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

Giezen, M.

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5. Adaptive and Strategic Capacity: Navigating Mega Projects through Uncertainty and Complexity

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Author: M. Giezen

Introduction

The planning of a mega project can be a daunting task. The sheer size of the project (in numbers of affected actors or in amount of dollars invested) dwarfs day-to-day projects. And if the institutional context is taken into consideration, the task ahead can become almost paralyzing. Faced with this complexity and uncertainty, a common response is to simplify, to compartmentalize procedures and events into smaller sections with accompanying calculated risks (Dryzek 1987; Faludi 1996; Miller & Lessard 2001). However in contrast to incremental approaches, where you make small changes and might end up with a different outcome than planned beforehand, there is a strong sequential rigidity in these smaller sections because the steps all lead to a particular point and destination. The process becomes inflexible: every end of a phase or section needs to fit with the beginning of the next predetermined phase, and there is little room for adaptations. Thus, if a problem occurs in one phase it will have an effect on all subsequent phases. Cost and schedule overruns will be difficult to prevent or overcome. In addition, the sequential rigidity of the process design will also make it hard for outsiders to get involved. Outsiders are a threat to the project because they have different objectives and are not easily controlled. And for a process that leaves little room for adjustments, unpredictable actors can become a liability. Democratic influences are therefore considered as unproductive obstacles that need to be overcome.

Since the 1960s, there has been an effort in academia to promote a more adaptive decision-making process in planning. In particular, the strategic choice approach from the Institute for Operational Research has made an effort at finding a way to deal with uncertainty in a structured but practice-based manner (Faludi & Mastop, 1982; Friend & Hickling, 1987; Friend & Jessop, 1976; Friend, Power, & Yewlett, 1974). More recently, the academic focus has been on deliberative planning and looking for ways of enabling outsiders to take part in the processes of decision-making and deliberation (Gregory & Failing, 2002; Healey, 1999). Some researchers have turned to complexity theory for inspiration (Innes & Booher, 2010) while others look towards evolutionary theory

(Bertolini, 2007; Lambooy & Boschma, 2001). Yet others have focused their energy on articulating the principles of an adaptive policy and planning process (Marchau, Walker, & van Wee, 2010). These authors all see the need to move beyond purely rationalistic planning, and respond to and work with unexpected changes. In doing so they fundamentally depart from a planning practice where closed processes are common. Mega projects in particular seem to have a closed process as they often enter the public domain as engineering solutions instead of policy problems (Priemus, 2010). This paper, in line with these authors, aims to look specifically at how mega project planning and decision-making responds to change in the context and deadlock in the process, and develops and examines ideas about how to organize these processes through empirical work on three mega projects The paper first looks at practical adaptations made in these projects, continues developing a framework about the organization of the process and then finally looks back at the projects to understand how the elements of the framework played out in practice.

This article thus adds to existing literature by linking two key analytical concepts developed in previous work: adaptive capacity and strategic capacity within the planning process. Adaptive capacity categorizes the types of adaptations or non-adaptations that are made to the organization and scope of mega projects and relates them to changes in a project and its context. Strategic capacity focuses on the strategic organization of the decision-making process and looks at issues such as ambiguity, redundancy, and resilience. The two concepts have been applied to three mega transport project decision-making processes in the Netherlands. The first is a high-speed train line called the HSL-Zuid that runs from Amsterdam to Brussels and Paris. The second, RandstadRail, is an interregional light rail project between the regions of The Hague and Rotterdam. And the third project is an extension to the Rotterdam metro network, then known as the Beneluxlijn. While adaptive capacity deals with ways of dealing with uncertainty and complexity, strategic capacity is about organizing the process so it is best equipped to maximize the value from uncertainty and complexity. This article aims to delve more closely into the relation between these two concepts.

The first section introduces the two concepts of adaptive capacity and strategic capacity starting from a perspective on three types of uncertainty. The subsequent section introduces the three cases and presents the results of the analysis. Then I continue by looking more closely at the relationship between adaptive and strategic capacity before ending with the conclusion.

Adaptive planning and decision-making

Although complexity is often considered a problem, it is the uncertainty built into that complexity that is the true source of worry. Uncertainty creates a feeling that things are so complex that they go beyond understanding and control; this makes humans uncomfortable. Consider the example of a labyrinth of underground tunnels. For a casual visitor entering the labyrinth for the first time it would be a complex, perhaps unnerving, environment. Yet for someone who works every day inside the tunnels, the complexity of the labyrinth would not be an issue. So it is uncertainty that is the key concern here and how to fight it or use it. Uncertainty makes things complex because one lacks an overview of all elements, relations and consequences. Uncertainty and complexity are thus strongly related to one and other, but it seems for this research that uncertainty is key. There seem to be three approaches to the issue of uncertainty and thus complexity: fight it, use it, or ignore it. The first two can be considered as reactive resilience and active resilience respectively, and I will discuss their advantages and disadvantages later. The third could potentially have disastrous effects because it builds up uncertainty and the process or organization is unprepared. Just think about the example of how crossing the street while ignoring uncertainty will likely get you in danger.

A useful distinction in types of uncertainty is to divide it into three categories (Van der Heijden, 1996): risk, structural uncertainty, and unknown uncertainty. Risk involves uncertainty about particular outcomes, but there is sufficient knowledge and experience to make a probability estimate. This is the field of risk analysis (Grimsey, 2002; Songer, Diekmann, & Pecsok, 1997). The second deals with the uncertainties that we know we cannot calculate the possibilities or effects of. However, we know that they can happen. This is the field of contingency planning (Alexander, 2000). The third are the unknown uncertainties. These are events that we could not have expected or even conceived of happening. There is no planning against these. However, it is likely that an adaptive organization would be better capable with dealing with such events than a rigid organization (Allen, 2001; Hagmann & Chuma, 2002; Marchau et al., 2010). Thus the adaptability of the process and its association of actors (Latour, 2005) becomes a strong factor in the way uncertainty is dealt with.

Figure 1 shows the main line of argument of this article and the expected general relation between the concepts of adaptive and strategic capacity. Adaptive capacity stands for the capacity in practice to respond to change in the context and deadlock in the process. This is of course strongly determined by the strategic capacity that looks at the way the planning and decision-making process is organized. In return the adaptations actually

made can be on the project level, but also on the process level again influencing the strategic capacity. Adaptive capacity and strategic capacity are thus in continuous interaction with each other and are both influenced by changes in the context. The framework of analyzing the adaptive and strategic capacity of the process of decision-making and planning a mega project is further developed in the next paragraphs of this section. And the final paragraphs of the article will explore more in depth the relationship between adaptive capacity and strategic capacity.

