ambitions was initiated, it became clear that the secondary channel was to be constructed in an area that had been previously designated for a large housing project. As these conflicting aims for the area were both initiated by the national government, "we were given a strong position to advocate a more integrated approach to the water-safety ambitions. […] Local and regional stakeholders soon started to explore how these interests could be effectively integrated," a designer, employed by the local municipality, explains about the step taken toward a more integrated approach. With local government in the lead, an integrated vision on water works, urban development, and recreation for the area was formulated. This allowed for these interests to be developed coherently and for improvement in the quality of the area around the river as a whole (Figure 4). Like the RvdR-program in general, this project's approach has attracted much international attention as an innovative example of dealing with water-safety challenges in an urban environment.

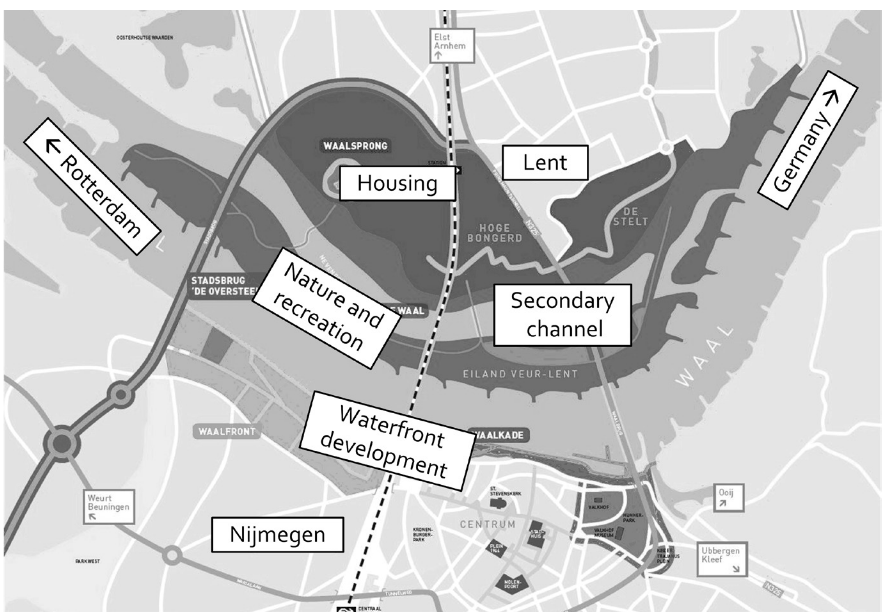

Figure 4: The integrated plan RvdR Nijmegen, including the secondary channel, locations for urban development (Lent), and the new island (Adapted from: Nijmegen Municipality)

Design approach

Following the initiation of an integrated approach, designers were given distinct roles in the project's organization. Two so-called "quality teams" (Q-teams) were established and commissioned to monitor and adjust plans with regard to spatial quality. A local Q-team was appointed for this specific project, while a central Q-team was appointed for the overall RvdR-program (Hulsker et al. 2011; Klijn et al. 2013). Experienced architects and landscape designers participated in both teams. In addition to the activities of the Q-teams, the day-to-day work on working out the integrated plan for the area was done by landscape architects from the local municipality.

Merit of design for subsequent process (Table 3)

The multifunctional ambition initiated a broadening of the project's scope and attention to the creation of viable relations between the different interests in the area. This expanded scope includes attention to a coherent consideration of the water infrastructure, urban developments such as the housing project, and new opportunities for leisure and recreation, as well as local and regional road infrastructures in the area.

The integrated plan firmly connects the national and local levels of scales. The initial sense of urgency rose from the ambition to enhance the safety of the Dutch waterway system. This policy interest is institutionally embedded at the national level, although in practice it is, of course, also a regional and local concern. To be able to develop an effective plan for the bottleneck at Nijmegen, this national interest was linked to regional and local spatial interests in the area, such as housing and recreation.

