Navigating mega projects through complexity and uncertainty: strategic and adaptive capacity in planning and decision-making

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3. Adding Value to Mega Projects: Fostering Strategic Ambiguity, Redundancy, and Resilience in the Decision-Making Process

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Introduction: The opening and closing of mega project decision-making

The question of how to cope with complexity and uncertainty when making decisions on mega projects is an intriguing issue. It has been the subject of extensive strategic planning research. The different coping strategies may be set out on a continuum. At one side, a growing number of researchers claim that complexity and uncertainty should be considered as integral to the decision-making process. They advocate recognizing complexity and uncertainty in project goals, in the treatment of knowledge and action, in the setting up of the actor constellation, and in management and planning. According to this approach the decision-making process needs to be organized to adapt and respond to changing situations. In short, these researchers believe complexity and uncertainty should be at the heart of decision-making. They fear the 'tunneling' of the decision-making process; ie, that it is closed off from outside influences (De Bruijn & Leijten, 2007; Priemus, 2008; Priemus, 2010b; Swyngedouw, Moulaert, & Rodriguez, 2002). At the other end of the continuum, the more established 'closed' approach prescribes dealing with complexity and uncertainty in a cautious way. While the challenges of complexity and uncertainty are not completely neglected, adherents of this approach focus on preventing or reducing the occurrence of complexity and uncertainty in the first place (instead of integrating them in the style of decision-making). According to the 'closed' approach (e.g. Burke 2003; Cooke Davies 2001) the objectives of the project should be narrowed into a-priori defined trajectories and outcomes (e.g. only transport objectives). Knowledge and action perspectives should be compartmentalized very economically (e.g. through piecemeal engineering, rational lines of decision-making and project implementation in successive isolated parts). Actor constellations should be reduced to the core group of stakeholders. Trajectories of decision-making should be rationalized for the sake of efficiency and to overcome the constraints of time and finance. Characteristic for this approach of dealing

with complexity and uncertainty is also the frequent promotion of top-down styles of decision-making through the revision of legislative procedures (Wolsink 2003).

The differences of approach between the two poles of strategic thought are so straightforward – with regards to both the diagnosis and the remedy – that the solutions of one perspective are often considered as being the crux of the problem for the other. While approaches in the first-mentioned pole of the continuum urge to open the decision-making processes and to use the potential of complexity and uncertainty to enrich the process of deliberation and adaptation, the adherents of the other pole recommend removing duplication and 'noise' as far as possible and tend to close the possibility of interfering variables. European-wide comparative studies into decision-making on urban mega projects confirm the recurring tensions between the different approaches (Majoor, 2008; Salet & Gualini, 2007; Swyngedouw et al., 2002) and mega infrastructure projects are no exception (Altshuler & Luberoff 2003; Priemus et al., 2008). It seems that the second group (which includes most practitioners) feels the pressure of political rationality: the demand for precise ambitions and outcomes together with prudent budgeting of time and money – vital ingredients for making a project politically feasible. Simple and direct solutions are preferred above academic claims to bring better deliberation and even more efficient outcomes by widening and opening the horizon of decision-making. Thus, the opening and the closing of decision-making processes appear to split the current strategies aiming to cope with complexity and uncertainty in mega projects. We do not simplify the assumptions of the different approaches; the solution is not somewhere halfway in between. Actually, we believe, both tendencies (both the opening and the closing) are necessary conditions for a well-balanced and rich decision-making process.

In this paper it is argued that intelligent strategies of decision-making require both the widening and the closing of the horizon. Decision-making of mega projects consists of numerous operational decisions, both sequential and simultaneous, rather than just a small set of hierarchical mega decisions. These operational decisions need to be embedded and rationalized within specific domains and competences, and are thus necessarily to a certain degree closed. The pragmatic, step-by-step way of proceeding with precisely-defined terms about ends and means for each part under construction is not considered as controversial, also not by theoretical researchers advocating the widening of project perspectives (e.g. Priemus, 2010a). It makes sense to divide complexity in manageable parts. Nevertheless, we believe the selective strategies of pragmatic decision-making have to be guided by widening perspectives, not just at the beginning but throughout the whole process. The opening and closing of decision-making processes should be organized as forms of mutual enrichment. This strategic capacity avoids the frequently-observed

'tunneling' of decision-making processes while at the same time allows practitioners to 'close' operational decisions, when required, to further the process. The widening of perspectives can be organized in different ways. It could be made an integral part of internal decision-making processes or might also be organized externally at a certain distance from day-to-day project management via strategic boards of advisors, external participation, hearings, expert meetings, etc. In both cases, intelligent organization of decision-making requires a reflective evaluation of the process at different intervals, including outside perspectives and critically discussing the progress, the required adaptations and the need to reset the aimed outcomes.

In this paper we will analyze some basic principles in project decision-making that may serve as a strategic frame of reference for the more focused day-to-day decisions. In line with our central argument we define three hypotheses as the baseline of this paper. Firstly, we claim that instead of tunneling decision-making towards pre-determined outcomes, a strategic ambiguity of project mission is needed to create a productive interaction between moments of strategic reflection and moments of hedging and closing the process. Thus, throughout the unfolding decision-making process different outcomes of negotiations may be found under the changing conditions and different contexts. Secondly, we claim that a certain redundancy of knowledge and actor constellation is needed to enable innovative outcomes (via recombination of solutions) in the operational lines of decision-making that face emergent uncertainties. Screening decisions off from external ideas and opposition would limit the capacity to generate added value to the project. Thirdly, we claim that a balance has to be found between adaptive and reactive resilience. Within the decision-making process the project should be deliberately designed to estimate potential adaptations should the context change and at the same time it should be able to prevail when changes threaten its survival.

The next section of this paper discusses the concepts of 'strategic ambiguity', 'redundancy' and 'resilience' within decision-making processes. In the subsequent section these concepts will be illustrated by means of two mega infrastructure projects in The Netherlands. In the final section we will return to the core question and hypotheses of the paper in order to discuss what we learned about how to combine the strategies of opening and closing in the processes of decision-making of infrastructure mega projects.

