Unconventional thinking;

a design strategy for transition in the Dutch construction sector

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De bouw agenda

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Colophon

Master thesis
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Unconventional thinking by Design, a strategy for transition in the Dutch construction sector.

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Executive Summary

The Bouwagenda is a collaboration between the Dutch government, the construction industry and knowledge institutes to tackle the challenges that currently face society. The most important challenge is the challenge of climate change and the transition of the construction sector to a circular system. This transition needs to happen in a revolutionary way. This thesis is aimed at proposing the first steps of a strategy on transitioning the construction sector by researching the significance and possibilities of a "different way of thinking" in the design of construction projects.

A transition is defined as a process of fundamental and irreversible change in a society's culture, (institutional) structures and practices. Two factors play an important role in transition: outside pressure and niche innovations. Outside pressure opens up the so called regime (how we do things) creating opportunities for niche innovations to develop and break with the conventions in the regime. Governing this process is considered a paradox since societal change is found too complex to handle in terms of straightforward management. Transition management therefore aims to develop governance systems to manage transition. A four step cycle stimulates the forming of coalitions and the execution of innovative experimental projects. These innovation experiments are an important driver for change but are alos differnt from conventional construction projects. An abduction 2 design approach to actually create innovative solutions in these experimental projects is found to be a promising strategy.

To be able to apply this transition management strategy to the Bouwagenda the current situation of the construction sector needs to be examined. Based on literature and case studies the most important barrier was found in the separation between client and contractor. Also the organisational structures of experienced clients and high risks that come with large construction projects were found to be barriers in applying a transition management design approach.

Inspiration for a strategy to overcome these barriers was found in competitive student innovation teams that create bottom up innovative solutions. National Bouwagenda Challenges are found to be the basis of a strategy for transition. The strategy consists of two parts, a management tool that can be used to assess the progress of the transition and make adjustments accordingly, and an innovation process for construction projects that take on the challenge. This process overcomes the barriers and is centred around early client and contractor collaboration in a design process and a designerly way of thinking.

Validation of this strategy showed promising results for implementing this strategy in the sector. The Bouwagenda is working on setting up challenges for the roadmap. Actual testing of the innovation process is needed to find if it actually results in an innovative project.

Transition towards a sustainable construction sector is depenend on clients willing to think unconventional and allow experimental construction projects to be build.

List of Definitions

Construction industry: the market of the construction sector

Construction sector: every organisation that is part of the Bouwagenda.

Broad prosperity: prosperity based on the monitor broad prosperity.

The Bouwagenda: The physical document and the group of people that work for the Bouwagenda.

Front end of construction project: The appraise and Select phase of a construction project.

Design: devising courses of action aimed at changing existing situations

The design: the result of the synthesis in a design process

The design process: reflection, analysis, synthesis and experience

Market: All Dutch companies involved in construction projects.

Government: The Dutch government

GNP: Gross National Product, this is the total value of the produced goods and services, minus the productions costs.

Knowledge Institutes: schools, university's and private knowledge institutes like for example TNO.

Multidisiplinary Team: a team consisting out of multaple disiplines. In a construction project this means that the client and constractor both take part in the team.

Product: This can be anything that is designed. A building is also refferd to as a product.

Prosperity: prosperity based on GNP

Revolution: a man made transition

Transition: fundamental change in society

Taskforce Bouwagenda: The members of the Taskforce Bouwagenda

Value: To think something is important to you; the importance of usefulness of something.

Acknowledgements

To all the people that helped me throughout my graduation.

Graduation is a special project. It's the project marks the border between education and professional life. Therefore I could only realise it with the help of many persons and I am much obliged to them.So I would like to thank all the people that helped me with this project.

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To all the people from the Bouwagenda, Richard Mulder, Joris van den Heuvel and Lotte van der Vleuten, thank you for being so open and making the time to discuss my findings. I hope that this thesis will help in succeeding your goals. I would also like to thank Cees Buijs for sharing years of experience and knowledge about the sector and the bouwagenda.

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A special thanks to Margaret for helping me during the end of my graduation to actually get my insights on paper. As many know, report writing is not one of my qualities, but you took the time to help me with structure and grammar. I could not have done it without you! Also Aart and Esmée thank you for all your support

I would also like to thank Madelief for supporting me and allowing me the space to work on my graduation. Graduation sometimes takes up your whole life and you understood that and supported me when I was struggling.