Moreover, the plan established linkages between strategic land-use ambitions and operational implementation of these. For example, while working on the plans as a strategic vision for the area in relation to wider local and regional ambitions, a detailed study into the hydrological operation of the secondary channel also took place. Strategic and operational ambitions have thus been iteratively combined. Another example of this linkage of planning domains is the tender process. The project organization invited private parties to translate the strategic ambitions into operational designs. To make sure the operational designs would appropriately fit the strategic ambitions, the local Q-team supervised this design process. To maintain the pursued level of area quality, interventions on the detailed design of the bridges in the area have taken place.

The project developed and implemented a multidisciplinary vision of the area by means of an iterative process, in which design has been a helpful aid in discussions and in creating a clear and shared vision on the proposed development. The main landscape designer explains about the role of design in jointly creating a plan for the area:

> Visual design allowed to show various options and to conduct a discussion on the basis of this visualization. In the beginning, these were general designs, illustrating how the situation could become. The purpose was to identify important issues and qualities. That is something that we defined together. After that, we continued along the same way with more detailed visualizations.

The development of this vision has been an iterative process in which detailed visualization has been helpful in discussions and in creating a clear and shared view on the proposed development.

To operationalize these iterations, the project organization approached the incorporation of improvements to the wider area as a dual effort. These efforts combined depiction of improvements to the overall quality of the area with the calculation hydraulic effects. For the latter purpose, all interventions proposed in the light of the attention to area quality were tested against water-safety specifications. Due to modifications to the plan following from the attention to the local quality interventions in the area, water safety is now expected to improve even more than anticipated at the start of the project.

Getting to understand each other's language has been an important merit of the design approach. A designer involved explains how this learning emerged in the Nijmegen case:

> In the end, we were just a group of planners and stakeholders together in a room. I remember

> meetings with experts from all kinds of disciplines. Plans are then brought forward and discussed. That goes well, if everyone is open to learn about other interests. […] It has also been crucial to get to know the local residents and vice versa. Therefore, we did not stay indoors but went outside with the residents. To get a better idea of their interests and to make sure they understood us, we took them along into the area and each explained to the other what was important to us. […] For that purpose we also made 3D-visualizations.

Finally, the designers involved added dual merit. On the one hand, the project organization's designers took a leading position and acted as intermediaries between the various interests in this project (water safety and location quality). On the other hand, the experts in the Q-teams were independent authorities who influenced planning where necessary. The main functions of the Q-teams were to monitor plans and process and to provide ample substantial knowledge about designing at the interface of waterways and urban land uses. For this role, authority based on vast expertise, a strong communicative attitude, and knowledge about design aesthetics have proven to be essential capacities.

Project outcomes: Influence of design (Table 4)

The project managers and designers who were interviewed see a positive influence of the applied design approach, not only in terms of the process but also of the eventual plan content. The proposed adaptations to the secondary channel are seen as improvements to the quality of the area as well as to the technical functioning of the channel in terms of water safety. The quality team also changed the design of the bridges. The initial design provided for simple bridges. After intervention of the Q-team, it was recognized that these failed to meet the high aesthetic quality standards of the area's overall development, and new bridges were designed. Concerning public support, the people interviewed believed the project's design approach has been helpful in gaining and maintaining the support of several key residents. Moreover, the positive attitudes that were gained this way may have indirectly contributed to the realization of the project within the initially anticipated timeframe. Arguably, this is a bold achievement, given that major infrastructure works are prone to problems with meeting required delivery schedules.

5.2 Utrecht Ring Road

The city of Utrecht is located at the heart of the Netherlands and is one of the main cities of the Randstad area. The city's ring road consists of three main motorways of the Dutch national infrastructure network and a northern arterial road under local and regional management. The ring road is considered the "central hub" of the Dutch road infrastructure network (I&M 2013b). It suffers from capacity problems on all four sides of the city, affecting local and regional as well as national traffic interests (I&M 2013a). Our case pertains to the eastern section of the ring (motorway A27), where bypasses are proposed to separate local and regional traffic. Other interests in this area include national and local roads, a university campus, a university hospital, office locations, an increasing amount of residents, and areas with cultural, historical, or landscape value.

Both the province and city of Utrecht advocated the necessity of an integrated approach for these topics, which together determine the quality of Utrecht's eastern urban area. To serve not only the infrastructure network but also the livability and attractiveness of the city of Utrecht, the project's ambition is that the quality of the area not be worsened and, where possible, will even be improved (Figure 5) (RWS 2014).

