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

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2. Planning Infrastructure in the Face of Complexity: Enhancing the Adaptive Capacity of Mega Projects

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Introduction

The planning of an infrastructure mega project is like a big obstacle course: there is always something to trip over. These projects are extremely complex and controversial and as a result there are continuously new surprises, challenges, and problems to deal with. In any project, stakeholders need to have a well-developed adaptive capacity to respond to these challenges. Current policy does not take this need for adaptive capacity sufficiently into account. The current approach in infrastructure mega project policy seems rather to simplify complexity by reducing it to numbers in, for instance, decision-support models (Hooghiemstra et al., 1999; Miyamoto et al., 1996; Montmain et al., 2009; Salling and Banister, 2009; Salling et al., 2007) or by limiting the opportunities to disagree with the plans using special laws and 'fast track' procedures (Elverding, 2008; OECD, 1993, 2004). The main concern seems to be to reduce time and cost overruns, even though these are just as often caused by politically motivated decisions, as by technical or procedural inefficiency (Akintoye et al., 2003; Altshuler & Luberoff, 2003; Bruzelius et al., 2002; English & Guthrie, 2003; Flyvbjerg et al., 2003; Flyvbjerg et al., 2002, 2006; Glaister, 2008; Klijn & Teisman, 2003; Koppenjan, 2005; Priemus, 2008; Siemiatycki, 2010).

And yet while there is also a relatively well-developed movement amongst academics towards more adaptive decision-making and planning processes (Bertolini, 2007; Gregory & Failing, 2002; Marchau et al., 2010; Priemus, 2010), the practice of mega project policy seems to be moving in the opposite direction. Thus there is a discrepancy between academic literature and policy. While theory moves towards more adaptive planning and decision-making, the practice of mega projects, and especially the contextual policy, is moving in the opposite direction. There might be different explanations for this. There are issues of entrenched power relations and of institutional obduracy, but there are also issues of communication between theory and practice. One problem in this last respect is the still very different level of abstraction in which theory and practice operate: seen from theory practice might not be reflective enough, but seen from practice theory might seem too stylized. On the theory side, improving on this thus requires it being more specific on the

mechanisms through which decisions are made in the practice of planning mega projects. Accordingly, this article wants to explore the type of adaptations made in the cycle of planning, decision-making, and constructing a large project, and the mechanisms that keep a process in inertia or move it forward from deadlock by adapting. Our hypothesis is that these different mechanisms determine the adaptive capacity of the decision-making and planning process and thus its ability to overcome deadlock. Insight in this will articulate and specify existing theory and might also help more concretely understand how practice can improve.

To do this we will develop a conceptual framework that enables us to study and classify adaptations. This framework will build on the work of authors (mentioned above) whom feel that, in the face of irreducible complexity, a radically different approach to planning is necessary: an approach that cultivates adaptive capacity in the planning organization and decision-making process. The framework consists of a typology of four different sorts of adaptations, or lack thereof: incremental, radical, socio-historical and inertia. Complementing the above-mentioned, mostly theory-driven studies, we aim in this paper to empirically derive insights from the actual practice of mega project planning. In order to do this, the framework is applied to a mega project in the Netherlands to explore the patterns of and the mechanisms behind the adaptations made in the planning process. The project, RandstadRail, is an interregional light-rail project that has innovatively linked two different regional systems, and that has been also reasonably successful in managing cost and time overruns. However, the project was also riddled with deadlocks and bottlenecks: it took about 20 years to reach an administrative agreement between the different governmental organizations involved in the project. Our assumption is that the planning and decision-making process of this project will have seen many sorts of adaptations to overcome these deadlocks and bottlenecks, and is therefore an interesting case study for exploring adaptation patterns. In particular, we will ask: What moments of adaptation can be identified in this project and what mechanisms drove these adaptations? Are there lessons to be learned for other projects? What might constitute adaptive capacity in the practice of infrastructure mega project planning and decision-making, and how might adaptive capacity be cultivated?

In this article, the conceptual framework of adaptive capacity is developed in section 2. Section 3, discusses the methodology used in the empirical research. Section 4 presents the analysis of the case and the adaptation patterns and mechanisms found. The conclusion and discussion section presents the insights derived from practice (rather than theory) on the need for and mechanisms of adaptation. The general response to deadlock when developing mega projects is to make incremental adaptations like mitigation measures. It

seems that only with strong opposition or deadlock, more radical adaptations become possible and that these do not necessarily lead to more expensive projects or to delays. A more pro-active approach towards developing adaptive capacity might even speed-up the process. The tendency in policy to move towards a more simplified planning and decision-making process is likely to work counterproductive if adaptive capacity is not taken into consideration.