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Graduation was a lot of fun and helped me understand a lot more about design and the world than was intended.

With Gratitude,

Tomas

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The structure in this report is based on the design cycle. In chapter 1 the context is explained, who are involved and what is the problematic situation. Chapter 2 aims to find the desired situation for the Bouwagenda, what is needed to solve the problematic situation. In chapter 3 the barriers to reaching the desired situation are indicated. The combination of the desired situation and the barriers form the design challenge formulated in chapter 4.

Chapter 5 describes the process to finding a solution to overcome the barriers. Chapter 6 describes the solutions and Chapter 7 gives an example of how the solutions can be used. Chapter 8 validates the solution by testing the solution with multiple stakeholders. Chapter 9 reflects on the process and a conclusion is made..

Introduction

"Finding the solution to a problem is absurd, Either you know what you are looking for so there is no problem or you don't know and you cannot expect to find anything" Meno Paradox

The construction sector is not necessarily the sector that a product designer is interested in when finding a topic on his graduation thesis. After being introduced to the sector by Jonge Geesten, an organisation that tries to let different generations work together to find new values [Rooijen (2009.)], a curiosity for innovations in this sector was found. As part of the jury for the innovation price of InfraTech2017, one of the biggest infrastructure fairs in the Netherlands [InfraTech (2017)], I got in touch with all the innovations that the sector had to offer. A lot of different innovations were presented, but I also heard a lot of doubts about how the sector should innovate. As a strategic designer I learned about product innovation in the consumer sector but the construction sector seemed a bit different.

When the Bouwagenda was presented a revolution to a sustainable sector was promulgated. Innovative solutions and a build environment centred around the user were needed. All the important decision makers had gathered and a plan was presented to transition the construction sector to a circular sector. Upon reading the plan the ambitions were clear. Things needed to change, but the actual process of creating an innovative solution was not described. At the time I was not able to properly describe what process was needed to create innovative solution in the construction sector. Was it different then the process for innovation in the consumer sector or was the construction sector actually different?

In order to find out what was needed for the sector to transition towards a sustainable future, I dedicated my graduation thesis to this subject.

Picture 1: *Innovation price InfraTech2017 [InfraTech (2017)]*

1. The Context, the Bouwagenda

1.1 Introduction

"A revolution in the construction industry is needed" Bernard Wientjes april 2017 chairman of the Bouwagenda.

The Bouwagenda is a collaboration between the Dutch government, the construction industry and knowledge institutes to tackle the challenges that currently face society. The most important ones are that of climate change and the use of our resources. Besides this challenge there are also challenges with respect to the growing and changing population and the large scale replacement of infrastructure to keep the Netherlands safe and accessible. The construction sector shall have to participate actively in developing solutions to these problems. The Bouwagenda is developed to structure the challenges and stimulate the sector to face them in order to reach the goals set for 2050. This task, however won't be easy and the Bouwagenda argues that we need to think in a totally different way and we need a revolution to get there [Taskforce Bouwagenda (2017)].
In this chapter the Bouwagenda is closely examined. What is the origin of the Bouwagenda, who are involved and what are exactly the challenges that it wants to overcome?

1.2 Origin of the Bouwagenda

The Bouwagenda was initiated at the 29th of November 2016 by the ministers of Economic Affairs & Housing & Infrastructure and Environment together with the construction industry. Upon the question why the Bouwagenda is initiated minister H.G.J. Kamp of Economic Affairs answered:

"The current government considers the construction industry of large economic importance for the Netherlands. After years of crisis the sector's production and revenues are recovering. Now it's important to make sure that the construction industry is successful and sustainable in the future. We want to work together for the things that are important for all citizens of the Netherlands. Future proof infrastructure, renovate and sustainable housing and workspaces, and integrating ICT and future technologies" Minister Kamp of Economic Affairs. [Ministerie van Economische Zaken en Klimaat. (2017)]

To maintain prosperity in the Netherlands, account must be taken of both economic and sustainability drivers. Together with a willingness from the sector these are the reasons for the government to start de Bouwagenda. Economic values change because of a changing and aging population in the Netherlands. This has an effect on the build environment because the construction sector should take these new values into account. With a current yearly production of 60 billion Euro the construction sector is one of the biggest sectors of the Dutch economy,[Ministerie van Economische Zaken en Klimaat. (2017, May 02)] and therefore impact will be considarable.