Three principles: strategic ambiguity, redundancy and resilience

'Governance' and related words are of a Greek origin and refer to the art of steering. When sailing through different conditions, a steersman adapts to changing circumstances

while keeping his eye on the destination. And the same is true when planning and making decisions on mega projects. The process is complex, uncertain, and far from linear: a big ocean with storms, lulls, whirlpools and sharks. It is crucial to have information available in order to adapt when needed. However, it is also crucial to define the mission in a manner open to these adaptations while also maintaining a sense of direction. Otherwise the ship will be lost at sea. In the following paragraphs we discuss the meaning of three coherent concepts responding to this challenge.

Strategic ambiguity of destination

Usually, the formal decision-making of a mega project starts with a principal document covering the aims of the project and a principal indication of means, organization, financial conditions and time horizon. The formal start may be preceded by initiatives of exploration, social debates and other research (sometimes already quite a long time) but the starting policy document marks a new stage of decision-making and always reveals the principal mission of the project. The starting document is one of the strategic moments where open reflection is essential; it shapes the process further down the line. However, even with the most careful preceding exploration, the decisions on the ambition and implementation of the project within this principal stage will be challenged by emerging issues of complexity and uncertainty. Mega projects usually take more than 20 years to be realized. During this long trajectory there are changes in political and financial conditions, fresh insights and technical opportunities, fluctuations in financial markets, and other unforeseen events. The only certainty is that conditions and resources of realization will develop differently than expected at the outset.

To deal with this conundrum we introduce the concept of 'strategic ambiguity' in the definition of project mission. Two operational qualifications are required. The first regards the level of abstraction of the project mission. Often, the ambition of the project is made operational as a very well-specified output target: a bridge, a tunnel, an airport, a railway connection. The ambitions are operationalized as recognizable artifacts. For political reasons and for reasons of communication with society it is thought to be important to visualize the aimed outcomes of the project with a clear design of the artifact. Although the artifact as a symbolic marker is very useful for communicating possible futures and enhancing social acceptability, the definition of the project mission should be at a more abstract level. It should reveal the general purpose and motivation behind the desire to construct a mega project. In his seminal work The Nerves of Government, Karl Deutsch discusses the relation between purpose, goals and feedback (Deutsch, 1966). To a large extent this relation is similar to our requirement of abstractness of project mission as the

first characteristic of strategic ambiguity. Decision-making about mega projects should start from a basic sense of purpose: "a major or strategic goal, preference, or value that is to be pursued through a set of intermediate movements towards intermediate goals" (Deutsch, 1966: 187). The purpose involves a definition of a problem at a level that leaves maneuverability. And in order to achieve a principal goal or purpose effectively, a feedback mechanism must be in place. "The system must receive information concerning the position of the goal and concerning its own distance from it; and it must receive information concerning the changes in its distance from the goal brought about by its own performance. The messages are often negative in that they oppose the previous actions of the system, so as to oppose overshooting of the target" (Deutsch, 1966:184). The project mission should provide a principal sense of direction under changing conditions of complexity and uncertainty. This sense of direction is not identical to a desired stable state in the future: it is a principal mission instead of a goal-instrumental outcome.

The second qualification of strategic ambiguity goes further than Deutsch. It refers to the recognition of competing or even conflicting purposes behind the development of the project, for instance with regards to economic, social or environmental sustainability (Buck et al., 2005). Usually, in starting policy documents an indication of priority is given in case of competing or conflicting purposes. This is an important key to define the sense of direction of the project. However, this does not mean that all purposes should be subjugated to the dominant principle and that all conflicts between different principles are solved once and forever. It is important to allow for a tension between the different purposes throughout the decision-making process. Experience with mega projects shows that conflicts of purpose are not negotiated and resolved in one single principal project decision but will return in later stages and are continually renegotiated within the smaller decision ranges of singular parts of the project, as particular project effects become clear (Altshuler & Luberoff,, 2003; De Bruijn & Leijten, 2007) . These conflicts lead to useful intermediate evaluations during the long realization period of projects. In planning and making decisions on mega projects, it often seems that such feedback mechanisms are treated as a necessary evil as the project generally enters the process already as a developed solution and a problem-driven search is thus thought superfluous (Priemus, 2007a; 2007b). Decision-making becomes focused on getting a project through as undamaged as possible, instead of creating a solution with most added value. Strategic ambiguity is crucial because it recognizes complexity and emergent properties, and that the framing of a project is never finished (De Bruijn & Heuvelhof, 2010; Glasbergen & Driessen, 2005)

Redundancy

Having a sense of direction and a properly functioning feedback mechanism in place thus reduces the chance of arriving at an unbalanced result. However, it is also important to have something to choose from when tensions arise. The generation of knowledge about alternative development paths is crucial in this respect. Not just at the start of the project, but throughout the whole decision-making process, there needs to be a redundancy of knowledge about possible alternatives. Such knowledge can be generated by a project organization, however it is just as important to receive knowledge from external sources (Allen, 2001; Nonaka, 1994; Schindler & Eppler, 2003). We thus introduce the concept of redundancy with regards to the organization of knowledge within the project and with regards to the composition of the actor constellation. In practice the tendency is to reduce the number of participants in decision-making and to be efficient in organizing project information. Still, the feedback of redundant organization and information is needed for deliberation and adaptation at strategic intervals. Otherwise there are high risks of deadlock (Teece et al., 1997) and groupthink (Henningsen et al., 2006).