Adaptive Capacity

This section relates the concept of adaptive capacity to organizational learning theory. We define adaptive capacity as the ability to adapt to actual changes in the context or changes in the perception of the context by the actors involved. It is similar to the definition used in ecology (Folke et al., 2002; Folke et al., 2005; Hagmann & Chuma, 2002; Shrivastava, 1983): "systems with a high adaptive capacity are able to reconfigure themselves when subject to change without significant declines in crucial functions" (Folke et al., 2005: 452). According to this literature, to be sustainable in the long run it is crucial for ecological systems to be able to adapt to changes in their environment. Applying this insight to our object of study, we assume that the adaptive capacity of the planning and decision-making process is crucial to the long-term sustainability of the mega project.

Based on an analysis of literature on adaptations, Smit et al. (2000: 229) argue that it is important to identify three components of adaptations. The first is the system of interest, which in our case is a mega project and the actors associated with it. We see actors as part of an association connected to each other around a general theme (Latour, 2005), in this case the mega project. We are interested in the adaptations made throughout the process and therefore look at this association of actors and trace their actions in relation to this process. The second component is the related stimulus. What is it the planning process is adapting to? This is the subject of the empirical analysis in section 4, which identifies several stimuli. The third aspect is the processes and forms involved. What are the mechanisms behind these adaptations? This is the core question of the paper and will be also answered in section 4.

As an association of actors can be said to resemble a very loose organization of all actors interested and allowed to participate, and as in social systems learning is strongly related to adaptation, we chose to take inspiration from organizational learning theory for development of our conceptual framework. In their seminal work 'A Behavioral Theory of the Firm', Cyert and March introduce organizational learning and define an organization as "a coalition of individuals, some of them organized into sub-coalitions." (1963: 27). "To

assume that organizations go through the same processes of learning as do individual human beings seems unnecessarily naive, but organizations exhibit (as do other social institutions) adaptive behaviour over time" (1963:123). In figure 1 we present our conceptual framework: a contextual change triggers adaptive capacity of the planning and decision-making process, leading to different types of adaptations and outcomes depending on the mechanisms activated. There are four types of adaptations, with their learning counterparts between brackets: incremental (single loop learning), radical (double loop learning), socio-historical (triple loop learning), and inertia (zero learning) (Argyris & Schön 1978; Shrivastava 1983; Sun & Scott 2003). The main question of the article is then: what are the main mechanisms driving a project towards a particular type of adaptation or inertia? And with what impacts on the process and the project?

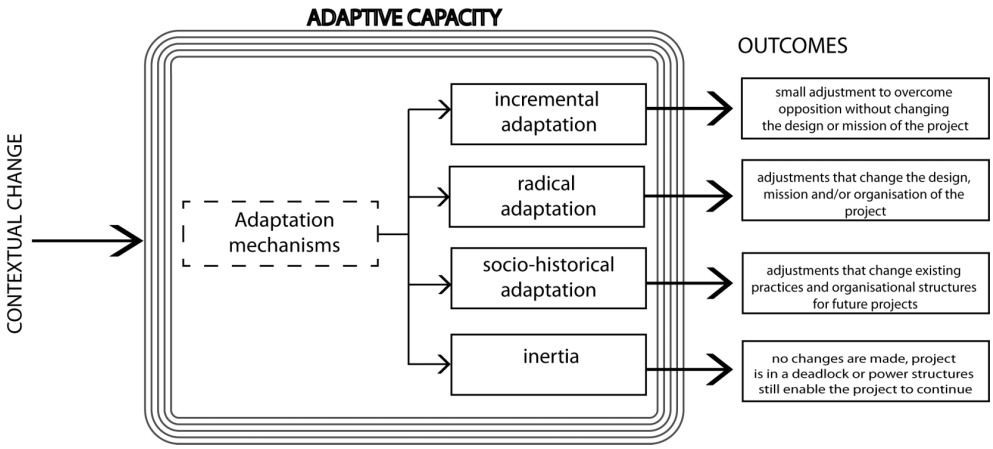

Figure 1: Conceptual scheme

Incremental adaptation relates to the idea that change comes in many small steps (Cyert & March, 1963) and that organizations learn incrementally (Argyris & Schön, 1978). Individuals and organizations often adapt because they detect errors that need to be corrected. However, generally it is not desirable to fundamentally change present policies or present objectives as that often requires large investments in time, money, and skills. For a rail line to be successful it might be good to shift from heavy rail to light rail, but the direct investments that need to be made might be so considerable that the potential future benefits are put aside. The benefits are in the future but the costs are right now. However, complex problems can rarely be solved within the safe boundaries of current procedures, objectives and policies. A more severe adjustment is needed. Indeed,

sometimes radical adaptations are necessary. Radical adaptation involves the adjustment of objectives, policies, and practices in a fundamental manner. Organizations, for instance, sometimes need to radically renew themselves to survive strong competition and adapt to newly emerging technologies (Crossan et al., 1999). As in the example mentioned above, an investment to change from heavy rail to light rail might be the only way for some rail routes to compete with the car.