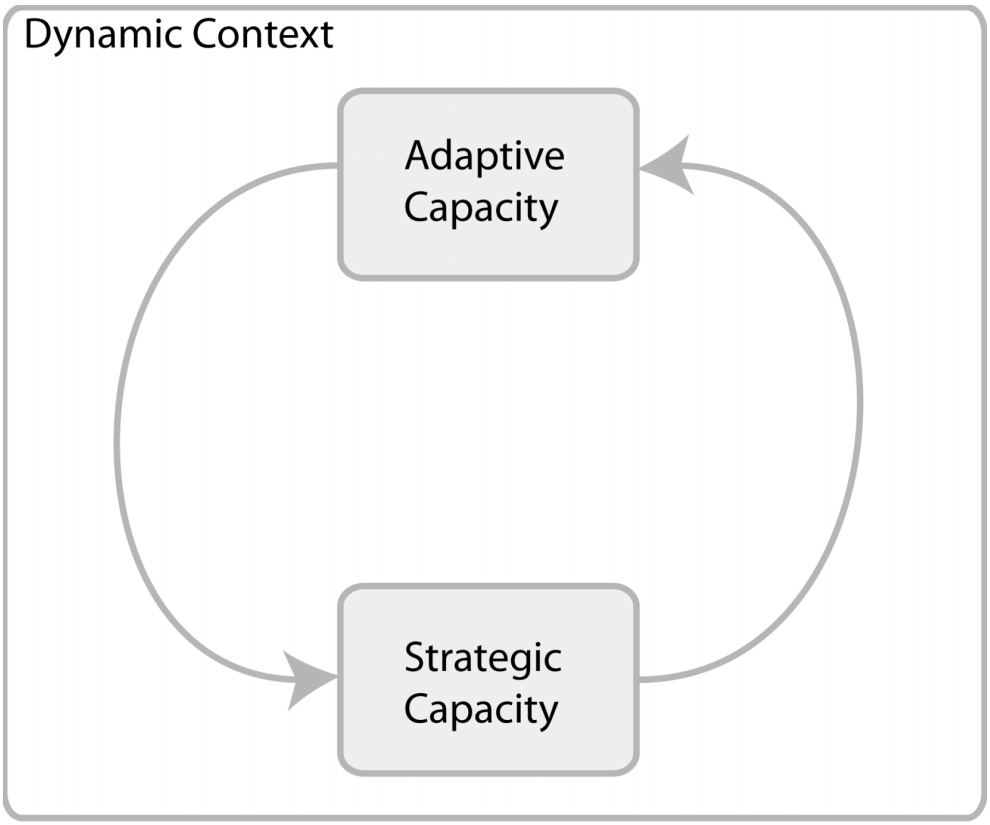

Figure 1: conceptual relations

Adaptive capacity

In the biological as well as the social world, there is a constant drive to find a better fit to a changing environment. We, as a social group search for better-fitting solutions to social problems. We make adjustments that are influenced by our environment while at the same time we influence those same environments. Planning is also about finding solutions to

problems; however, in addition it wants to develop these solutions according to a predefined plan. As such, there is a natural aversion against all things uncertain. However, as the world becomes less controllable for planners, the need for adaptive planning approaches becomes greater.

In order to analyze planning and decision-making in relation to their potential to adapt, I have split adaptive capacity into four categories parallel to four types of learning identified in organizational learning literature (Argyris & Schön, 1978; Easterby-Smith, 1997; Romme & van Witteloostuijn, 1999). The underlying idea is that in the social world learning and adapting are strongly related. These four types are: incremental adaptations, radical adaptations, socio-historical adaptations, and inertia.

Incremental adaptations are changes everyone does in their daily lives and which are also common in planning and decision-making. Small changes are made to a project or process in order to reach a more optimal result (H. A. Simon, 1991). This type of adaptation is easily accepted because it poses little threat to the overall plan, vision, and goals. For example, noise mitigation measures are often an incremental change made to a mega project. Taking it one step further are radical adaptations. These are changes that challenge the current process and content in a fundamental way. These adaptations move out of the comfort zone as they mean that things have to be done differently and plans have to be rewritten. They often require more investment of resources and greater flexibility of involved actors (Miner & Mezias, 1996). Changing a project from a state-financed project to a privately owned project is an example of such a radical adaptation that might occur within mega project development. The third type, socio-historical adaptations, challenge not only the process and content of the project at hand, but also change general practices. They change the way a project is planned, decided upon, or managed for future projects to come. An evolutionary step for society as a whole, as it were. One example of a socio-historical adaptation is the construction of the TGV between Paris and Lyon which shaped the future railway system in France and perhaps in Europe. Lastly, inertia is the inability to make a change when it is required or would be beneficial to make an adaptation. Many times inertia will not have a great impact because it maintains the status quo. However, there are also moments when doing nothing, or not making an adaptation, can have a disastrous effect. For instance, waiting too long with changing preferred techniques, even when signs are appearing that inaction could cause great delay, can have catastrophic results in the later phases of the project as delay adds to delay.

Strategic capacity

Adaptive decision-making and planning of mega projects is important, but how should this be organized? With the development of the concept of strategic capacity, I aim to show the added value of organizing the process in an adaptive manner. Albrechts (2004: 747) defines strategic spatial planning as "a public-sector-led (Kunzmann, 2000) sociospatial … process through which a vision, actions, and means for implementation are produced that shape and frame what a place is and may become." I agree with this definition. However, I disagree with the normative standpoint that it has to be public sector-led as communities or the private sector could also do spatial planning in a strategic manner. And because I look at decision-making as well as the planning of a mega project, sociospatial becomes too limiting. Thus, in this paper, the strategic capacity is the 'ability of the decision-making and planning process to accommodate combination and recombination of actions and means under a vision that shapes and frames a project or place.'

Strategic capacity can be organized around three coherent concepts: strategic ambiguity, redundancy, and resilience. Strategic ambiguity relates to two aspects of project decision-making. Firstly, the level of abstraction of the project mission determines for a large part the flexibility one has throughout the decision-making process (Deutsch, 1966). If the mission is formulated too concretely, flexibility is lost that might be necessary later. Formulated too abstractly, it might become difficult to bring parties together to make a final decision. Secondly, there is generally a tension between purposes. Do you keep the project simple by focusing on one purpose, or do you make it a cross-sectional, multi-functional project in order to maximize the added value of the project? (Buck, Gordon, Harding, & Turok, 2005). Redundancy is about building into the process more alternatives than would be strictly necessary or efficient. It enables the possibility to use alternatives when the first preference turns out to be unachievable, unpractical, or undesirable (Landau, 1969; Low, Ostrom, Simon, & Wilson, 2003). For this it is first of all important to have a redundancy in the actor constellation. External actors can provide the necessary feedback mechanisms to remain critical to one's own ideas. In relation to this, a redundancy in knowledge is also essential for adaptive decision-making (Allen, 2001; Nonaka, 1994; Schindler & Eppler, 2003). Humans are good at seeing what they want to see, but as the famous gorilla experiment[1] by Simons & Chabris has shown, we have greater difficulty in seeing the things we did not know we should be seeing (Simons & Chabris, 1999). This 'inattentional blindness' in an institutional setting can thus be reduced by a redundancy of

[1] People are asked to watch a video where six people are passing around basketballs and count how many times the balls are being passed. While attention is focused on counting the basketballs, a gorilla appears in the middle of the action. Around half of us do not see the gorilla because we are too focused on the task at hand.

actors and knowledge. Resilience can be described as reactive and active resilience (Dovers & Handmer, 1992; Thomas & Mengel, 2008). The first discusses the ability of an entity to respond to challenges by minimizing the effect these challenges have on it. Active resilience is geared towards accepting adaptation as a necessary feature of the planning process and using it to add value. In planning mega projects it is the difference between having a project design and protecting it against outside influences and changes (reactive resilience), or creating a more open planning process in which the possibility of adaptation is built into it (active resilience - Teece, et al., 1997).