The concept of redundancy has been used in different scientific disciplines. Although the word refers to everything that is not essential for the immediate functioning of a system, in many instances it is seen as essential for survival over a longer period of time. In his seminal paper on the principle of redundancy, Martin Landau underpinned the need for additional information in order to enable the recombination of solutions under unexpected occurrences (Landau, 1969a) . An airplane is a widely used example of redundancy. There are about 15,000 systems identifiable in a plane, while it would be possible to run a Boeing 777 on a few hundred systems (Low et al., 2003) . However, because of the many uncertainties involved in air travel there is a multifold of systems designed for safety purposes. This means that if one system fails an alternative is able to take over its function. There are several attempts at translating the concept of redundancy to decision-making that focus especially on the development of alternatives and the selection between them (Joumard, 2010; Kane & Del Mistro, 2003; Keeney, 1996; Low & Ostrom, 2000).

Redundancy is a way of dealing with uncertainty in policy making and planning. "If facts are in question, then we simply do not have knowledge of the appropriate means to use in seeking an outcome. We may have hunches and rules of thumb and we may write elaborate plans which anticipate all conceivable outcomes, but these are only hypotheses. It is, therefore, an obvious and "rational calculus" to employ a pragmatic and experimental

procedure: that is, a policy of redundancy which permits several, and competing, strategies to be followed both simultaneously and separately" (Landau, 1969b: 355).

In practice, however, early in the process there are tendencies to close the system to external actors and information, especially when a feedback mechanism has not been developed. Thus the process is inadequately matured for generating a redundancy of alternatives. Decision-making may proceed via the selected trajectories but planners and policy makers need to find a balance between re-opening the process time after time to develop a proper feedback mechanism and closing moments moving towards the intended goal, such as Allen illustrated with the so-called Law of Excess Diversity for complex systems: "For a system to service as a coherent entity over the medium and long term, it must have a number of internal states greater than those considered requisite to deal with the outside world" (Allen, 2001: 175 emphasis in original).

In this paper we focus on two operational indicators of redundancy. The first regards the constellation of actors involved in the decision-making process. The implementation of mega projects is generally organized via the closed arrangements of project organizations (the contractual decision-taking). The process of reflection and making decisions, however, should be wider and provide more feedback mechanism than is strictly necessary. The second operational indicator of redundancy is closely related to the open actor constellation of decision-making. It focuses on the organization of knowledge to examine different trajectories and realize the project. Knowledge should be fuelled by 'outside-in' strategies instead of being monopolized by stake-holding project management.

Resilience

The concept of resilience deals with the ability of the decision-making process to deal with unexpected influences without risking indefinite delays in the process. The process should be able to learn and adapt. This involves the ability to entertain "flexibility and adaptability, and preparedness to cope with uncertainties and unanticipated situations and directions." (Handmer et al., 1999: 269). Resilience can be reactive or proactive (Dovers & Handmer, 1992a) . In other words, decision-making can be aimed at returning to a particular equilibrium or it can already be designed to change and adapt.

Reactive resilience is the traditional approach whereby a stable position is assumed that is protected against external shocks. A proactive approach assumes that an unstable environment requires adaptation. "Moreover, in the face of recognized uncertainty and complexity, policy formulation processes, and the research that supports these, [planners]

must be open to the possible need for unexpected or unconventional responses to issues. The emphasis becomes the development of an ability to manage a range of possible directions." (Dovers & Handmer, 1992b: 276). It is important to manage a redundancy of options, alternatives, and directions. Resilience relies on the availability of redundant information in order to recombine different pathways.

In accordance with the previous notions of strategic ambiguity and redundancy, two conditions are crucial for resilience. First of all, there should be adequate redundancy of information to enable recombination of the policy trajectory. Secondly, it is important not to close the process to external influences more and earlier than necessary. Resilience implies that key decisions are made in the short term, which also leaves space to maneuver in future decisions. If the mega project starts as a narrowly-defined solution as mentioned above, then everything becomes a threat to it. It becomes path dependent: options to improve the project more than marginally are unlikely to be generated. From a problem perspective, resilience means that the commitment to the mission and overarching goals remain intact; however, the chosen solution can still change.

To summarize, we advocate a strategy guided by a certain ambiguity on the principal aims of the project; the opening and closing of the process to external influences; and measures to enhance its resilience, or its capacity to overcome the unexpected. This approach contrasts with strategies prevalent in practice, which are directed at closing the decision-making process. Yet, we distinguish ourselves from other academic positions by recognizing the pragmatic rationale behind the desire to make early selections of trajectories and stakeholders in decision-making. We also argue that to get more value out of their large investments in mega projects, politicians and planners should be keen to introduce adequate feedback at strategic intervals to adapt successfully to fluctuating conditions and the changing potential of resources. We introduced three coherent concepts of feedback aiming at the widening of project horizons and present an overview of them in table 1. The operational indicators of these concepts will be tested in the next sections which investigate the management of mega project decision-making in practice.

Table 1: Conceptual Scheme

Strategic Ambiguity	Redundacy	Resilience
Abstraction of project mission	Actor constellation	Active
Recognition of competing purposes	Organization of knowledge	Reactive

For this paper we have investigated two large transport projects in The Netherlands. The first is a high-speed train line that runs from Amsterdam to Brussels and Paris. And the second is an interregional transport project that links different transport systems between Rotterdam and The Hague. The analysis is done on the basis of 25 interviews per case with stakeholders, and of newspaper articles and policy reports. The interviews were done with key stakeholders and consisted of a narrative interview and a hypothesis-led interview. The first focused on reconstructing the process through stories while the second focused on particular issues such as the driving forces of decision-making and issues of risk and uncertainty.

HSL-Zuid

The high-speed train line HSL-Zuid, between Amsterdam and Brussels and Paris, is probably one of the best-known pieces of rail infrastructure in the Netherlands. Famous for its cost and time overruns, is it nevertheless an innovative project in issues such as public private partnerships and cost-benefit analyses. The project is very much a child of its time as there was at the outset a lot of funding for infrastructure projects due to profits from selling natural gas and the privatization of state entities. The route is shown in figure 1.