In certain situations, adaptations made to the institutional and social context of an organization are the only way to deal with persistent issues. These have a lasting impact on future practices and change the playing field. These adaptations need not always be directly related to the mega project but do have a direct impact on the project and its association of actors. For instance an institutional change from a centralist state to a federation, as happened in Belgium in the nineties, will have a strong impact on the association of actors surrounding a mega project such as the high speed train between Amsterdam and Brussels. Sometimes these adaptations can offer a way out of certain deadlocks and bottlenecks in the decision-making process by causing a rupture in the existing political and power structures (Kenny, 2006; Sun & Scott, 2003).

Next to moments of adaptation, there are of course many moments when adaptations do not take place. For our purpose we do not look at all moments of non-action but we discuss moments of inertia. This is a situation in which there is a pressure or necessity for adaptation, yet none is made (similar to the concept of zero learning discussed in Romme ^ Van Witteloostuijn, 1999). This happens because the general preference in organizations is to continue with existing institutional routines (Bateson, 1973) in which new information is routinely acquired or there is an automatic response to a stimulus.

Now that the conceptual framework has been developed, we will use it to explore a mega project and search for the moments of inertia and adaptation and the mechanisms we see behind them. The main question will be deconstructed into two sub questions. What type of adaptations can we identify and what mechanisms are at work behind these adaptations? With what impacts on the process and the project? The conceptual framework offers a structure to analyze adaptation within the highly dynamic process of planning and constructing a mega project. The next section discusses the research design, case selection and analytical techniques used to come to an answer.

Research Design and Methodology

This research uses a case study research design: "A case study is a empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." (Yin, 2003: 13). The adaptive capacity of the planning process is clearly a phenomenon that is in continuous interaction with the context. The case study method is especially useful to look at "how?" questions (here the mechanisms behind the interactions between planning process and context) and to enable the use of insights emerging to generate hypotheses that might apply to a wider population (Gerring, 2007). We analyze a Dutch interregional light-rail project called RandstadRail. It is a large project that involves planning on and between different levels of government, spatial scales and transportation systems. Most importantly, it is a project that, while ultimately considered successful by many, had to overcome many bottlenecks and deadlocks in the planning and implementation process. Based on the assumption that in order to do this the project had to adapt, we expect it to be an excellent case to apply our conceptual framework and thus explore patterns and mechanisms of adaptation.

In this article the structured narrative interview is the primary source of data. This type of interview focuses on stories that subjects tell, on their recounts of past events. The interviewees are prompted to reconstruct the process without being pushed into a hypothesis-driven direction: "After the initial request for a story, the main role of the narrative interviewer is to remain a listener, abstaining from interruptions, occasionally posing questions for clarification, and assisting the interviewee in continuing to tell his or her story." (Kvale & Brinkmann, 2009: 155). We chose this method in light of the exploratory nature of our enquiry into mechanisms. In addition, we fortified the information gathered from these interviews with that from more structured interviews and document analysis.

For each of the projects, different stakeholders were interviewed. The following prompting questions were used to solicit a narrative on the moments of adaptation:

- *What were the crucial moments in the decision-making and planning process?*
- *What were the moments of breakthrough or stagnation?*

The research design could be defined, most closely, as abductive, since the analysis of the data combines deduction and induction. We chose this in order to be able to identify the crucial moments of adaptation, to identify the underlying mechanisms, and the impacts of

adaptation or inertia. Sections of each interview are inductively coded when the respondent identifies a crucial moment or a moment of breakthrough or stagnation. These moments are subsequently deductively coded into the type of adaptation: incremental, radical, socio-historical, and inertia. Quotations are coded as incremental when the changes described do not have an impact on the main goals, mission or preferred design and route of the project. Radical adaptations, by contrast, are coded as such because they do have an impact on all of these aspects. In quotations where adaptations indicate a break from past practices and institutions, they are coded as socio-historical. Finally, moments are coded as inertia when the quotation discusses a crucial moment of no change or of stagnation. There are also quotations that show crucial moments which do not fit the typology because they, for instance, do not discuss the moment in terms of change or non-change. These quotations are coded as unclassified. The coded sections are then inductively coded for mechanisms that influenced the adaptation. Coding is done within Atlas.ti 6.0 software. The motivation behind this approach is to analyze the adaptive capacity of planning and decision-making processes grounded in actual mega project practice from an empirical basis. The developed adaptive capacity typology is used to structure the analysis without forcing predefined hypotheses on the empirical work.

There are 14 extensive interviews, covering all the main types of stakeholders involved in RandstadRail, all done by the same person following the same questionnaire. We stopped at this number of interviews as we at that point reached theoretical saturation (Bryman, 2008): that is, no new information was being added, as new interviewees started mentioning the already-identified moments in similar ways. Table 1 provides a classification of interviewed stakeholders.