Increased global awareness for climate change changed the thinking about sustainability by governments. An important milestone was the Paris Agreement. "*The Paris Agreement builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort. [United Nations Framework Convention on Climate Change". United Nations (2017)]*

By signing this agreement, the Netherlands agreed to participate in tackling climate change. One of the ambitions that derived from this agreement is that the Netherlands will be a circular system by 2050. "The Netherlands circular by 2050" is a nation-wide programme that combines 325 parties in five transition agenda's. One of these transition agenda's is the Bouwagenda that is specified for the construction industry. [Nederland Circulair 2050 (2018)]

Besides these external pressures there are also internal pressures with regards to the prosperity in the Netherlands to take sustainability into account. To better understand what prosperity means for the Dutch state we first have to focus on how prosperity is measured. In general the prosperity of a state is measured by the Gross National Product (GNP). This figure indicates the economic growth of a country which is seen as the most important indicator of prosperity. But as Robert F. Kennedy once wrote in one of his speeches: *"Yet the gross national product does not allow for the health of our children, the quality of their education or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials". [Kennedy (1968)]* And even though this speech was written in 1968 it has still significance, especially when it comes to measuring the health of the world that we live in. The Central Bureau of Statistics (CBS) therefore developed a new indicator for the prosperity of a country: "the monitor broad prosperity". This monitor takes into account factors like pollution, biodiversity, the quality of social systems, etc. [CBS (2018)]. By plotting the broad prosperity in comparison to the GNP over the past 150 years (see figure 1) we see an increasing GNP but a stagnating broad prosperity since the 70's. This is mainly due to environmental factors, increasing income inequality, and the departing of social relationships. The new monitor broad prosperity also makes an estimation of the broad prosperity "in the future" as they call it. This estimation is based on four so called "capitals" that we have built our society on (see figure 2), social capital (our social systems), economic capital (how much money we have and machinery), human capital (health expectancy, education, etc.) and natural capital (biodiversity and use of resources) [Lintsen et. al., (2018)]. Especially with respect to the natural capital a decrease of the broad prosperity is predicted, having an effect on the ecological well-being. Besides outside pressure, there is also internal pressure for the government to keep the Netherlands a prosperous.