In 1977, the HSL first entered the public domain with the AmRoBel report (Ministerie van Verkeer en Waterstaat, 1977) . This study explored the possibility of a high-speed train connection between Amsterdam, Rotterdam and Belgium. For about a decade it remained on the agenda through PCBA, a working group consisting of the infrastructure ministry and the railways. The group continued to explore possible high-speed connections between Paris, Cologne, Brussels and Amsterdam and presented its final report in 1988 (Ministerie van Verkeer en Waterstaat, 1994; SNCF et al., 1988).

At crucial moments in decision-making on the HSL, the process was dominated by political discussions about route alternatives and in particular the options shown in figure 2. Route A, the preferred option, offered the most direct connection between Rotterdam and Amsterdam, straight through the open space of the so-called 'Green Heart'. Route B, by contrast, would avoid the Green Heart completely. Route D followed existing tracks connecting the cities and Route C bundled the HSL with existing road infrastructure between Amsterdam, The Hague and Rotterdam. Eventually the preferred Route A route was realized, although route C, an option proposed by engineer Willem Bos late in the process, gained strong political and public support. Route C would have solved many problems as it spared the Green Heart and also linked The Hague to the HSL. The current

state (April 2011) is that the line is in operation with a speed of 160 km/hr for trains with national destinations and up to 300 km/hr for journeys to Paris.

Figure 1: Route HSL-Zuid

Table 2: Crucial moments HSL-Zuid

	Date	Event
	1977	AmRoBel report: route study for high speed train Amsterdam-Rotterdam-Belgium
	1979	HSL Zuid first appears in Strategic National Documents
	1986	PBKA report: viability study on train lines between Paris-Brussels-Köln-Amsterdam
	1987	Starting Note: beginning spatial core decision procedure to establish HST
September	1993	Decision to make a new HSL Green Paper (Ministerie van Verkeer en Waterstaat, 1994)
March	1994	Presentation of 'the new HSL Green Paper'
	1994	Public consultation, marked by intense debate about the route to follow
May	1996	Decision made to build a tunnel under the Green Hart
May	1996	Final decision by the government sent to parliament
July	1996	Belgium and Netherlands reach an agreement about the route. The Netherlands pays €400m as compensation
July	1997	The Spatial Core Decision HSL Zuid comes into force
September	1997	Parliament ratifies agreement with Belgium
February	1999	Start tender for infrastructure provider
April	1999	Start tender for transport provider, exclusively for NS
March	2000	Official start of HSL-Zuid construction
July	2000	Signing of base construction contracts
December	2001	Signing of contracts for infrastructure provider and transport provider
	2005	Construction base finished
	2006	Southern section Rotterdam to the border finished
	2007	Northern part finished
September	2009	First paying passengers are transported