Table 1: Classification of stakeholders narrative interviews.

Type actor	#
National government	1
Regional government	1
Local government	1
Rail Network Provider	1
Municipal Transport Aldermen	1

Type actor	#
Transportation company	1
Academic expert	1
Local community member	1

Of course, the reconstruction of the case is not done purely on these interviews. There are also 14 other interviews that feed into the reconstruction of the case, bringing the total of interviews for the case at 28. These questions focussed on particular aspects such as sources of complexity and uncertainty, context, and project success. Furthermore, official documents and newspaper articles have also been incorporated in the reconstruction of the case and selection of interviewees. However, to explore the value of the conceptual framework, the focus of the analysis is, as mentioned above, on the crucial moments of breakthrough and stagnation identified by the stakeholders in the narrative interview.

Section four will present the empirical results and analysis from the RandstadRail case study. In this section we will discuss the moments of adaptations in their respective categories and then endeavour to identify the mechanisms behind these adaptations.

Adaptations and adaptation mechanisms in RandstadRail

RandstadRail is an interregional transportation project in the city regions of Rotterdam and The Hague. It is one of the first light-rail transport projects in the Netherlands that connects two regional transport networks. As a result of the prominence of the regions, there is a multitude of actors other than the national state which has a dominant stake in the project (these include: the Province of South-Holland; the regions of The Hague and Rotterdam; the municipalities of the Hague and Rotterdam; and smaller municipalities). During the planning process, RandstadRail developed into a hybrid project consisting of three transport modes: metro, tram, and bus. The metro connects the city centres of Rotterdam and The Hague. The metro line also links several new towns between the two cities. The second section consists of two tramlines between The Hague and Zoetermeer, a satellite town of The Hague. The third element is a bus connection between Zoetermeer and Rotterdam. However this last section has yet to be developed. The routes are shown in figure 1. The planning process experienced repeated deadlocks and bottlenecks as conflicts arose among the regions and between the regions and the national government, mostly regarding financing and competence issues. Eventually a financial agreement was made (the regions got the requested funding from the national government in a lump sum,

but could not claim more in the case of cost overruns) and the organizations were reasonably successful in controlling time and cost of project implementation. The project was also successful in attracting, and even surpassing, the amount of predicted passengers. Table 2 provides a chronology of the project.

Figure 2: Route RandstadRail (schematic)

Table 2: Timeline RandstadRail

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

Date	Event
1995:	Introductions of the Stadsregio Rotterdam (SRR) 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 3-6 billion NLG (€1.3- €2.7 billion). The national state asks for solutions requiring less investment
December 1999:	Additional advice by the RandstadRail Steering Group (State, PZH, SRR and SGH) to achieve higher quality of transport by suggesting to link the lines to the urban rail networks and make 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 lines 3 and 4 is given to HTM
February 2006:	Concession for transport and maintenance of the Hofplein line section (the Erasmus line) is given to the RET
November 2006:	Derailments of line 4
October 2007:	Lines 3 and 4 are fully operational between de Uithof and Zoetermeer Oosterheem. This means that RandstadRail The Hague is now fully operational
August 2010	The Rotterdam Section of RandstadRail becomes fully operational

Incremental adaptations

The crucial moments mentioned by the interviewees and coded as incremental changes mainly focus on the following topics:

- The decision not to put the project out to an open tender
- Adaptations during construction of the tunnels
- Combining the two transport systems

Tender

RandstadRail was developed during a period of neo-liberal reform in which market mechanisms had to be introduced in the public transport sector. Policymakers often referred to European legislation, claiming that privatization was unavoidable. At the end of the 1990s, it was thus seen as a logical step to put the project out to public tender. However, both regions were hesitant to do so as one transport organization had just recently been privatised (Rotterdam) and the other was still a municipal department (The Hague). They thus opposed a radical change. In the end, the governments gave both companies the first right of tender. An alderman from The Hague recalls: "We would not put the whole of RandstadRail to the market, but we would give the current providers an important stake in order to cooperate during the whole start-up of this project." While they did thus yield to pressures for privatization, the regions successfully mitigated the impact by obtaining the first right of tender for their transport providers. The change towards public tender was a radical change; however, the adaptation was only incremental, as this effectively neutralized the effect of an imposed change of the legal environment and of the practice of public transport provision.