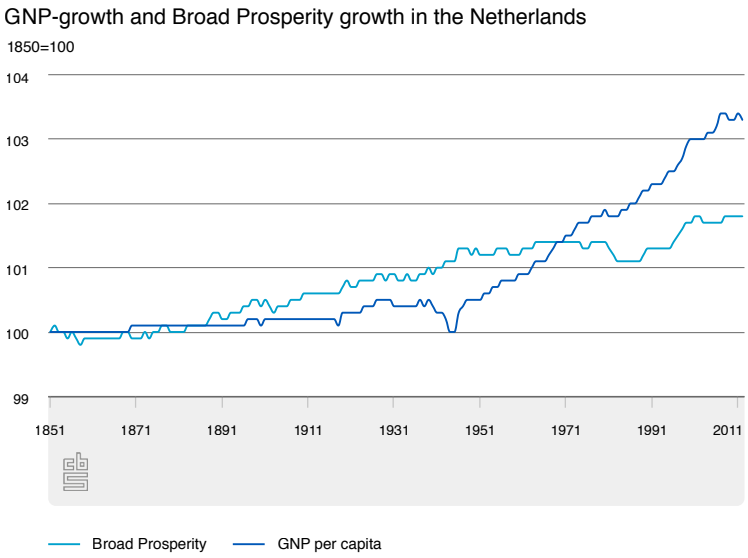

Figure 1: *GNP-Growth and the broad prosperity growth [CBS (2018)]*

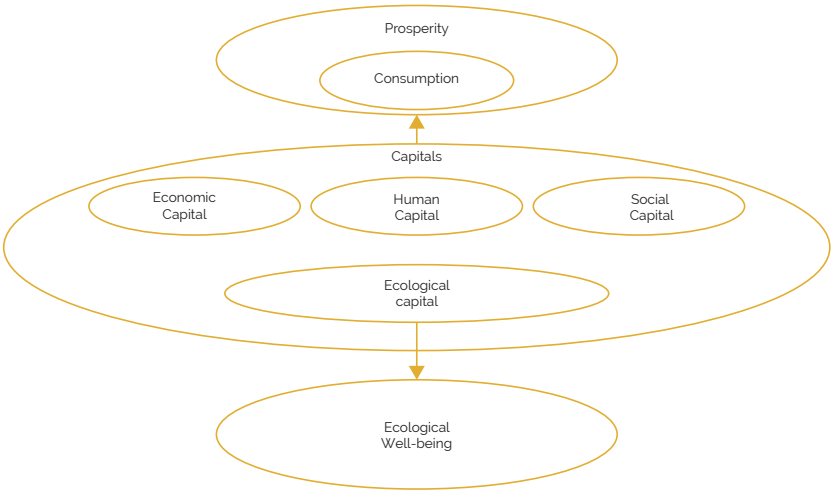

Figure 2: *Visual representation of capitals that make up our prosperity [Lintsen et. al. (2018)]*

1. The Context, the Bouwagenda

1.3 Stakeholders

In figure 3 a scheme of the organisation of the Bouwagenda is presented. This scheme is derived from a scheme of the stakeholders within the Bouwagenda document [Taskforce Bouwagenda (2017)]. Within the Bouwagenda a Taskforce was formed with key figures from the so-called "golden triangle" (the government, the market and knowledge institutions) to draw up a plan how to change the sector. This Taskforce is described as "the parliament" of the construction sector with Bernard Wientjes, as chairman. Bernard Wientjes is currently chair of the supervisory board of KPMG and professor at the University of Utrecht [KPMG (2018)]. Also a coalition was formed with over 50 partners of the Bouwagenda. These partners are organisations that represent the Dutch construction sector.

In order to support the Taskforce in their daily operations a programme bureau was initiated. This bureau manages the execution of the Bouwagenda and is directed by the taskforce members.

The Bouwcampus in Delft is the physical place where the programme committee of the Bouwagenda holds office. The Bouwcampus was initiated to "accelerate innovation in the construction sector and to stimulate other ways of working together" by the investment and innovation agenda for housing and utility construction [Oosten et. al. (2012)]. The Bouwcampus brings together parties in a pre-commercial phase to create new ideas in co-creation sessions.