Now that the concepts have been introduced, I will use them to analyze three mega projects in the Netherlands. After briefly introducing the research methodology, this paper will present short introductions to the cases. After that, I will present the main results of the analysis. Where adaptive capacity looks at tactics to deal with complexity and uncertainty, strategic capacity shows what is required to plan and prepare for these eventualities. The question for the rest of the paper, through exploring the relationship between the two concepts in the different cases, is how to organize and perform the decision-making and planning process in such a way that it is adequately able to deal with the uncertainties and complexities that come with mega projects. I will focus on two aspects in particular. The first is the need for particular types of adaptive responses to certain contexts. The second is the way in which adequate responses are the product of the strategic capacity within the process.

Research design

This research has used a combination of desk research and a narrative-reflexive interview approach. I looked at official documents and newspaper reports, and interviews were done with a variety of stakeholders per project. Whenever possible, two interviews were done per stakeholder, amounting to 59 interviews in total (around 20 per project). The first was a narrative structured interview geared at collecting the stories of the interviewers about the crucial moments of the decision-making and planning process. The narrative interview aims to prompt respondents to tell their story without influencing the direction towards the researchers own hypotheses (Kvale & Brinkmann, 2009). The second interview was of a reflexive nature which lets the respondents reflect on a general and project level about particular issues such as uncertainty and complexity, sustainability, and crucial factors influencing the decision-making and planning of mega infrastructure projects.

Using a multiple case study approach, the research analyzes three of the largest transport infrastructure projects in the Netherlands that were completed within the period

2000-2010. All three are primarily rail projects. Their scale differs from the local/regional, interregional, and (inter)national. The rest of this section will briefly introduce the three cases.

HSL

The HSL-Zuid is a high-speed train line between Amsterdam, Schiphol airport, Rotterdam, and Brussels. It entered the public domain with the AmRoBel report in 1977 (Ministerie van Verkeer en Waterstaat, 1977). The study explored the potential of a high-speed rail connection between Amsterdam, Rotterdam and Belgium. After this report, the project remained dormant on the agenda but was incorporated into several governmental documents.

The project is best known for its highly political decision-making process culminating in a standoff between two ministers and a political power play by the then prime minister. After a false start in 1991 with an unbalanced starting note sent to parliament, the decision-making process got under way with the new HSL starting note in 1994 in which an analysis was presented of the different alternative routes (Figure 2), and a selection was made culminating into the so-called preferred route (Route A). However, during the procedure alternatives that were filtered out early on started resurfacing under influence from pressure groups, universities, and individual citizens. The most prominent alternative in the discussion was the Willem Bos alternative (Route C) that coupled the line to existing road infrastructure. The transport minister championed the preferred route, however the spatial planning minister championed the Willem Bos alternative in an attempt to save the green area between Utrecht, Amsterdam, The Hague and Rotterdam which is known as the Green Heart. As the Ministry of Spatial Planning saw that although the support in parliament was strong, the support within the government, and especially that of the prime minister, was for the preferred route, the department introduced the idea of a drilled tunnel under the green area. This offered the way out of the political deadlock and the prime minister, also being the political leader of the same party as the minister of spatial planning, forced the minister, his own party and the smallest coalition party to vote in favor of the preferred route with the tunnel option. Construction started in 2000 and commercial transport commenced in 2009.

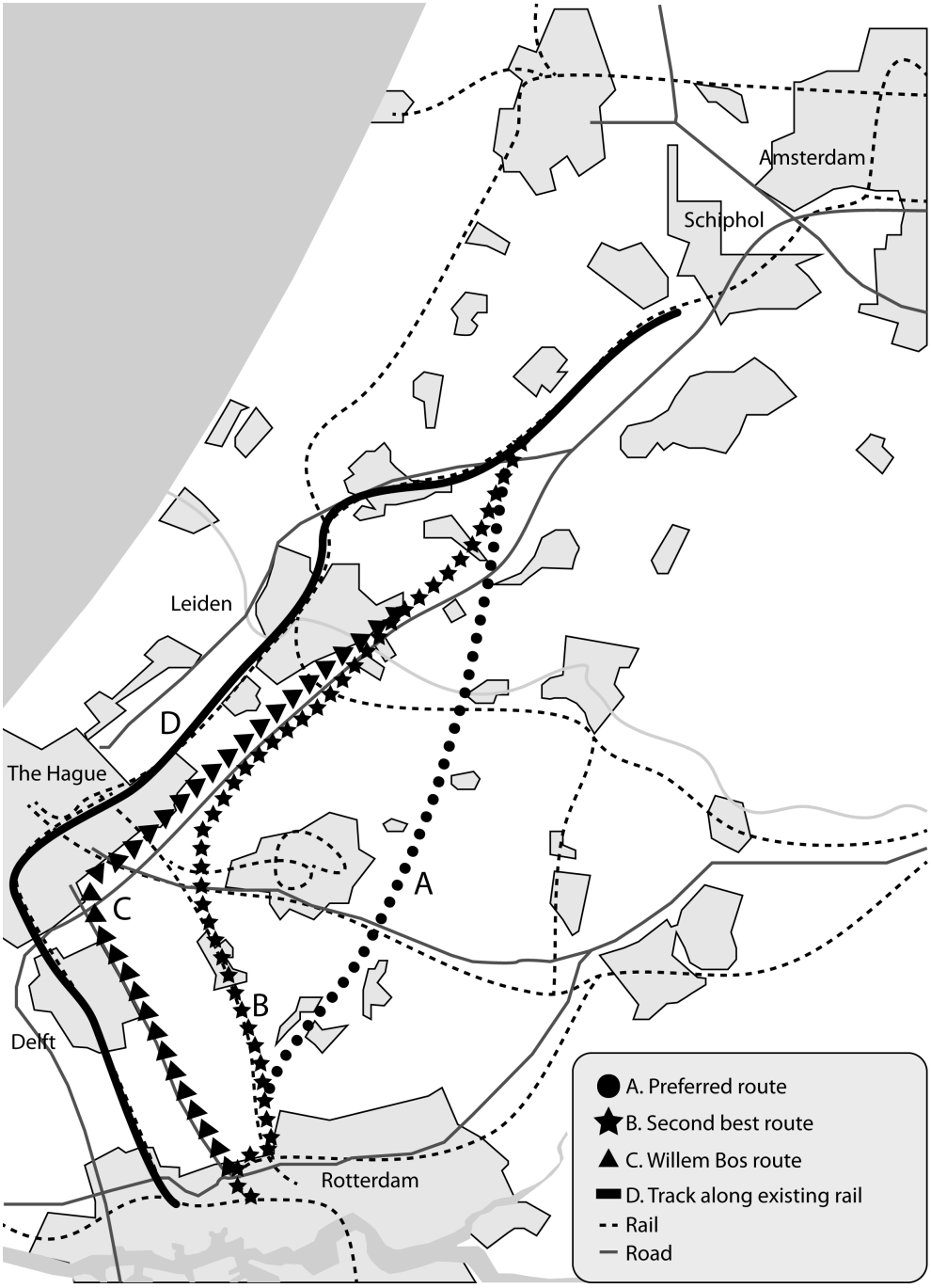

Figure 2: abstracted route of the HSL

RandstadRail

The RandstadRail project is an interregional light rail/bus connection between Rotterdam and The Hague. The decision-making process was dominated by a long stalemate period in which the Rotterdam region wanted a metro and The Hague wanted a tram. The first plans for the project emerged during the 1980s. However, the ambition remained dormant until the public transport companies of the regions inspired the debate with a jointly written report (ANP, 1995). This was the same year when the city regions were introduced. One year later, the regions and the province undertook an exploration study. However, the project proposed was considered too expensive. The following years, the project remained in a deadlock because the two regions wanted different modes of transport as mentioned above. It was not until the state put a lot of pressure behind its demand to come with a proposal that the regions decided to just cut the project into three pieces: one tram-based system for the The Hague region and one metro-based line for the Rotterdam region. A dedicated bus line connection between Zoetermeer and Rotterdam was devised to further reduce the total project cost. After an administrative agreement was made between the different parties in 2005, the project was finished relatively swiftly. Somewhat too swiftly, perhaps, because as the sections in the Hague opened, derailments became an issue because the period of building, testing, and operations had been so compressed that the tracks had not been tested properly (TU Delft, 2008). Currently the project is fully operational.