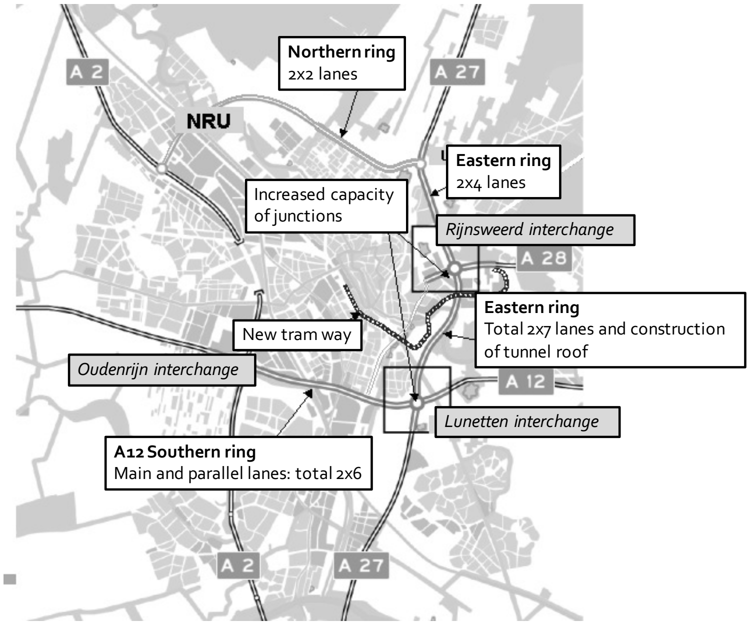

Figure 5: The proposed works at the Utrecht Ring Road (adjusted from VERDER 2010)

Design approach

Design and designers have played an influential role in furthering the project's contradictory ambitions of transportation and livability. Adequate attention to spatial design was secured during the planning process through the establishment of an independent quality team, consisting of experienced spatial designers (Lörzing 2013) who were to serve as counterpart to the infrastructure planners. As soon as "it was felt that the infrastructure planning agency lacked the capacity to realize the project's dual ambition of improving the motorway network as well as the general quality of the urban area," this Q-team was officially appointed to advise the responsible politicians at decision-making moments, explains the project manager for the infrastructure works. Additionally, the Q-team closely worked with the project managers and technical designers of the infrastructure planning agency: A "go-along situation" is coined by one of the members of the Q-team. Compared to Nijmegen's situation, the Q-team in Utrecht seems to be more directly embedded in the planning process.

The designers on the Q-team were positioned as independent authorities. The team, with vast substantial knowledge, had a prominent role in communicating ideas to decision makers and to the general public. In this role, the Q-team members used their creative capacities and a strong political-administrative sense.

Merit of design for the subsequent process (Table 3)

In early 2014, a preferred solution was selected for the southeast section of the A27 motorway. This alternative includes raising the traffic capacities on Utrecht's southern and eastern ring road, as well as enhancing livability in the area by allowing for the exploitation of spatial development opportunities concerning housing, office locations, education, and healthcare (RWS 2014). Two alternative solutions for the bypass system on A27 were drawn up (Figure 6). One member of the Q-team unobtrusively explains the process and the role of experts in the team:

> The fly-over [in the originally intended alternative A] would rise high above the present housing [at Lunetten interchange]. It became clear that this would be dramatic for the neigh-

> borhood in terms of noise and landscape impact. The Q-team drew attention to a different solution: An asymmetric solution that remains much closer to the surface—also a major budget saving. Traffic engineers initially rejected this alternative since they essentially prefer a symmetrical solution [for north-south and south-north directions]. However, little is wrong with an asymmetric solution. It is just not standard practice.

The project manager from the infrastructure agency clarifies how the perspectives of the infrastructure planners were turned around, nevertheless:

> The Q-team opened our eyes and helped us to overcome our organization's dogma of symmetric solutions. In the light of this project's multifunctional ambition, the asymmetric option is the better one. This solution handles traffic more effectively, features a slimmer design and uses less urban space, and spares us the construction of several large and unpleasant fly-overs. Moreover, as large fly-overs are often expensive, alternative B is the cheaper solution."