Adaptations during construction of the tunnels

Respondents saw the construction of the tunnels as a sequence of incremental adaptations. These adaptations were mainly of a technical, problem-solving nature. For instance, the foundations of a certain building obstructed the drilling path. This was solved by removing some elements and caused only a minor delay. Such technical adaptations to the construction process are incremental adaptations because they do not change the nature or route of the project, but they are nevertheless essential. Respondents feel that these types of problems always occur when you are digging in the ground. It is therefore crucial

that there is sufficient knowledge and expertise in the project organization to deal with these emergent problems. The general project manager states: "Generally a project organization is always finishing a project with blinkers on. A good project manager tries to look to the future to prevent and to make sure that when he sees risk [it is possible] to manage it. And that he solves the problem." Not being able to deal with these demands can lead to severe cost and time overruns. For instance, the tram tunnel in The Hague (a related but separate project) required many of these incremental adaptations, but they were not always carried out adequately or promptly enough. It took several years to seal the tunnel's walls in order to prevent moisture from leaking through them because of the lack of technical know-how or an inability to make a more radical adaptation to the design. Generally it seems that mega projects have many unforeseen, emergent problems of a technical nature. To be solved they require incremental adaptations, and thus the presence of technical adaptive capacity in the project organization.

Combining the two transport systems

The decision to combine the two transport systems (metro in Rotterdam and tram in The Hague) followed a long period of deadlock. The functional specifications remained unspecified for a long time because both regions wanted to use the existing light rail systems in their respective regions. "It was clear for The Hague: 'we are not going to pull in the Rotterdam metro into The Hague' And for us [the Rotterdam Municipality] it was unacceptable that we would build a tram on ground level when we have a metro tunnel it can go into, especially when looking towards the future." Incremental adaptations were made in order to deal with this situation. The regions came to the compromise of using two systems: the tram and the metro. In a certain section they make use of the same track to make it possible to change from one to another using a passenger platform with two different heights. Although proponents of a single type of transport system generally see it as a sub-optimal solution, it showed also an incremental adaptation of great strategic value. Not making the link might have led to a non-decision, or to a more expensive single mode solution that would have added another type of transport to the regional systems. The project in this form effectively integrates two different urban transport networks at a fundamental level because it enables the regional traveller to travel directly into the urban area without transferring. The Rotterdam metro runs from The Hague Central Station to Rotterdam Central Station and then continues on the existing metro network to the southern part of Rotterdam. The tram section goes from Zoetermeer towards The Hague Central Station and then continues further towards the western part of The Hague. A new system, for instance light rail, would most likely have gone from Rotterdam Central to The Hague Central Station after which one would have to change to either the metro or the

tram. It would link systems but not integrate them. Thus, the project can be seen as an incremental change because it did not impact the way both transport companies implemented their transportation strategies and shows, once again, that incremental changes can also have a great impact and value.

Incremental Adaptation Mechanisms

First, basic incremental adaptations, especially during construction, are the changes that have to be made when faced with emerging technical issues. They might seem like easy adaptations, but failure to adapt adequately can have great consequences that can seriously compromise a project. There has to be enough technical expertise in the project group to cope with adversities as they appear, such as leaks in the sheet piling or unexpected objects in the ground. There are many of these challenges that can have disastrous effects if the right measures are not taken promptly. Think of the delays caused by not being able to repair leaking walls.

Second, in the case of RandstadRail, there were many incremental adaptations that had to be made to fit the project in the physical landscape. Aqueducts, viaducts, small tunnels, and sound screens are all examples of these types of incremental changes. Having too many of these mitigation strategies is seen by some respondents as the main reason why mega projects come with an increasingly expensive price tag. They are supported in this view by academic literature (e.g. Shane et al., 2009). In line with the idea that mega project building has entered the 'do no harm' era (Altshuler & Luberoff, 2003), mitigation of effects has become key to the public acceptance of mega projects, but also leads to strong cost increases. Sometimes a more radical adaptation could be cheaper when taking the mitigation cost into consideration as well.

Third, an overarching mechanism that leads to many incremental adaptations, which have small as well as large impacts, seems to be that of accommodating what can be called 'protectionist' stakeholders. These are stakeholders with a vested interest that they want to maintain; they are not willing to look for alternatives (Forester, 2006; Healey, 1999; Innes & Booher, 2010). In particular, RandstadRail's decision not to put the project out to an open tender can be interpreted in this sense. The outcome of the decision-making phase of RandstadRail, resulting in a metro and a tram system that are connected mid-way, is also a clear case of incremental adaptation because of the accommodation of protectionist stakeholders. Sometimes an incremental adaptation that answers to most demands, might be better than sticking to the original plan (inertia), or to a more radical new plan.

Radical adaptations

The quotations that are coded as radical adaptations, dealt with the following issues:

- Lump-sum financing agreement
- Financing from under-exhaustion
- Tunnel in Rotterdam

Lump-sum financing agreement

RandstadRail was developed in a period immediately after which several large national, regional and local projects had had large cost and time overruns. The Ministry of Transport, who finances practically all infrastructure projects, was especially frustrated by the overruns at the local and regional level. It had to finance the extra cost but had very little influence over how the project was managed. In addition, local governments had very few incentives to control cost because it was not their money. The Ministry was thus hesitant to finance regional and local projects without having a system in place to enforce control over the cost.