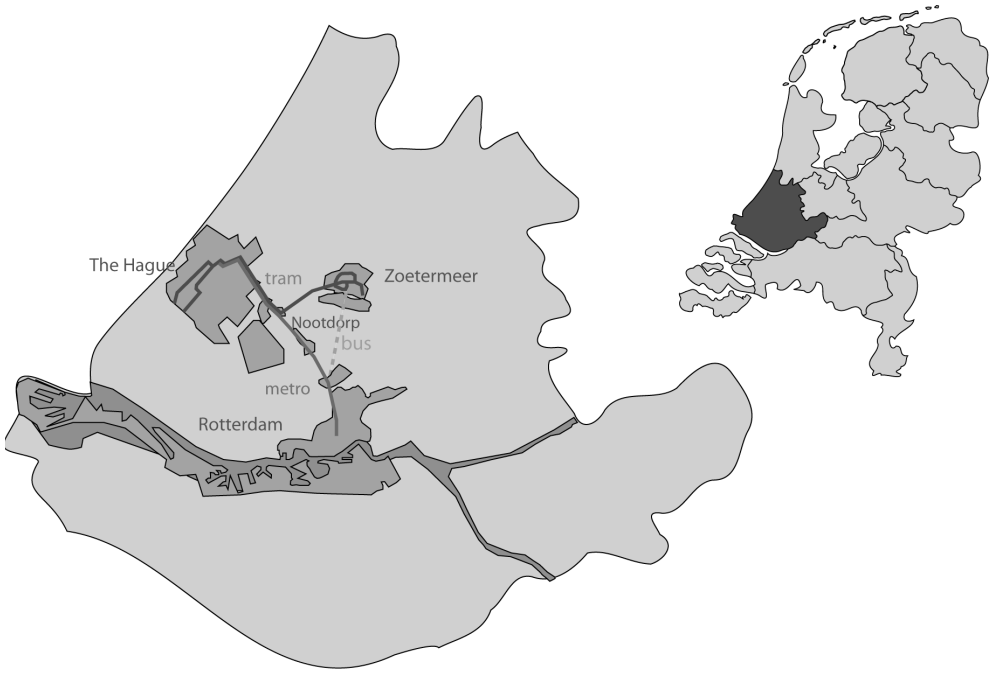

Figure 3: abstracted route of the RandstadRail

Beneluxlijn

The Beneluxlijn is a metro extension in the Rotterdam region. The project has received very little attention by researchers even though it was one of the largest infrastructure projects of the country in the late 1990s and the early 2000s. The project was also very successful in budget control and remained very close to its original schedule (possibly this explains the limited academic attention). The Beneluxlijn was designed in the early nineties in the 3M report that proposed three new extensions to the Rotterdam metro network. This project was the last on the list, but was the first realized due to a window of opportunity. This opportunity presented itself through the desire of the Ministry of Transport to build a second Beneluxtunnel to accommodate increased road traffic towards the Rotterdam harbor. In exchange for the increase in car traffic, the surrounding municipalities demanded a public transport solution as well. As the transport department of Rotterdam had already made the plans for the Beneluxlijn, the connection was easily made. Thanks to the 'Tour de Force' program (in which project planning had been done before funding had been secured), the design and decision-making process had already been prepared and thus construction could begin relatively quickly. The line opened in 2002. At the start there

were problems with the signaling system: however, these were resolved by a reduction of the frequency of the metro trains.

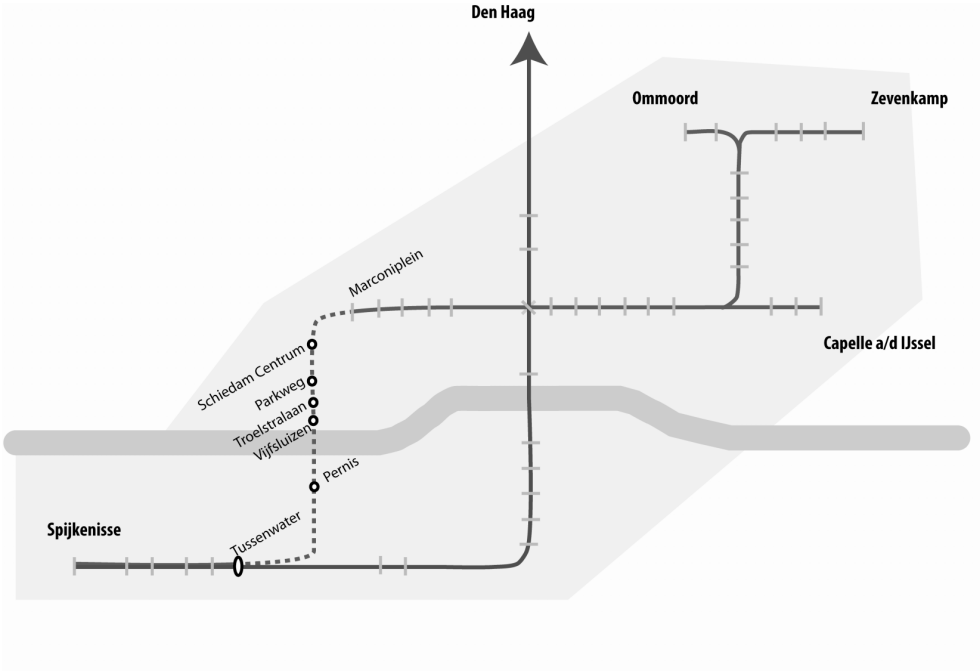

Figure 4: abstracted route of metro network Rotterdam. The dashed line is the Beneluxlijn

Results

This section will start with a comparative discussion of the adaptive capacity within the three projects. It will then continue with the comparison of the strategic capacity of these three cases. The results show differences but also relative consistency in relations between different factors.