In the end, alternative B was selected as the preferred solution for the bypass system.

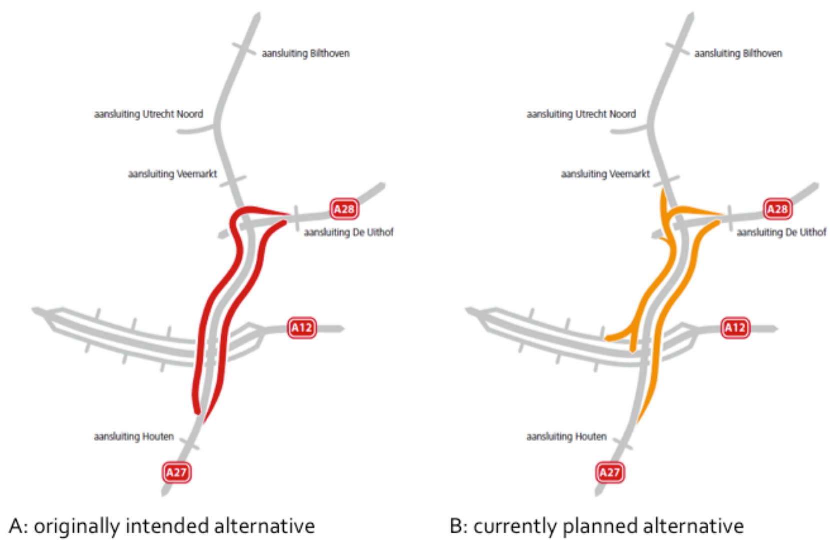

Figure 6: Two configurations for the bypass system on the eastern section of the ring road (A27) (adjusted from RWS 2012b)

During this process of developing an appropriate solution for the traffic system, issues and potential solutions became apparent in design discussions by switching between strategic and operational design domains. In the design process, the focus was simultaneously on improving both long-term and short-term influences. Finally, by combining potential improvements in transportation and other land-use functions, the selected alternative B stands out in connecting the national interest of transportation with broader interests in livability at the local scale in a more synergetic way than alternative A (Figure 6). It must be noted that, despite the achieved improvements to the bypass design, which lead to more positive outcomes for the surrounding area, the concern of residents close to the ring road has not been eliminated. Residents remain concerned about the effects of the increased traffic capacities, such as increasing noise and air pollution or the redistribution of these problems between locations in Utrecht.

In the planning process for the Utrecht Ring Road, designing modifications to the existing infrastructure became a dynamic process of stepwise iterations. The iteration combined general visions on local area quality and the detailed technical performance of the infrastructure network. In this process, the selection of the traffic system was recognized as an important precondition for opportunities with regard to local area quality. To understand the influence of the motorway infrastructure on the local environment, planning issues were explored in design sessions, where the problems were explored from various perspectives (i.e., narrow and broad, general and detailed). To operationalize the broad ambitions in concrete designs, planners subsequently engaged in a combined process of calculation and depiction. Various alternative design proposals were prepared to solve the transport problems in the area. These efforts included estimating traffic-related effects of these proposals, as well as their effects on local spatial development ambitions. In this process, it proved hard to obtain a realistic and useful view on all design parameters. Especially, useable noise data proved to be only available at a very late stage.

Despite this positive picture, effective involvement of the designers in the Q-team and successful interaction between the Q-team and infrastructure planners were not straightforward. The project manager explains that it took a dedicated session to learn about each other:

> After a few sessions it was clear that the Q-team and the project organization did not understand each other and some irritations surfaced. For example, the Q-team was advising about the role and position of infrastructure within the "urban tissue." The infrastructure planners could not grasp that conception and apply it in their work. Only after a session where we explicitly explained fundamental conceptions and underlying ideas to each other did we achieve a workable base, and after that, interaction appeared not that difficult anymore.

As an independent authority, the Q-team has been instrumental in clear communication (of ups and downs) to the general public, as well as to decision makers. The involvement of an independent team has facilitated discussions between the project organization and the general public and instructed the board of decision makers on the pros and cons of various alternatives. Indirectly, this has taken away concerns, which, in the end, has been key in the acceptation of the project. As such, "the involvement of the Q-team has also indirectly had a positive influence on the project's progress," according to the infrastructure project manager.