After protracted discussions and deadlock, and the appointment of a new minister, the regions and the Ministry decided to finance the project through a lump sum agreement. This meant that the regions were given a certain amount of money (about half a billion euro each), but that they had to pay their cost overruns (or keep money they did not spend). It proved an effective way of placing the financial risks at the same governmental level as the operational risks, and thus make both more manageable. A regional government official summarizes the positive result that followed: "This method worked well for the national state, because they would not spend more than planned beforehand. And it stimulated our organizations to ensure we operated within the budget." This crucial decision to transfer financial and operational risk to the municipalities of Rotterdam and The Hague resulted in a successful outcome in this case. These municipalities were experienced in doing these types of projects and were also better staffed than the regions. Thus the project was adapted by moving the financial and technical risks towards more capable governmental levels with strong project-management capacity. This was a radical – and in this case successful – change to the previous approach to the financing of these types of projects, and as the respondent above remarks elsewhere in his interview: it is unlikely RandstadRail would have been financed without this type of financing construction.

Financing from under-exhaustion

An important additional factor contributing to effective financing of the project is an agreement made with the Ministry of Transport to use the under-exhaustion of the budget. For years, the project budget of the Ministry was not fully used. The agreement was to use these 'leftovers' for the project RandstadRail. An alderman states the benefit of this approach: "The fact that money would become available every time was very nice, not least because we did not have to borrow money. Thus this saves a large amount of money in interest." In combination with the lump sum agreement, this radical adjustment to the financing of these types of projects proved to be very effective in minimizing the cost overruns.

Rotterdam Tunnel

The tunnel in the Rotterdam section has already been mentioned above. The original plans envisaged RandstadRail running as an above-ground route through a historical part of the city towards Rotterdam Central Station. Inevitably, it caused strong opposition from inhabitants of that area. For a while there was a deadlock in the process as it became clear that the opposition would be too strong to ignore. In an effort to overcome the opposition, the engineers of the municipality developed an alternative route using a drilled tunnel. Going underground is a straightforward, but expensive, way of neutralizing local opposition to an infrastructure project. An official from the municipality recalls: "It was a kind of escape, it was like puncturing a malignant boil [on one's skin]; the pressure was just released." If the modification would have only involved placing the above-ground sections in a tunnel, the change could be considered incremental, as others mentioned in the previous section. However, a further step was taken to consider new route opportunities that became possible by the inclusion of the tunnel in the project. The project team designed a new route that included a previously-unplanned stop in an area that had no metro connection, thus opening up new development possibilities there. The route was also realigned in order to drill the tunnel under infrastructure instead of under houses, thus further reducing risks and opposition.

Radical Adaptation Mechanisms

The most typical triggering factor for radical adaptations is a strong opposing force or forces. When there is resistance and strong objections to ideas, it becomes necessary to find creative solutions that go beyond small incremental changes. However, strong opposition can also create a stalemate situation that can extend over a long time. What is different with inertia (see below), but also with incremental adaptations (as discussed

above), is that eventually there is also a willingness to find a win/win situation and an ability to let go of predetermined preferences. There has to be an interest of stakeholders in finding new options that do not just resolve the stalemate, but also add value to the project. The tunnel in Rotterdam is a good example. There was strong opposition to the route. In order to overcome the opposition a drilled tunnel was presented as a solution. However, in this case the tunnel was also used to rethink the potential routes and it led to a different route with a new station. Thus, the tunnel was not only used to overcome opposition, but also to add value to the project. This seems not so much due to a particular institutional setting – which was, of course, the same as in other moments of the decision-making process - but rather to a mentality that has to be present in the stakeholders. It requires a state of mind that is more aimed towards creative solutions than the protection of vested interests. Even though we do not have enough evidence to generalize this observation to all mega projects, we can remark that similar conclusions are reached in the literature on joint fact finding processes (De Bruijn & Leijten, 2007; De Vries, 2008; Karl et al., 2007; Susskind et al., 1999: 331) and collaborative planning (Innes and Booher, 2010).

Related to the factor of strong opposition, but somewhat different, is that there should be a willingness to accept one's inadequacies and place responsibilities with the organization that is best placed to carry out the project. Deferring the financing to the regions was one example. Another one was the regions accepting that their central municipalities (Rotterdam and The Hague) were better able to manage this type of mega project. For an organization it is a radical step to hand over the keys of its multi-million euro project.

Finally, and especially when there is a stalemate situation, a change within the institutional setting can create opportunities for more radical adaptations. In RandstadRail, the introduction of new ministers prompted the reconsideration of project financing arrangements and eventually opened up the process to lump sum financing.