Adaptive Capacity

The three projects show all the different types of adaptations. However, in essence they show the same patterns. Mega infrastructure projects have a tendency to start as a solution without a well-organized problem search. It is the project that is given the political relevance, not the problems that need to be solved. As such, these projects are a confirmation of other literature on this topic (De Bruijn & Leijten, 2007; Priemus, 2007). As solutions, there is a strong preference within the project team and the political champions

for incremental adaptations or inertia as a response to emerging challenges. There is a tendency to discard alternatives and to keep out external influences that might cause more radical adaptations to the project. The HSL project was given the design restriction from the outset of having to reach a top speed of 300km/hr. This restriction severely limited the potential for alternatives, while the premises on which it was built (time savings as the inescapable condition for its success) would eventually crumble. RandstadRail was first conceived as a light rail project of the future. The ministry, however, thought the initial plans were too expensive. Moving out of this deadlock by means of a solution acceptable to both parties took about a decade of inertia. The Beneluxlijn was kept relatively simple from the start and its main objective was to change as little as possible in order to prevent scope creep. There was a strong preference to make it a connection between A and B, and with not much in added extras (for instance there were no connected urban development initiatives at stations). The HSL and RandstadRail experienced extensive periods of inertia relating to inflexible protectionist stakeholders and taboos. For instance, for a very long period it was taboo in the RandstadRail project to discuss the functional specifications of the concept "light rail" because Rotterdam wanted a metro and The Hague a tram, and the State wanted one coherent project. The best solution to the involved stakeholders seemed to be to keep the definition at the abstract level of light rail. However, when eventually a compromise decision was made to develop an hybrid system combining a metro and a tram section, there was very little time to design the specifications of the project and prepare for construction. Several respondents singled out this late specification as an important factor contributing to derailments on the line after operations began.

Incremental adaptations are omnipresent in the development of mega projects. Small changes are made constantly. However, I will highlight several incremental adaptations that are more prominent than others. The decision for the Green Heart tunnel in the HSL is in essence a very expensive incremental adaptation. It came forth from the desire to resist the more radical adaptation of choosing an alternative route. In RandstadRail the decision to not put the project out for public tender but to give both municipal transport companies their own section of the pie was an incremental adaptation in order to not challenge the existing institutional structures. Public tender would have radically changed the way the urban transport was arranged. The Beneluxlijn's main incremental adaptations were in the form of noise mitigation adaptations.

Radical adaptations seem to generally take place within the projects after long periods of deadlock and inertia. It takes a lot of opposition to lead to more radical adaptations. The HSL also had its periods of inertia or deadlock. They were responded to with radical adaptations to the process. I would like to highlight two of these moments. The first was

when the first HSL starting note was presented to the public. There were so many questions and objections to the project that a radical adaptation was made to stop the whole project procedure and to start a new one. The second relates to the solution found for breaking the deadlock between Belgium and The Netherlands in their negotiations on where the line would cross the border. To force a decision, the Dutch government paid the Belgians a large compensation to agree to the Dutch preferred route. A radical decision, as it had not been done before, but again an example of incremental adaptation or even inertia in the preferred design of the route and the project. The negotiations were also solved because of a radical adaptation of the institutional structure. The deadlock had been partly caused by old grievances between the Belgians and the Dutch about other projects. However, the federalization of Belgium led to a fresh, new Flemish transport department that was keen on learning from and cooperating with their Dutch counterparts. This new institutional context opened up new opportunities and scope for adaptations. RandstadRail also had its radical institutional adaptations, and that were triggered by changes in the context. Most importantly, the introduction of city regions as a new administrative layer between municipalities and provinces was of strong influence for getting the project on the move again by breaking the deadlock between the two municipalities. The Beneluxlijn did not have any noticeable radical adaptation, which exemplifies its approach to keeping the project as simple and predictable as possible.

The HSL project was a unique, first-of-its-kind project and has contributed several institutional innovations that can be considered socio-historical adaptations. It made progress in public private partnership, which until then had only very sporadically been applied in the Netherlands. New types of contracts, such as "design, build, finance and maintain", had to be researched in other countries. The new signaling system that caused so much delay will most likely be implemented more smoothly for future rail projects. However, these innovations seem to have been a prime factor behind the cost and time overruns in the project. In terms of inertia, within the process of decision-making on RandstadRail there was a shift from transport responsibility from the municipality to the region. This event caused the inertia that existed. And it does not seem that it is likely to change back again. The Beneluxlijn, for its part, did not have any socio-historical adaptations.

Strategic Capacity

This section will discuss the results following the three main concepts of strategic capacity.

Strategic Ambiguity

The HSL project had relatively abstract ambitions of linking the Netherlands to the European high speed rail network and to improve the international accessibility of Amsterdam Schiphol Airport. These ambitions should have kept the process open, were it not for several additional requirements. Most notably the 300km/hr demand mentioned earlier limited the design flexibility of the route and the technical options greatly, as the radii of turns increase strongly between 250km/hr and 300km/hr. The abstraction level became very concrete, and the ambitions of the project shifted strongly towards the design criteria and journey times, leaving potential alternatives to attaining the more abstract ambitions aside. These of course came back with a vengeance later in the process with the political support for the Bos variant gaining momentum.

RandstadRail had the very open ambition of creating a light rail connection on the interregional level between Rotterdam and The Hague. And over more than a decade, this ambition was as far as the project went. Rotterdam preferred a metro connection and The Hague a tram, and the project was deadlocked as it had to be communicated as one coherent system towards the national government. It was only when the national government pressured the parties, and limited the amount of funding available, that they reached an agreement about a project with three different types of transport systems: metro, tram, and bus. This way the tension between the different interests and purposes was resolved.

The Beneluxlijn had a very practical ambition from the outset. Connecting one metro line to another through the Benelux tunnel. There was little strategic ambiguity as the project followed this concrete ambition and did not extend its purposes or interest to other fields than strictly transport infrastructure. As such it was very efficient to plan and execute.

Redundancy

At one point the HSL project organization employed over 100 people and was fully geared at generating alternatives and appraising them. So it would seem that there was great capacity for creating a redundancy in knowledge. However, this redundancy was very much aimed at testing alternatives to strictly predefined criteria, of which the demand of 300km/hr was especially limiting. Alternatives that were important during the final decision-making process were filtered out very early during the design phase. In part it might be because of the lack of redundancy of actors at this earlier stage, that only at later stages alternatives were raised again that seemed to have strong support. At that stage, however, it became frustrating for those that had invested time and effort in developing the preferred routes to go back to the drawing table.

In the RandstadRail project there was little redundancy in the organization of knowledge and actors, because the project was kept very abstract while the three main parties negotiated, and became very concrete and inflexible after the three parties had reached an agreement. And thus the project was never opened to feedback cycles other than municipal- related organizations or consultancy firms. An example of where this became very apparent was when the protests against the planned route on ground level through a neighborhood to the north of Rotterdam Central Station took the organization by surprise and resulted in a difficult deadlock. With a possibility for feedback from outsiders earlier on, there was a good chance that this type of conflict could have been foreseen and taken account for into the decision-making and planning process.

The Beneluxlijn project had relatively little redundancy because of the Tour de Force in which the project planning had already been done before the project was actually in sight of being funded. As a result, the project planning was done behind the scenes; this did not offer an incentive for inhabitants to mobilize themselves. The project was primarily dependent on inter-municipal cooperation between Schiedam and Rotterdam and thus also remained a mainly technical affair. However, a lot of attention was given to including and interacting with local residents during construction as part of its context management program.

Resilience

The HSL project primarily exhibited examples of reactive resilience. The project started out with a preferred route early on. Although many alternatives were developed, the appraisal criteria decided upon at the start of the process quickly led to one preferred route. And as one respondent noted, when the preferred line has been drawn, it becomes very difficult to stop that idea. The eventual tunnel under the Green Heart is the prime example of reactive resilience within the project. In order to get a parliamentary majority for the preferred route, the tunnel was introduced as a compensation for crossing the Green Heart.