Project outcomes: Influences of design (Table 4)

The option now selected for the A27 may be regarded as the alternative with the highest quality. Not only does this option leave the best room for local spatial development ambitions, but it also allows redress of "mistakes" that were made during the initial construction of motorways in the area, mentions the project manager. An example of redressing mistakes from the past is the construction of a tunnel roof over the motorway. The roof allows the partial restoration of a historical connection between the urban area and surrounding landscape that had been cut off during the road's initial construction. A similar influence on quality and budget can be discerned with regard to the motorway's underpasses for local traffic. The Q-team showed that the most expensive solutions are not necessarily the best ones.

6 Discussion: Crossing boundaries

This paper deals with the challenges of setting a wider frame to infrastructural projects: An area-oriented view at the infrastructure/land-use interface. Empirical work shows that design approaches have been helpful. The interviewed designers brought forward merits of a design approach to improve the interactions between participants, as well as the capacity to pay due attention to the functional interrelatedness of land uses (Table 3). In the cases studied, these merits are recognizable and effective: They helped to improve the projects' eventual performance on project-concrete indicators such as time, budget, stakeholder satisfaction, and public support (Table 4). Moreover, in terms of water safety and traffic capacities, the developed solutions promise better performance than initially anticipated.

6.1 Expanding and crossing boundaries

These improved performances are attributed to the applied design approaches. In retrospect, the fact that these results would not have been met in a more conventional setting indicates that there are boundaries that prevent these solutions from being found. In order to find ways forward in dealing with interrelatedness and fragmentation and to give concrete directions for operationalization of a design approach in contemporary infrastructure development, this section discusses the three types of boundaries that were crossed in the design practices we studied for this paper: (1) Geographic boundaries, implying (2) integrated cultures of thinking, requiring (3) proactively linking these cultures by smart institutional interventions.

Infrastructure has a value for serving other land uses by facilitating flows of traffic or water between areas. Infrastructure connects locations to other locations or to different scales. But the infrastructure itself can also be a valuable part of the integral spatial configuration of an area. This variety of relations can be distinguished in Nijmegen as well as in Utrecht. In both cases, eventually, a conventional focus on purely territorial optimizations was abandoned and replaced by an approach that aimed to pay attention to the experienced interrelatedness of the land uses in the concerning areas. For that purpose, the projects applied a relational design approach that explored potential synergies between land uses, domains, and scales, instead of by focusing on minimizing the negative effects of interrelatedness. Examples are the optimization of motorway design combined with urban livability and opportunities for spatial development in Utrecht or Nijmegen's effort to combine the construction of a secondary channel with ambitions in nature, recreation, and waterfront development.

In both cases, this relational design approach acted as a de-escalator of conflict between fragmented actors. Through process-related merits, such as permanent iterations between vision and detail, as well as learning, designing became a platform for collaborative exploration of problems and potential synergies. That allowed participants to create new, shared design solutions, instead of looking for the minimal conditions for consensus about a negotiated compromise. Based on our explorations, these merits hold for the development of both road and water infrastructure.

6.2 Marrying two distinct cultures of thinking

A question that remains is how to position this relational approach as a replacement of or as an addition to conventional, technical approaches to design? As mentioned earlier, by expanding the geographical boundaries from the primary infrastructure site to the area surrounding it, a more extensive and complex range of actors and interests come into play. This is more profound than just having to deal with more interests. What happens is that the conventional infrastructure perspective is supplemented with an additional culture: An inclusive land-use perspective (see also Table 1). The cases illustrate how a larger geographical perspective requires a culture of thinking that is tailored to deal with a wider range of interests, stakeholders, procedures, etc.

Our study illustrates that neither the physical reality nor the societally perceived reality can be denied; both cultures are needed for planning at the studied interface. The cases illustrate how a relational design approach is strong in developing appealing visions of the future of places. This is a process of fueling expectations, seductive images, and rhetorical power needed to generate political willingness on the various relevant scales. However, an infrastructure project also needs to perform in a technical sense.