Socio-historical adaptations

The respondents discussed one socio-historical adaptation:

- The city regions

The city regions

Respondents refer to the creation of the city regions as a crucial institutional adaptation that greatly impacted the project: "The fact that the responsibility for public transport

went to the region was crucial. Before the change, everyone had their own agendas and every party was drawing little rail lines wherever they wanted." Before the change in governmental structure, all the affected municipalities had to be involved in most of the meetings. The Province of Zuid-Holland was expected to coordinate, but was powerless to push for definite solutions. Afterwards, the responsibility moved to organizations whose prime business was stimulating regional connectivity and that had a mandate from the involved municipalities. Thus, they were better equipped to negotiate and make decisions, especially because the aldermen of Rotterdam and The Hague were also the aldermen of their respective regions. The actors involved in RandstadRail responded keenly to this institutional change and used it to set the project in motion. Now that the project has been delivered, the regions have claimed their place within the governmental structure on the grounds of this success. This is an adaptation that is a fundamental break with the past and is not likely to be undone in the near future. Therefore the introduction of the city regions can be considered a socio-historical adaptation.

Socio-historical Adaptation Mechanisms

The introduction of the regions triggered an adaptation that changed the way transport in the regions and thus also the province was organized. It created new practices of organizing regional and interregional transport, decision-making and planning. Nevertheless, the relationship between RandstadRail and the introduction of the regions is complex. On the one hand the introduction of the regions gave a crucial boost to RandstadRail. On the other hand, however, one of the very reasons for instituting the regions was the need to cope with complex transport projects like RandstadRail, and later, delivery of RandstadRail provided some much-needed legitimacy to the young institution. The mega project seems thus to have been simultaneously the recipient as well as the driver of this socio-historical adaptation.

Inertia

The quotations that were coded as inertia discussed the following topics:

- Functional specification
- Time schedules

Functional specifications

The functional specification of the project remained a taboo for a large part of the decision-making process. It is the primary reason for the long period it took to decide on

the mode of transport. The Rotterdam Region preferred a metro whilst The Hague Region preferred the tram (Rotterdam uses the metro as the backbone of its public transport system; The Hague has no metro system in place and has the tram as its primary transit network.). An official from the municipality recaps the situation: "And as long as we talked about light-rail, which is an umbrella concept, we completely agreed with each other. But at that moment, nobody dared to relate this to the functional specifications." However, the two parties clearly opposed each other and neither wanted a system that was different from their own. That kept them in a deadlock for a long time, until it was clear that a decision had to be made or the opportunity for funding might have been lost. Eventually, the actors were able to unlock this stalemate through the incremental adaptation discussed in section 4.1.

Time Schedules

Related to the inertia above, the tram accidents plaguing the first months of operation were also attributed by the respondents to the fact that the functional specifications were decided upon very late. This meant that there was little time to develop, build, and test the new systems and to decide on how to integrate them. For instance, the metro has an automated blocking/breaking safety system while the tram does not have any automatic safety system but is driven manually. In addition to the late decision on the specifications there was also a strong political pressure in The Hague to finish the project on time. This resulted in a very short period to build the system and only six weeks were planned to test it. As a project manager remembers: "A date was chosen in a very early phase upon which RandstadRail had to be taken into service. Decided politically, ambitious of course, but that is what the politicians wanted. And that date was not abandoned." The respondents see the inertia of the political system to not change the construction and testing period, as the main reason for these accidents.

Inertia Mechanisms

As earlier discussed in the paragraph about incremental adaptations, 'protectionist' forces are an important mechanism to create an inertia situation. It is the strong protection of vested interests without the willingness to search for a solution that adds most value to the whole. It can be a rewarding strategy for these types of actors to block the planning process until their interests or demands are incorporated in the project. As already mentioned in the paragraph on radical adaptation mechanisms, unless an open mindset can be created, the planning process will be fraught with long periods of inertia. RandstadRail was in such a state for a long time. It was taboo to speak about the technical specifications of the project. It was clear that one party wanted a metro and the other

wanted a tram, but unity had to be maintained for the negotiations with the Ministry of Transport. Thus, for a long time the functional specifications of the project were left out of the project discussions. Later, the inflexibility of the time schedule forced a hasted opening of the system resulting in several accidents.

Identifying Adaptation Mechanisms

In the previous sections we identified different mechanisms behind the adaptations made in RandstadRail. Incremental adaptations seem primarily a response to emergent technical adversities, the need for impact mitigation strategies, and, more in general, accommodation of 'protectionist' forces. Solving technical issues and developing mitigation strategies are very common in the planning of mega projects. And perhaps because of their omnipresence, their potential disastrous effects are easily neglected. Without adequate technical and operational knowledge at the disposal of those who make decisions, during the construction of a tunnel small leakages might lead to flooding, houses might subside, or monuments might collapse. Similarly, too many mitigation strategies may easily be promised, but can have a catastrophic effect on the time and cost budgets of a project if they do not also add value to the project. Often, protectionist forces are a prime cause of these mitigation strategies, and often play also a role in emergent technical issues, limiting the possibilities to find new approaches and solutions. When no ways are found to accommodate these protectionist forces, they can keep the project in a stalemate. Alternatively, 'taboos' can be created: difficult issues are left out of discussions in order to make progress on other fields. In both cases, total or partial inertia is the result. This seems, however, to offer only a temporary solution: if not dealt with, unsolved issues will surface again later.