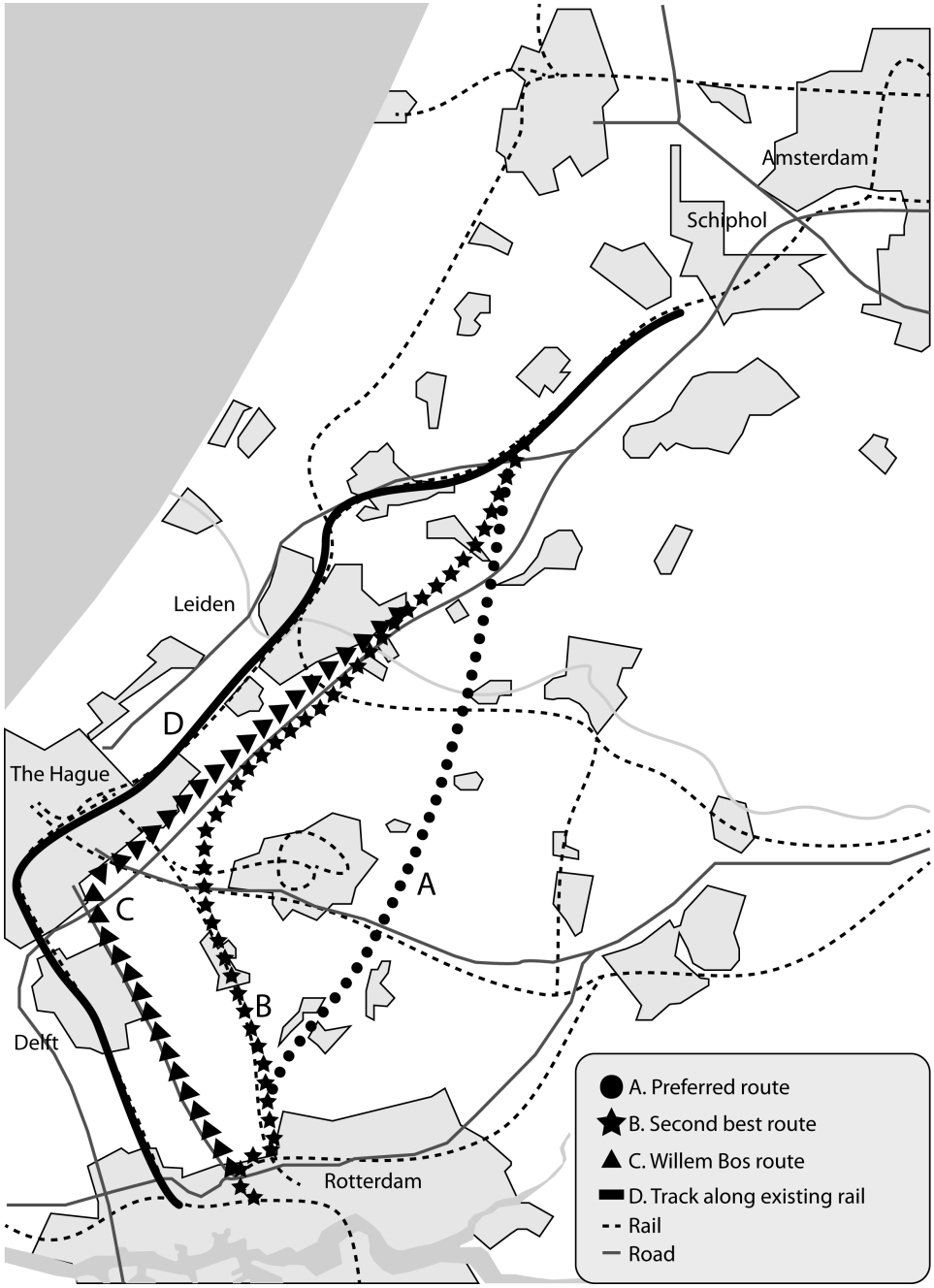

Figure 2: Map of alternative routes

Strategic ambiguity

During the decision-making process two ambitions dominated. The first was to link the Netherlands with the European high-speed train network. The second was to use the HSL to improve the accessibility of Schiphol airport (the magnet of the national economy) and at the same time substitute air travel thus making a significant contribution to the environment (Ministerie van Verkeer en Waterstaat, 1996a).

The first ambition was clear. Linking to the European network was deemed crucial for the so-called 'main port' strategy of the Netherlands. The economic importance attached to the link is exemplified by the claim from a former minister Kroes who, in the mid-1980s, presented the metaphor of Jutland; if it failed to connect to the European network, the Netherlands could become the second Jutland of Europe (Aarden, 1997; NRC Handelsblad, 1996) . A terrifying vision for this densely populated country and a metaphor that returned in discussions in parliament and newspapers for the decades to come (NRC Handelsblad, 1996, Aarden, 1997). In general, thus, the ambition to link to the European network was widely supported.

The second dominant ambition, using high-speed trains as a substitute for air travel, was also popularly supported. For environmental reasons it seemed important to provide a rail alternative to the plane for mid-range distances. At the same time, it could complement the long-range links offered by Schiphol airport, improving its competitive position. However, the fact that low cost carriers and the low taxation on kerosene would limit the influence of the line was not discussed or completely foreseen. The substitution ambition was abstract enough to receive support from a broad section of organizations, politicians and the public.

An ambition that received little exposure initially was the importance of the HSL for national rail transport. A number of respondents argue that opponents of the project did not pick up this ambition because they "aimed to show that the investment was too big for just a few yuppies travelling to Paris" (interview NS official). Later on, however, the importance of the investment on a national level would spark a discussion on not only alternative routes but also alternative projects such as investing the money in upgrading the network to 25,000 volts. Keeping this national ambition out of the public debate might thus have been more important for proponents of the project than for opponents. In the main, however, both camps kept the tension between different purposes out of the decision-making process. This tension might have sparked more feedback cycles and alternatives than the decision-making on a high-speed train connection could have withstood.

A similar reasoning might be applied to a second neglected ambition, that of spatial developments. The project was presented solely as an infrastructure/transport project while the ambitions on land use development were not included in the discussion. As some respondents mention, the legal procedure for planning large transport projects is not very compatible with an integrated planning approach (Interview Green Lobby SNM). The institutional system around large transport projects is strongly aimed at getting the project through the decision-making process and not on developing alternative solutions to the spatial planning problems that one would like to solve. It is not designed for, nor do the dominant actors see the benefit of a tension between these different purposes.

A concrete ambition mentioned in the starting document of the HSL was that the line would have to accommodate speeds of up to 300 km/hour. This served to limit the number of route options as the radius of turns, slope of the track, and the construction techniques for such high speed track all have special requirements. Indeed, from this perspective the alternatives considered in the decision-making all compared poorly with the preferred route that was more or less a straight line between Schiphol and Rotterdam. The 300km/hour criterion was introduced early in the project life cycle, thereby limiting alternative projects and routes in the decision-making process. As one respondent said, French TGV trains generally move at slower speeds through urban areas as they pick up passengers and the Randstad could be considered one urban area such as Paris and its suburban villages (Interview Community Organization). The 300km/hr preference was also reflected in assumptions about the image of the project: "A direct high speed line upon which a speed of 300km/hr can be reached has a larger appeal than a connection that is 20-25% longer with a maximum speed of 160 or 200 km/hr." (Ministerie van Verkeer en Waterstaat, 1994: 93).

Redundancy

The HSL decision-making followed the PKB procedure which meant that the Ministry of Transport with (in this case minor) support of the Ministry of Spatial Planning (VROM) prepared a starting document to be approved by the government. This was then opened up to public consultation and the mandatory advice from institutions such as the commission for the environmental impact assessment (Ministerie van Verkeer en Waterstaat, 1995) . The first starting document failed because it was very limited in its analysis of alternatives and consequences. There were so many unanswered questions in the consultation round that the document was pulled back from the decision-making process. One problem a respondent noted was that the note was prepared by the Dutch Railways, and then sent to the ministry to be analyzed for impacts and effects (Interview

Project Leader). The comments from the ministry would then be sent back and the response was generally that the suggestions were impossible to implement. There was a strong communication problem within the early project organization. For the new document, a new project organization was set up that incorporated many different specialist competences and eventually over 100 employees. As one respondent reflects, this created a machine that could calculate the effects of adjustments within a week (Interview project group employee) - important in the negotiations with the municipalities as they could show how adjustments would affect the whole route and not just the section within that municipality. However, access from outside sources remained very limited. The idea was still that the routes and alternatives would be developed by the project organization internally and then presented to outsiders. As a result, the Route C 'Bos alternative' (see Figure 3), which appealed to many different interests, emerged only at a very late moment in the decision-making process and had to be appraised and go through an environmental impact assessment (Ministerie van Verkeer en Waterstaat, 1996b) while the rest of the developed routes had already reached a final stage. Similarly, the possibility of a tunnel under the Green Heart came very late in the process (this solution was finally adopted). As one respondent argues, with the tunnel option the route could have been redesigned as going underground opens up a world of different possibilities (Interview Consultancy Group). The tunnel idea came from the Ministry of Spatial Planning (VROM) because they opposed the preferred route developed by the Ministry of Transport (Interview civil servant VROM). Although it would obviously make a lot of sense to include the institution responsible for spatial planning in the design of a spatial project, the HSL was developed within the transport sector and its ministry. As already mentioned, the ambitions on spatial developments and land use were largely ignored.