RandstadRail also showed examples of reactive resilience. As with the HSL, a tunnel solution was developed in response to strong opposition by inhabitants. A solution came as a reaction to an external block. Another reactive response was the late decision by The Hague to replace the tracks. This was something that could have been proactively appraised. An example of proactive resilience was the tram tunnel in The Hague. While the tunnel was meant for normal trains, the planners incorporated the possibility of allowing RandstadRail vehicles to pass through. Therefore the tunnel was built with redundant space to accommodate for future uses and additional vehicles.

The dogma to "keep as much above ground as possible" inevitably led to a defensive or reactive planning frame within the Beneluxlijn project. The organization had already developed the preferred route in the 'Tour de Force' program and therefore adjustments would be more of the reactive type. A proactive measure was the inclusion of a small piece of infrastructure that makes it easier to build another future extension towards the coast.

The projects have shown great resilience but they have also been framed in a very narrow manner as purely transport infrastructure projects; the added value of a project is thus limited and uncertainties and complexities are coped with through mitigating measures or reactive resilience. The rigidity of the narrowly framed project and process makes it impossible to add value by adapting the plan to solve multiple problems that are not only about getting people from A to B (but can also be, for instance, problems of area livability, landscape preservation or urban development). To create a project that contributes to spatial qualities as well as mobility, there has to be a capacity to recombine options, elements and strategies, as well as to make adaptations to the project in order to make it fit as a solution to multiple problems. Thus, in order to adequately deal with uncertainty and complexity, and add value at the same time, a continuous recombination of different project elements seems necessary. Having redundancies and strategic ambiguities through the process can stimulate the opening and closing of the decision-making process to provide value and proactive resilience. Because the development of a mega project is full of uncertainties and complexities, a well-organized strategic capacity seems fundamental in making projects resilient as well as responsive to the context in which they are developed.

It seems that the successful planning and decision-making of mega projects is conditional on the right adaptation at the right time. Sometimes a radical adaptation is necessary, sometimes an incremental adaptation and sometimes no adaptation. It is dependent on the type of project and its ambitions, and on developments in the social, economic and institutional context. There is an in-built preference for incremental adaptations because there is generally a firm belief that the preferred option, developed at the early stages, is often the best. However a long the way, sometimes an alternative might seem better and a radical adaptation is necessary or desirable for a better result. Of course, by the same token, a wrong radical adaptation or one taken at the wrong moment could lead to disastrous effects. However, a mechanism that opens up the process to potential radical adaptations, rather than creating a deadlock, is desirable. And it seems the best way to do that is to bring diverse actors and views into the process – thus organizing your own opposition – and to bring the context into the project, through building into the process a

redundancy of actors and knowledge and thus proactive resilience. A sufficiently ambiguous project mission can be seen as an essential ingredient of such proactive resilience.

Adaptive and Strategic Capacity facing Uncertainty and Complexity

This section explores the relation between adaptive and strategic capacity. They find each other in uncertainty and complexity. The first is about the different options to respond to uncertainties within the process. Is the process open enough to be able to make radical adaptations, which can be unpredictable, or does it keep it closed and only allows for incremental adaptations or even just sticking with the status quo? The second is about the design of the process: how to organize the decision-making and planning process and what does this means for the strategic value of the project and the way it deals with complexity and uncertainty? Both come forth from the observation that policymakers and planners have a tendency to close or simplify the process in order to keep complexity and uncertainty out. This affects the process and content framing of a mega project.

Mega projects contain complexity and uncertainty as do most things in life. However, as already mentioned, planners can fight this issue, ignore it or try to use it. It is in relation to these different strategies that we frame the content and the process of a project. In the case of mega infrastructure projects it seems that the framing is often kept very narrow in an attempt to reduce complexity and uncertainty. This framing in turn influences the institutional capacity for adaptive and strategic planning, which is also kept narrow. This framing and the concept of strategic capacity are two sides of the same coin; they both involve the organization of the process and content. However, strategic capacity as used in this research has a stronger focus on how the process is organized in relation to uncertainty. Framing has a broader and more general scope. Strategic capacity is a specification of what it means when we say a project is narrowly framed. Adaptive capacity discusses the ability to adapt to changing circumstances. In large part this is structured by the design of the process as a result of the strategic capacity. To further articulate this notion, I will discuss each of the three aspects of strategic capacity and their influence on inertia, incremental adaptations and radical adaptations (for a summary , see table 1). As socio-historical adaptations could be considered as an incremental or radical adaptation with lasting effects, I will leave these out of this part of the analysis.

There is an ambivalence in the relationship of this concept with inertia in that too much as well as too little ambiguity can lead to inertia. I will start with the abstraction of the mission. The more abstract the mission, the more open the process is for change. The abstract mission of RandstadRail to create light rail connections between two regions left a lot of space for filling in the specifics. However, because it left so much space, the decision-making remained at that abstract level for a very long period of inertia. The abstraction was too high. By contrast, the mission of the Beneluxlijn was no abstract at all in its aiming at creating a metro extension between several fixed points within a very limited budget. As a result, there was very little space for extending the mission to other ambitions such as spatial developments. It was purely a metro infrastructure project. Here, the inertia was in the fact that the project was not able to expand or change. The abstraction was too low. Thus there is a balance between abstraction and concreteness that seems necessary to move forward without getting deadlocked. The tension between purposes seems to also have an ambivalent nature towards inertia. Generally a strong tension between different purposes will lead to inertia in first instance. For instance, the tension between the tram and the metro kept RandstadRail deadlocked for more than a decade. However, as the radical adaptation section has shown, strong tension can also be necessary to trigger movement.

There is a less clear relation between strategic ambiguity and incremental adaptations than with inertia. Small steps can be made within great ambiguity and within very limited ambiguity. Small steps are easy to make. Thus, unless there is a period of inertia, incremental steps are difficult to relate to ambiguity.

The relationship between strategic ambiguity and radical adaptations seems to be clearer. A low level of abstraction of the mission makes it harder to make more radical adaptations. For instance, the 300km/hr criterion for the HSL was a very concrete ambition that limited the options for alternative routes. And thus the potential for more radical solutions to the more abstract ambition of linking The Netherlands to the European high-speed train network was perhaps unnecessarily limited by the specific speed criterion. A high abstraction of ambition leaves more room for radical adaptations; there are many roads that lead to Rome. Thus the more specifications you bring in the process, especially early on, the less options become available and a path dependency or deadlock becomes a more likely outcome.

To conclude, it seems there is a pattern that the higher the ambiguity, the higher the adaptive capacity, or in other words the more types of adaptation that are possible. And

thus the lower the ambiguity in the process, the lower the adaptive capacity of the decision-making and planning processes (only incremental adaptations or inertia are possible; see Figure 5).

Redundancy

Redundancy is brought into the process to prevent inertia from occurring. Redundancy gives options and insights that might be needed to move beyond a moment of inertia or deadlock. With the HSL case the redundancy of alternatives was filtered out early on in the process to reduce the number of options when the project entered into the decision-making process. However, as it turned out, some of the early alternatives that were filtered out later returned to the decision-making process. Had different appraisal criteria been used, these alternatives would have been very serious options. And those not directly involved at the beginning might have had different criteria against which to judge the project. That is why a redundancy of actors, already at the outset, is also important to prevent inertia from unexpected opposition forces.