In an apparent paradox, radical adaptations generally also seem to require strong opposing forces. If there is no strong opposition, it can seem unnecessary to make a more radical change. The difference between the 'protectionist' forces mechanism and these 'oppositional' forces mechanism seems to be that oppositional forces are open-minded with respect to changes and have the desire to add value to the project. There is an ability to find a new collective frame of the situation (Rein & Schön, 1996). This process can be enhanced further when stakeholders are aware of their own weaknesses and are thus willing to delegate responsibility to others. The psychology of decision-making should thus not be underestimated. Furthermore, we can conclude from this case that changes within the institutional setting can aid this process by bringing a fresh wind to a deadlocked situation, and thus provide an opportunity for radical adaptation. Without the above two

factors, however, this does not seem to be a sufficient condition, at least in the case we have explored.

Finally, our case shows that mega projects can act as major socio-technical experiments that function as frontrunners for larger institutional changes and practices, or socio-historical adaptations. Mega projects are at the forefront of many developments and are potentially agents of change, especially concerning project management and appraisal methods. They are thus affected, but also influenced, by institutional changes. Table 3 provides an overview of the identified mechanisms per adaptation type.

Table 3: Identified adaptation mechanisms

Adaptation	Mechanism
Incremental	Solving technical issues
	Impact-mitigation strategies
	Accommodation of protectionist stakeholders
Radical	Strong oppositional forces (but open to change)
	Stakeholder acknowledgement of own weaknesses
	Changes within existing institutions
Socio-historical	Development of new institutions
Inertia	Inflexible protectionist stakeholders
	Taboos

Discussion and Conclusion

This article has attempted to make a contribution to the study of mega projects by developing and illustrating the concept of adaptive capacity of the project planning and decision-making process, and by grounding and articulating the concept in actual planning practice (thus complementing existing literature rather concerned with principles of adaptive planning). Using literature from organizational learning as inspiration, a typology was developed resulting in four different categories of adaptations: incremental, radical, socio-historical and inertia. Empirical data was gathered from an in-depth case study of RandstadRail and crucial moments of the planning and decision-making process were inductively identified and deductively placed into the typology. A further inductive analysis was done in order to discern the mechanisms behind these adaptations.

The key finding is that the planning and decision-making of mega projects requires adaptations to overcome deadlocks and bottlenecks in the process and unexpected changes in the context, and that these adaptations should be of a type (i.e. incremental, radical or socio-historical) that fits the type of deadlock. This goes against the dominant practices as identified in the case study. There appears to be a general ingrained idea among mega project proponents that the first solution developed is the best choice and that only technical fixes, mitigation strategies and compromises should be applied to get this solution through the planning and decision-making process (as in the 'do no harm' approach (Altshuler & Luberoff, 2003). This leads to a built-in preference for inertia or –at the most- incremental adaptations (mostly as a way of acknowledging or accommodating protectionist stakeholders), even where more radical or even socio-historical ones (as those triggered by oppositional forces) could lead to better projects. The case study shows that radical adaptation is in practice something that is primarily an ad-hoc response to strong oppositional forces, rather than something that is being proactively integrated in the planning and decision-making process. Current political strategies and rational planning models applied in government do not seem to be improving on this, as they rather aim to simplify the planning and decision-making process of mega projects by excluding oppositional forces, or by limiting the scope of their involvement (for instance only at the start of the process – as presently being proposed in the Netherlands, or only when the final decision has to be made – as has been traditionally the case in The Netherlands). The explorations of this article suggest instead that such simplification is not the best strategy to deal with mega project planning and decision-making, as it does not acknowledge the need to adapt the project in all phases of the planning and decision-making process, in order to unlock unexpected deadlocks and/or cope with emergent opportunities and threats determined by developments in the broader context. In particular, oppositional forces seem something that should be accepted and, if harnessed properly, something that could increase the creativity of solutions and even speed up the process. More in general, in order to keep a process responsive to future developments and deadlock, it is necessary to build in adaptive capacity in the process. It would be crucial to identify symptoms of particular deadlocks in order to know which mechanisms can be used to prevent them from slowing the project down or preventing alternatives from surfacing. This leads to a key question for further research: how to design a decision-making and planning process for mega projects that makes adaptation a strategic choice rather than an ad-hoc response?

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