Information was a key element of the decision-making process. As already mentioned after the first note failed, a new project organization was set up to enable the generation and appraisal of alternatives. At its peak about 700 people were working there. When making the decision on the alternative routes, the discussion focused on minutes of travel time. The Bos alternative was perceived as slower - between 6 minutes (interview Community Leader) and 20 minutes (Interview NS) - than the preferred route through the Green Heart. Information like this is often contested because it is difficult to determine which aspects are taken into consideration. One respondent (Interview Project Leader) stated that the project organization always presented all information without choosing. This is of course only partly true. In the selection of appraisal criteria and in determining the weights there are always choices that will influence the result of the appraisals. Interestingly, alternatives that once were filtered out, such as the Bos alternative, returned back to the

table. So the narrow selection of alternatives, causing a lack of redundancy, was done too early and too rigidly, which led to alternatives coming back at a later moment, when there was no time to appraise them properly, or to explore implications for the rest of the project.

Resilience

The HSL exhibited the general reactive resilience tendency that seems to be shared by large infrastructural projects. At one moment in time there is an alliance of actors who feel that a particular type of project should be developed and then it becomes very dedicated. Such as one respondent (interview journalist) stated: "At one moment you decide to draw a line on a map and then it becomes very difficult to stop that idea." The HSL is not different. A project, from concept to definitive project design spread over decades with different politicians, coalitions and actors, yet the basic preferred route remained the same. The tunnel solution was the culmination of the reactive resilience of the preferred route. As it seemed the support for the Bos route was becoming a majority in the parliament with even two of the three parties in the government coalition backing the alternative, Prime Minister Kok had to step up and wield his power to push the preferred route through (Haan, 2004) . He had to pressure his own minister of spatial planning and find the additional 900 million guilders (about €400 million) for the tunnel under the Green Heart in order to please this minister as well as the Liberal minister of transport who favored the preferred route. It seems that reactive resilience depends on the financial means to overcome opposition and other difficulties. In part this resilience might also be a consequence of the PKB procedures which start with a clear note that more or less states: this is what we want to achieve, we have looked at these alternatives, and decided that this is the best option. What remains is external criticism as the main route design phase has passed making it difficult to have an integrative, adaptive planning approach.

Two main resilience strategies can be identified in HSL-Zuid. The first was to create an organization that could generate many appraisals of alternatives. Theoretically, this could lead to a highly adaptive design strategy. Practically, however, it seemed the use was more to show why alternatives were less desirable and changes in the route would be difficult. The second strategy was to develop an organization that could move in parallel. When a certain aspect would be obstructed, the organization would try to find a solution but would also at the same time work further on other aspects. The first type of organization would generate so much information that it would crowd out the opposition. It thus focused on generating a redundancy of information as a means of resilience, while the

second looked for resilience by redundancy of manpower to develop the project in parallel. The first focused on knowledge management while the second focused on project management.

RandstadRail

RandstadRail is an interregional transport project between the city regions of Rotterdam and The Hague. It consists of two light rail connections and a dedicated bus line as shown in Figure 3. The decision-making process for RandstadRail was dominated by a long period of negotiation under the umbrella concept of light rail without much detail on the specifics. The first specific plans for interregional transport between the two areas surfaced during the late eighties. However, it remained a latent desire until the public transport companies of the regions restarted the discussion with a jointly written report in 1995 (ANP, 1995; Het Financiele Dagblad, 1995) . This was the same year the city regions were founded. Together with the province of Zuid Holland, an exploration study was done the year after. However the estimated cost of the proposed system was between €1.3 and €2.7 billion. (ANP, 1995; Het Financiele Dagblad, 1995) . The national state, as prime funder of infrastructure projects, requested a cheaper solution (Algemeen Dagblad, 2000). In 1999 the solution was found by using the existing heavy rail lines and using the existing urban transport systems of the tram (The Hague) and the metro (Rotterdam), and downgrading the line between the town of Zoetermeer and Rotterdam from light rail to a dedicated bus line (Algemeen Dagblad, 2000). In 2001 an administrative agreement was reached between the different parties and construction began. The different sections were phased into use whenever finished. However, in 2006 transport on certain sections was stopped because of derailments (Haan, 2011; OVV, 2008). In August 2010 the final section in Rotterdam was finished and RandstadRail is now fully functional. The project is especially interesting because of its long period of deadlock in negotiations, its taboo on the specifics of light rail, and the complexity of the different parties responsible for the project.

Table 3: Crucial Moments RandstadRail

	Date	Event
	1989:	First plans surface for a regional public transport network linking The Hague with Rotterdam.
	1995:	The public transport companies RET, HTM, ZWN (now Connexxion), and the NS publish the report "RandstadRail, de file voorbij"

Date		Event
	1995:	Introductions of the Stadsregio Rotterdam (SRR, Rotterdam region) and Stadsgewest Haaglanden (SGH, The Hague Region)
November	1996:	Exploration study. SRR, SGH, and the Province of Zuid Holland suggest a light rail system that would cost between the 3 and 6 billion guilders (€1.3 to €2.7 billion, (1996)). The national state requests cheaper solutions
December	1999:	Additional advice by the RandstadRail Steering Group (State, PZH, SRR and SGH) to achieve higher quality of transport suggesting linking the lines to the urban rail networks and making the line between Rotterdam and Zoetermeer a high quality bus line. The foreseen investment is €0.84 billion.
December	2001:	Administrative Agreement between the State and the Regions about the financial aspects pending the subsidy application
December	2002:	Approval of the application by the Minister of Transport. This enables the regions to continue with the preparations for construction.
June	2003:	Start of construction in Rotterdam.
September	2005:	Concession for transport and maintenance of the infrastructure in the region Haaglanden and the RandstadRail line 3 and 4 is given to HTM (The Hague Transport Company)
February	2006:	Concession for transport and maintenance of the Hofplein line section (the Erasmus line) is given to the RET (Rotterdam Transport Company)
November	2006:	Derailments occur in line 4
October	2007:	Line 3 and 4 is operational between de Uithof and Zoetermeer Oosterheem. This means that RandstadRail The Hague is now fully functional
August	2010:	Rotterdam Section RandstadRail becomes fully operational