As with ambiguity above, the relationship between redundancy and incremental adaptations is difficult to interpret. Whether there is low redundancy or high redundancy in the process, incremental adaptations can still be made. However, a higher redundancy is likely to generate more potential incremental adaptations than with a low redundancy when the path dependency becomes a larger issue. For instance, the number of options for incremental changes were higher at the start of the HSL process when the alternatives were generated than after the filtering of options when rigid selection criteria limited the possibilities.

The redundancy of knowledge and actors should stimulate the potential for radical adaptations. As there are more options available and there is more information about the consequences of different choices, the barriers for making a radical adaptation are greatly reduced. However, the cases do not really exhibit this behavior. Radical adaptations have been made in reaction to strong opposition.

However, the same pattern seems discernible as with ambiguity. A high redundancy means a higher potential of adaptations possible, while a low redundancy seems to indicate that options are limited to inertia or at best incremental changes (see Figure 8).

Inertia and reactive resilience are strongly related. Inertia is all about not changing, about being resistant to external influences. The two regions in RandstadRail kept the project in a long period of inertia because each wanted its own transport system of the metro or the tram. These desires were so resilient that eventually the project was split up into different systems with different modes. The HSL was also strongly geared towards reactive resilience. Once the preferred route was decided, the project was geared towards preventing alternatives from threatening the project.

Reactive and proactive resilience need incremental adaptations. Reactive resilience, in particular, is dependent on incremental adaptations to escape deadlock. The Green Heart tunnel of the HSL is of course the ultimate incremental adaptation coming forth from reactive resilience in an effort to save the preferred route in the decision-making process. But also smaller mitigation strategies are examples of the relationship between reactive resilience and incremental adaptations. The relation between proactive resilience and incremental adaptations is also clear. The process is opened up for adaptations, as they are considered natural to the decision-making and planning of the project. The social program of the Beneluxlijn to communicate the project to inhabitants is an example of a proactive measure taken to make incremental adaptations to the project, if necessary.

Reactive resilience and radical adaptations do not go well together. Reactive resilience reflects a desire to keep everything the same while radical adaptations entail a big change to the status quo. In contrast, proactive resilience and radical adaptations could go together well. Especially when the mission is quite abstract, proactive resilience can incorporate radical adaptations. RandstadRail might be the best example where the ambition to create a light rail connection was (most likely unintentionally) proactively resilient in the sense that it eventually did not matter which transport mode or type or light rail it would be.

Table 1 summarizes the main links made in the paragraphs above. Figure 5 shows the patterns visually. Although it has proven difficult to exactly trace the influence of the different concepts on each other, especially concerning incremental adaptations, there are clear patterns of a process design limiting or stimulating particular adaptations. However, what does this mean for planning a mega project? This will be the question guiding the next paragraph.

Table 1: Relationships Adaptive and strategic Capacity

Strategic Capacity	Relationship with adaptive capacity
Ambiguity	Ambiguity stimulates inertia at two extremes. Both a high and low abstraction of ambition could lead to inertia. The lower the abstraction, the more limiting the process is for radical adaptations to be made. Very specific criteria are particularly detrimental to the radical adaptive capacity.
Redundancy	Redundancy is useful for preventing inertia or for having a way out of inertia because of the availability of alternatives. Analytically the relationship would be that redundancy stimulates radical adaptations because of a better understanding of consequences and alternatives. However, the empirical data is not conclusive enough to make firm conclusions because all three projects tend to limit redundancy.

Strategic Capacity	Relationship with adaptive capacity
Resilience	Inertia and reactive resilience are closely related. Strong reactive resilience is all about preventing adaptations. Proactive resilience is aimed at preventing inertia. Both types of resilience need incremental adaptations to prevent inertia. Reactive incremental adaptations are often geared at mitigation and proactive ones at keeping the process open and flowing. Where reactive resilience is averse to radical adaptations, proactive resilience is welcoming. Especially in cases with a high abstraction of ambitions, radical adaptations provide resilience for the goal of the project.

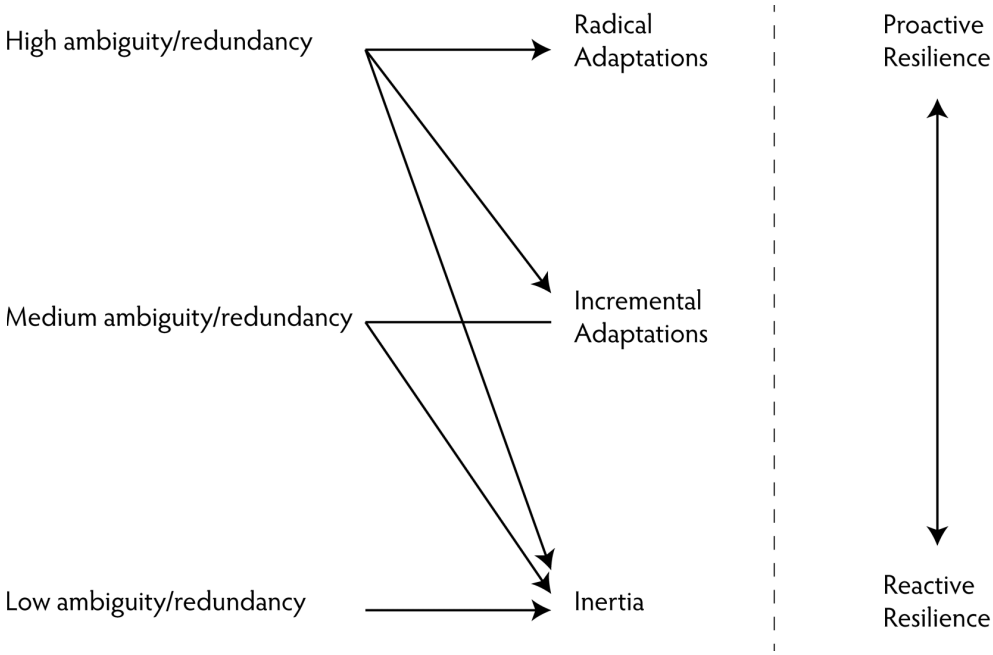

Figure 5: Conceptual relation between ambiguity/redundancy and adaptive capacity

Conclusion: pragmatic navigation between complexity and uncertainty

What seems to connect the different mega infrastructure projects is the desire to close the process as early as possible in order to create a sense of limited complexity and uncertainty. Of course it is important to close the process in order to move forward at several moments during the decision-making and planning process. However, we need to learn to adapt, to not get deadlocked while being resilient, and therefore redundancy and strategic ambiguity are crucial. The concepts developed and the relationships shown should be used by practitioners to understand what consequences the choices they make in designing the process will have on their capacity to respond to change and to be prepared for the unexpected.

Planning a mega project is not only about making a rigorous plan to follow step by step. There are risks, contingencies, and irreducible uncertainties that can become disastrous when ignored. Planning is a science of navigation in which there is a balance between opening and closing a process and content, between the certain and the uncertain, the simple and the complex. Planning is like sailing a ship, having a destination and moving your way around storms, through known and unknown territory with underwater rocks and unexpected sandbanks.