Relational design is unsuitable for optimizing technical performance of infrastructures. For example, it lacks attention to feasibility and effectiveness of infrastructural solutions or the capability to optimize the influence of these solutions within wider motor and waterway networks. This shortcoming should be met by a territorial, solution-oriented perspective, which is not at the forefront in relational design (see also Table 5).

Table 5: Strengths and weaknesses of technical and relational design in planning at the infrastructure/land-use interface as observed in the explored cases

	Strengths	Weaknesses
Relational design	• Vision centered • Linking multiple functions • Synergies/added value • Indirect planning domain • Interaction facilitating	• Lacks detailed engineering insights for infrastructure construction • Lacks tools to assess effects on flows, such as traffic and water, or costs
Technical design	• Engineering-centered • Detailed infrastructure design • Detailed assessment of effects (flows, cost) • Direct planning domain • Grand designs	• Neglects potential synergies between functions, scales, and domains • Does not facilitate interaction between engineers and planners

An area-oriented approach to infrastructure planning implies the marriage of two design cultures. This is what makes planning and design at the infrastructure/land-use interface so challenging. Throughout both planning processes, the outcomes of relational design were supplemented with a technical perspective (and vice versa, see Table 5). In addition to the collaborative explorations of the interrelatedness of land uses, both projects maintained a territorial design approach to work out detailed optimizations to the infrastructures. For example, the trade-offs made around Utrecht's motorway system (symmetric or asymmetric solution) involved deep technical considerations of various traffic solutions. In the end, these efforts led to improved traffic performance and reduced investment needs. In Nijmegen, a similar result was achieved and, eventually, the efficiency in terms of water management of the secondary channel will be higher than was anticipated before integration with other local ambitions.

This discussion illustrates that relational design is not better than technical design. Area-oriented infrastructure planning requires both: The effectiveness is in the balance between technical and relational design (Figure 7). A balanced process combines the strengths of technical and relational design in a continuous and iterative co-evolution of problem and solution (Table 5). On the process side, it combines the strengths of solutionism and collaborative exploration, while the side of the content design is fueled by territorial and interrelated interpretations of space. The emphasis of design alternates between technical and relational design, depending on the task at hand. This dynamic interpretation seems to be in line with ideas about "system synchronization," which advocates the combination of the different ends of a planning-to-design spectrum to compensate each other's weaknesses (Teisman and Edelenbos 2011).

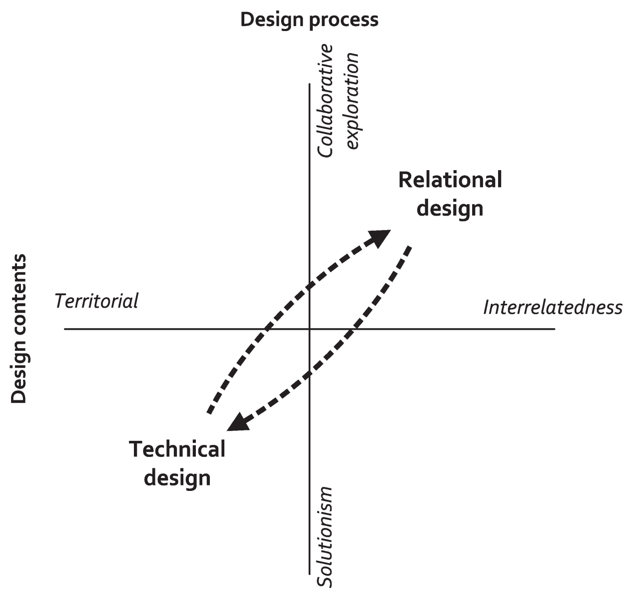

Figure 7: An adapted version of the conceptual model: Design as a dynamic combination of technical and relational design cultures.

6.3 Requiring institutional fixes

Since these two design cultures differ strongly and in many ways (Table 1), their natural tendency is to polarize. Traditions, professional backgrounds, internal structures, internal discourses, and practices will reaffirm and intensify the culture's identity. Combining technical and relational design, and continuously iterating between them, does not come naturally. It needs an on-going investment that is embedded institutionally in the project.