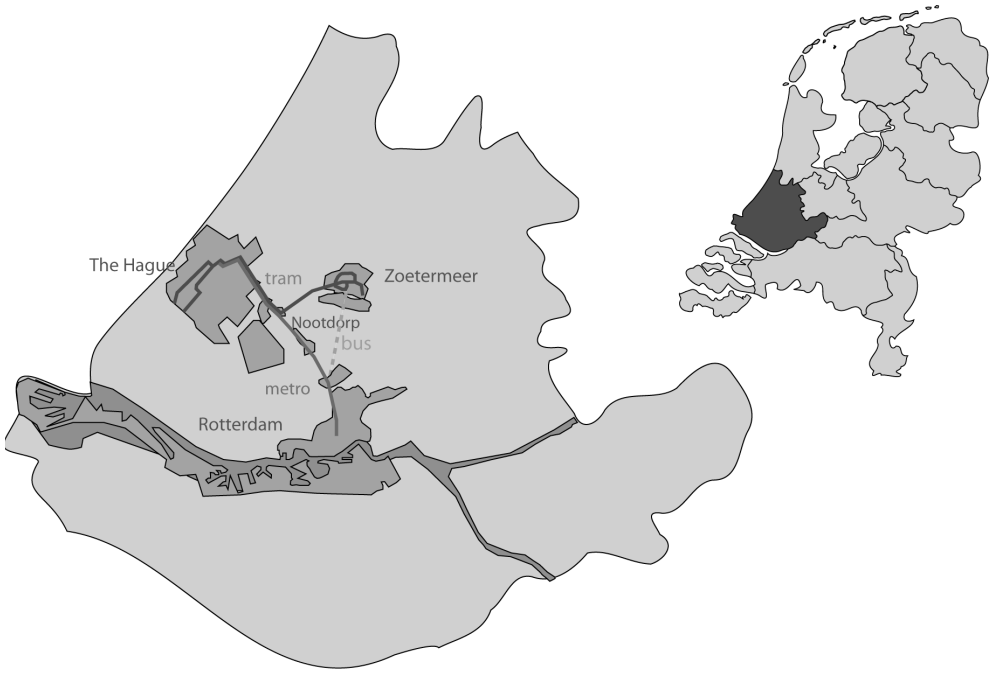

Figure 3: RandstadRail project

Strategic ambiguity

For years, ambitions remained abstract – a light rail project to solve the increasing congestion in the region. However, because the parties involved had different preferences for the specification of the system, clear decisions could not be taken. The Hague wanted a tram system and Rotterdam a metro system as these form the backbone of their respective urban transport networks. It was not until relatively close to the agreement in 2001 that the decision was made to separate the project into a section under responsibility of The Hague Region and another under responsibility of Rotterdam Region, or a tram and a metro solution respectively (Interview Transport Company). The early ambiguity was key, as we will see, to keeping the different participants on board. However, it had also less positive impacts. As one respondent notes, it may have been the cause of later accidents (Interview local government employee). The specifications were decided upon at such a late date that there was not enough time to test the system properly and review the consequences of the decision. And the aldermen were strongly opposed to changing the starting date leaving only three days for testing (Haan, 2011) . Another consequence of the

early ambiguity on light rail is that at a very late stage the decision was made to replace the tracks on the The Hague section because the state of the tracks was sub-optimal. Why the track quality was not assessed earlier is unclear. It seems to be the result of the very late closing of the process and making the final decision for a tram or metro, leading to a late functional specification of the desired quality of the tracks.

Although the ambition from the outset was to create a regional transport system, the different parties seemed to have their own agenda. Rotterdam wanted to secure their expansion of its metro to the north and The Hague wanted to expand its own tram system. The abstract definition of the project mission as 'regional light rail' left the choice open: it expressed strategic ambiguity in this way. However, as the two city regions could not change their local conditions the only alternative they could agree on was a completely new light rail system. Thus, after the first ten years, a deadlock situation was created as the financial situation at the Ministry was limited. The plans had to be adjusted to options of reconstruction of existing trajectories and the tension between the purposes only lessened when the combination of the two systems appeared to be cheaper than a new system and still the dominant interests of The Hague and Rotterdam could be fulfilled. The routes were divided, the money was divided, the responsibility for line management was divided, and the income was divided. The project is actually a collection of three projects that are kept under the same name because of the finance mechanism and a short shared section. The separation enabled the project to move forward because this solution resolved the tensions between different interests.

The definition of the mission remained narrowly focused on transport because it was already difficult to reach an agreement on the functional specifications, let alone the surrounding spatial developments. The project linked several new town developments but was not used as an instrument of strategic integrative planning. The project avoided the tension between purposes by solemnly focusing on a transport infrastructure-defined project.

Redundancy

In line with the above-mentioned lack of integration with land use planning, the constellation of actors was limited. Nevertheless the group was already quite complex with two regions and their municipalities, a national ministry, local transport organizations, heavy rail provider, and the national rail authority. Outside influence was limited to the obligatory consultations and responses to ad hoc concerns from lobbyists and inhabitants.

Feedback mechanisms were not organized in a way to enhance the decision-making process.