This article has developed and explored the links between the concepts of adaptive and strategic capacity in the decision-making and planning of mega projects. These concepts have been applied to the analysis of three of the largest transport projects in the Netherlands and further extended the results by looking at the relationship between these two concepts as well. Planning a mega project needs a responsive, adaptively designed decision-making and planning process that does justice to the uncertainty and complexity of the project and its context. Simplification of the process and limited framing of the scope of the project can help to keep a project manageable as was successfully achieved in the Beneluxlijn project. However, this seems to be a useful strategy only if a project is relatively uncontested, opposition is limited and the project is not part of a political play between powerful actors. When this is not the case, the reduction of complexity can bring in a lot of uncertainty because of the limited feedback from groups that can have a strong impact on the process. Alliances of lobbyists, community action groups, and political actors can provide unexpectedly strong opposition, as was the case in the HSL project. And also in the RandstadRail project, a simplification of the decision-making and planning process was infeasible because of the political power structures and interests at play. And as uncertainty and complexity become irreducible, better seamanship becomes necessary.

One has to navigate constellations of actors, oceans of uncertainty and archipelagos of complexity. And for that, a project process has to be designed to take into consideration issues of strategic ambiguity, redundancy, and resilience in order to build in adaptive capacity.

Albrechts, L, 2004, "Strategic (spatial) Planning Reexamined" Environment and Planning B, 31, 743–758.

Alexander, E R, 2000, "Rationality Revisited: Planning Paradigms in a Post-Postmodernist Perspective" Journal of Planning Education and Research, (19) 242–256.

Allen, P M ,2001, "A Complex Systems approach to Learning in Adaptive Network" International Journal of Innovation Management, 5(2) 149–180.

ANP, 1995, "RandstadRail kan in 2010 operationeel zijn" July 5.

Argyris, C, & Schön, D, 1978, Organizational Learning. Addison-Wesley, Reading, MA

Bertolini, L, 2007, "Evolutionary urban transportation planning: an exploration" Environment and Planning A, 39(8) 1998–2019.

Buck, N, Gordon, I, Harding, A, & Turok, I, 2005, Changing Cities: Rethinking Urban Competitiveness, Cohesion, and Governance (Cities Texts) Palgrave Macmillan, London.

De Bruijn, H, & Leijten, M, 2007, "Megaprojects and Contested Information" Transportation Planning and Technology, 30(1) 49–69.

Deutsch, K W, 1966, The Nerves of Government. Models of Political Communication and Control (2nd ed.). (Free Press, New York)

Dovers, S R, & Handmer, J W, 1992, "Uncertainty, sustainability and change" Global Environmental Change, 2(4) 262–276.

Easterby-Smith, M, 1997, "Disciplines of Organizational Learning: Contributions and Critiques" Human Relations, 50(9) 1085–1113.

Faludi, A, & Mastop, J M, 1982, "The "IOR school": the development of a planning methodology" Environment and Planning B, 9(3) 241–256

Faludi, A., 1996. Rationality, Critical Rationalism, and Planning Doctrine. Center for Urban Policy Research, New Brunswick.

Friend, J K, & Hickling, A, 1987, Planning under pressure. the strategic choice approach. Taylor & Francis, Oxford

Friend, J K, & Jessop, W N, 1976, Local Government and Strategic Choice (2nd ed.). Pergamon Press, Oxford

Friend, J K, Power, J M, & Yewlett, C J L 1974, Public planning: the inter-corporate dimension. Tavistock Publications, London.

Gregory, R, & Failing, L, 2002, "Using decision analysis to encourage sound deliberation: water use planning in British Columbia, Canada" Journal of Policy Analysis and Management, 21(3) 492–499.

Grimsey, D, 2002, "Evaluating the risks of public private partnerships for infrastructure projects" International Journal of Project Management, 20(2) 107–118.

Hagmann, J, & Chuma, E, 2002, "Enhancing the adaptive capacity of the resource users in natural resource management" Agricultural Systems, 73(1) 23–39.

Healey, P, 1999, "Institutionalist Analysis, Communicative Planning, and Shaping Places" Journal of Planning Education and Research, 19(2) 111–121.

Innes, J E, & Booher, D E, 2010, Planning with Complexity: An introduction to collaborative rationality for public policy. (Routledge ,London)

Kunzmann, K R, 2000, Strategic Spatial Development through Information and Communication. In W. G. M. Salet & A. Faludi (Eds.), The Revival of Strategic Spatial Planning. (Royal Netherlands Society of Arts and Sciences, Amsterdam)

Kvale, S, & Brinkmann, S, 2009, InterViews: Learning the Craft of Qualitative Research Interviewing (2nd ed.) (Sage Publications Thousand Oaks, CA)

Lambooy, J G, & Boschma, R A, 2001, "Evolutionary economics and regional policy." Annals of Regional Science, 35(1), 113–131.

Landau, M, 1969, "Redundancy, Rationality, and the Problem of Duplication and Overlap" Public Administration Review, 29(4), 346-358

Latour, B, 2005, Reassembling the Social: An Introduction to Actor-network-theory. Oxford University Press, Oxford.

Low, B, Ostrom, E, Simon, C, & Wilson, J, 2003, "Navigating Social-Ecological Systems" In F. Berkes, J. Colding, & C. Folke (Eds.), Navigating Social-Ecological Systems. (Cambridge University Press, Cambridge) pp. 53–82

Marchau, V A, Walker, W E, & van Wee, G P, 2010, "Dynamic adaptive transport policies for handling deep uncertainty" Technological Forecasting and Social Change, 77(6) 940–950.

Miner, A S, & Mezias, S J, 1996, "Ugly Duckling No More: Pasts and Futures of Organizational Learning Research" Organization Science, 7(1) 88–99.

Ministerie van Verkeer en Waterstaat, 1977, Amrobel; globale verkenning van tracés voor een Hoge Snelheidslijn Amsterdam-Rotterdam-Belgische grens. Ministerie van Verkeer en Waterstaat, Den Haag.

Nonaka, I, 1994, "A Dynamic Theory of Organisational Knowledge Creation" Organization Science, 5(1) 14–37.

Priemus, H, 2007, "Development and design of large infrastructure projects: disregarded alternatives and and issues of spatial planning" Environment and Planning B-Planning & Design, 34 626–644.

Priemus, H, 2010, "Mega-projects: Dealing with Pitfalls" European Planning Studies, 18(7) 1023–1039.

Romme, A G L, & van Witteloostuijn, A, 1999, Circular organizing and triple loop learning. Journal of Organizational Change Management, Journal of Organizational Change Management, 12 439–454.

Schindler, M, & Eppler, M J, 2003, "Harvesting project knowledge: a review of project learning methods and success factors" International Journal of Project Management, 21, 219–228.

Simon, H A, 1991, "Bounded Rationality and Organizational Learning" Organization Science, 2(1) 125–134

Simons, D J, & Chabris, C F, 1999, "Gorillas in our midst: sustained inattentional blindness for dynamic events" Perception, 28 1059–1074.

Songer, A, Diekmann, J, & Pecsok, R, 1997, "Risk analysis for revenue dependent infrastructure projects" Construction Management & Economics, 15(4) 377–382.

Teece, D J, Pisano, G, & Shuen, A, 1997, Dynamic capabilities and strategic management. Strategic Management Journal, 18(7) 509–533.

Thomas, J, & Mengel, T, 2008, "Preparing project managers to deal with complexity – Advanced project management education" International Journal of Project Management, 26(3) 304–315.

TU Delft, 2008, Evaluatie RandstadRail Eindrapport. Het RandstadRail-project: Lightrail, Zware Opgave (TU Delft, Delft)

Van der Heijden, K, 1996, Scenarios: The Art of Strategic Conversation. John Wiley Chichester, Sussex.