In the case studies, spatial designers in an intermediary role provided an institutional fix for this issue. In both cases, Q-teams were installed to serve as linchpins and to stimulate alternating between relational and technical design. The teams consisted of independent experts who gained authority from capacities such as vast substantial knowledge, a sense for the specific location, eminent communicative skills, and political-administrative sensibility. These design experts linked the different cultures of actors by giving direction to the content and to the interactive process. Moreover, designers do not only facilitate a constructive dialogue between the two cultures by creating conditions, designers are also able to analyze and to call attention to the specific aspects of the area into the dialogue. By translating ideas into spatial visualization (drawings, sketches, and maps), the confrontation with the area's problems, limitations, and possibilities produces new optional solutions. In addition to an institutionalized role for spatial designers, the interviewed experts plead to also involve cost experts, economists, and legal experts from an early stage onward to avoid disappointment in later stages.

The Nijmegen project illustrates a more formal interpretation of the intermediary role. In this case, the members of the Q-team were first of all involved as independent experts in spatial quality for monitoring the process and making adjustments at crucial project milestones. In Utrecht, while formal advice was given at every decision-making moment, the main merit of the Q-team was more continuous: A permanent high degree of constructive interaction between Q-team and project organization.

7 Concluding remarks

With this qualitative study, we aimed to test assumptions about the potential merits of design in dealing with the challenge of functional interrelatedness in a strongly fragmented stakeholder context. Additionally, we pursued to give directions for the application of design approaches within so-called “area-oriented” strategies in road infrastructure planning. The preceding case studies and discussion indicate that design approaches may indeed facilitate planning in situations of strong functional interrelatedness and deep institutional fragmentation. The cases also illustrate that design efforts are preferably set up in such a way that the strengths of technical and relational design complement each other. Coordination is needed for effectively combining the strengths of these design cultures. Regarding the role of designers, it is concluded that especially this coordination of the design process is important. Coordination requires a certain combination of capacities, such as vast substantial knowledge and a strong sense for the interrelatedness of land uses at the location, the communicative skills to address technical and relational designers and to link these cultures, and political-administrative sensibility. In situations of strong interrelatedness and fragmentation, this combination of content- and process-related skills is probably more effective than the creation of grand visions by omniscient artists or the employment of a general mediator. To secure the added value of spatial designers, it is therefore recommended to institutionalize these capacities in the infrastructure planning process. Additional essential preconditions to overcome fragmentation issues are an appropriate mindset and willingness to work together among participants. In the cases that were studied, the right mindset sprouted from a crisis in the planning process.

In the Introduction of the paper, we pointed out that the operationalization of collaborative governance is often problematic. The subsequent study illustrates that one of the positive effects of iterating between technical and relational design is that it may facilitate the practical operationalization of a collaborative governance style. The cases point at the capacities of well-coordinated design approaches to enrich planning with a proper and creative discussion about the interrelatedness of land uses. This capacity is in the open and equalizes dialogues between stakeholders with various interests so that a design approach may facilitate. This way, design becomes a platform for collaborative exploration of the potential synergies between the land uses in an area. In the end, both cases endeavored to achieve meaningful solutions that comprise a shared story about the future of an area, rather than solutions that are only acceptable as a product of negotiations. By means of permanent iterations between perspectives, the technical preconditions, which form an inflexible context, remain undisputed during the collaborative process.

In conclusion, this paper shows how design may help address strong institutional fragmentation by creating a platform for proactively exploring synergies between various land uses instead of a reactive discussion about mitigation of negative effects. These findings should also be applicable in planning systems outside the Netherlands that encounter similar issues with fragmentation. This would, however, require a certain willingness to work collaboratively and an open mindset, which could, like in the cases in this paper, emerge from a crisis in a planning process or from the shared political aim of enhancing the general quality of an area. Operationalization of the findings, nevertheless, requires tailored measures that fit specific institutional contexts. Further verification of the described mechanisms and the proposed interpretation of design would require a dedicated study that compares more projects in different international contexts. Moreover, the creation of viable development visions is only a first step in an area-oriented infrastructure planning processes. To effectively implement area-oriented infrastructure planning, it is necessary to cover a wider perspective on integrated planning and to explore subsequent steps. Examples are assessment of the created synergies for decision-making purposes (decision support instruments), or the exploitation of these values through applying value capture mechanisms.

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