The organizations of The Hague and Rotterdam also had different styles of feedback mechanisms. Rotterdam had a lot of experience and a strong civil engineering department tightly connected with the transport provider. Quick to tell the alderman or other administrators when something was 'unrealistic', the project team saw itself as a group of experts. This was less the case in The Hague where technical know-how did not match political desires (Interviews Regional Civil Servants). The lesser experience with large projects in The Hague can be seen in its problems with the tracks: the late decision to replace them and the choice for a particular type of switches was at the root of the accidents. Just organizing feedback was thus not enough, the quality and power of the actors also had to be adequate to provide a well-functioning feedback system.

In short, we can say that there was very little redundancy in RandstadRail's organization of knowledge and actors. Once the agreement was reached, there was no desire for externalities because the decision was made and it was now an issue of constructing the project. Knowledge was primarily organized at the municipal level as transport companies and transport departments were still closely connected. The organization of knowledge was kept within the transport sector itself. For all its negotiations over the decades, the project remained a technical affair.

Resilience

The project showed several examples of reactive resilience. One was the tunnel in Rotterdam. It was not in the original plans. However, public opposition against the preferred route at ground level was so strong that the engineering department explored alternatives. It came up with a drilled tunnel that would also offer the possibility to add an extra station in another area. This was a creative response of the project to external pressures.

Another reactive response was The Hague's late decision to replace the tracks. The quality of the tracks was found to be inadequate. However, this was only after the responsibility for the tracks had been handed over to them; a very reactive decision to something that could have been appraised well before.

An important decision that shows reactive as well as proactive resilience is the decision to strip the plans of the rail connection between Rotterdam and Zoetermeer. Although a few respondents and articles claim that there was not enough travel demand for such a large

investment, it seems the decision was mainly a financial and political one. The project had to become cheaper to fulfill the demands of the ministry. And this solution was something both Rotterdam and The Hague could live with as it was of lesser importance for them than the other sections. The decision to skip the rail line was thus reactive to financial constraints and a low transport potential. However, the decision to make a segregated bus line was proactive in the sense that it enables the municipalities to upgrade the line to light rail when the potential costumer base grows. Whether this will ever happen is unclear but at least the potential is there.

The tram tunnel in The Hague is also an example of proactive planning. As the plans were made to redevelop the inner city of The Hague, the transport professionals stated that a tunnel would be a good solution to future tram traffic caused by RandstadRail. However, at that time the RandstadRail project was all but certain. And thus the tunnel was built in such a width that metro vehicles could pass through it. Thus resilience was proactively created in order to deal with the uncertainty of future developments.

Discussion and conclusion

This paper discussed the interaction between opening and closing strategies in decision-making on large infrastructure projects. Although the general preference within the two case studies seems to show a rather closed style of decision-making, they also demonstrate that creative solutions and added value are to be found in the recombination of policy options during the decision-making process: recognizing the need of a wider project mission; the use of redundancies; and the organization of critical and knowledgeable actors. The project has to have an ambition that is resilient to withstand challenge on its basic premises: general enough to take conflictive views on board instead of denying their relevance, but still flexible enough to allow adaptation of specifics. The first case study (HSL) became controversial and was attacked on its basic aims because they were not abstract enough and neglected the environmental perspective (preserving the Green Heart) and urban development perspective (connecting the city of The Hague). The project had too few 'project owners'. This was far less the case in the second project (RandstadRail). In this project the purpose with respect to the aimed infrastructure was defined in general terms, although it also lacked explicit reference to the perspectives of land use planning. Both projects have never moved beyond infrastructure planning. Of course, there are expected developments around the stations in both projects, but this is not integrated in the plans. The desire to close the decision-making process was greater than the desire to come to an integrative, adaptive planning process. As a result, in both

cases the infrastructure planning and the spatial planning do not match optimally which can be expected to become manifest in the next stage of exploiting the routes.

From original conception to final go-no-go-decision, the infrastructure projects prove reactive resilience. The HSL was a national project and it was very unlikely that it would not be developed. The reactive character of resilience was demonstrated fiercely in the numerous adaptations that were made to enable the realization of the initially preferred route. Because of this structural bias towards an international transport perspective, an environmental perspective came in only as counteraction that urged a compromise (which was expensive and not optimal), while the urban development perspective was neglected. Nevertheless, the HSL organization did not offer adequate redundant information needed for a more pro-active resilience. For this reason, the very interesting option of policy recombination that combined all alternatives (the 'Willem Bos alternative') did not get a real chance to be included in the adaptive decision-making process.

The second case study on RandstadRail illustrated a very interesting tension between opening and closing strategies. This project opened in a very general way with respect to the purpose of infrastructure, aiming for 'regional light rail infrastructure' without specifying the differences between the metro (Rotterdam) and the tram (The Hague). However, the two city regions lost the first ten years by quarreling about their different interests and showed up with a completely new light rail system (neglecting both metro and tramline) and addressed in vain the costs of this utopian solution to the central government. The situation that followed was a deadlock with parties trying to bring the project within the available budget at the Ministry of Transport without one of the parties losing out. Eventually the parties closed the process by breaking the project into pieces, providing a widely-acceptable solution at the right price. From then on a combination of metro system, tramline system and bus system was feasible: it was elaborated productively via the combination of different policy options. At the end, there was adaptive progress and pro-active resilience.

In this paper we recognized the need to combine opening and closing strategies of decision-making, recognizing on the one hand the need to progress selectively in incremental ways and on the other hand to let this step-by-step approach be informed and guided by three coherent principles to open the decision-making at several intervals. We built a design of strategic capacity by analyzing the three closely-linked concepts of strategic ambiguity, redundancy, and resilience. In order to adequately deal with uncertainty and complexity while at the same time adding value to a project, a continuous recombination of the different aspects of the project is necessary. A striker has his eye on

the goal, but could sometimes be more efficient if he were to be coached by his colleagues. It is good to have a predefined mission, but if the situation changes it is also important to receive input from feedback mechanisms and to adapt the plan. The opening and closing of the decision-making process is assisted in its resilience by having redundancies and strategic ambiguities at different moments throughout the process. Mega projects should accept this deliberate intricacy, as feedback mechanisms are crucial to understanding the contextual complexity of the process.

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