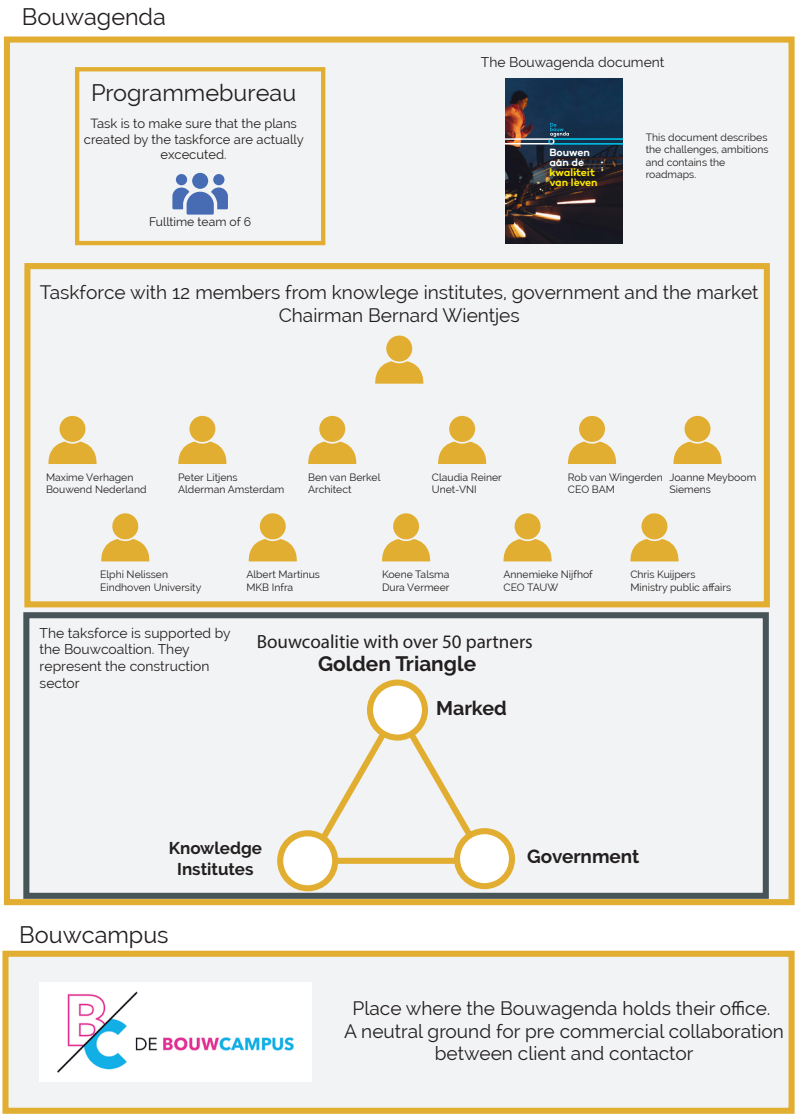

Figure 3: *The stakeholders of the Bouwagenda*

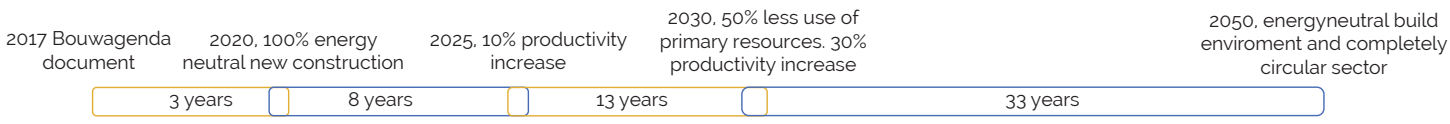

Figure 4: *Time-line of the Bouwagenda [Taskforce Bouwagenda (2017)]*

1.4 The challenges and ambitions of the Bouwagenda

The following challenges and ambitions are taken from the Bouwagenda document [Taskforce Bouwagenda (2017)]. The origin of the Bouwagenda is known to have economic and sustainability drivers. These drivers are formalised into three important challenges in the Bouwagenda document :

- A 100% energy neutral build environment by 2050
- A 100% circular sector by 2050
- 10% productivity increase by 2025

Figure 4 shows a time-line taken from the Bouwagenda showing their most important milestones

In an effort to describe the main challenges in more detail the following more specific challenges are described. They give a broader overview of the challenges that the construction sector is facing on a daily basis.
These are:

1. Energy transition: alternative energy solutions are needed to not be dependent on natural resources.
2. The use of resources: the sector needs to re-use build materials.
3. Changing climate: this means that investments in drainage and sewerage need to be made.
4. Becoming sustainable is not always cheap: solutions regarding financing of sustainability projects need to be enabled.
5. Urbanisation: a lot of people move to the cities and housing is scares.
6. Mobility: is changing and mobility is of vital importance of the earning capacity of the Netherlands.
7. Living with water: rising sea level and increasing rainfall ask for new initiatives.
8. Digitizing: the construction industry is falling behind when it comes to digitization.
9. Replacement of infrastructure: a lot of the infrastructure from just after the second world war needs replacement
10. Earthquake proof construction: for the people living in Groningen earthquake proof construction is important.

To structure the challenges, road-maps and overarching themes are presented with where a distinction as been made into the infrastructure, housing and utility sector. These three sectors, Infrastructure (24% of production), Utility (33% of production) and Housing (43% of production) together make up the construction sector. [Bouwend Nederland (2017)]
The road-maps are subdivided in the sectors' final products (see figure 5). For example, bridges, schools, healthcare buildings etc. The roadmap per product consists of a description of the urgency of the problem, the challenge, perspectives on the challenge, conditions, goals for 2021 and relevant initiatives for inspiration.

The overarching themes should be integrated in all the road-maps. The themes are divided in:

- Circular construction
- Design from an integral vision
- Digitizing and in computerization
- Human Capital
- Rules and measures that support change
- Working together based on trust

According to the document, integrating the overarching theme's into the road-maps "a totally different way of thinking" is needed. These changes in the road-maps should not be conventional evolutionary way but revolutionary. This should lead to realise the ambitions mentioned in the Bouwagenda document.

1. "A quality and scalability increase", meaning that a higher social return on investment is realised for sustainability, circular, future proof, high customer values. New solutions should be rapidly implemented in the sector.
2. "The construction industry as a circular system by 2050", all changes in the construction industry should be part of a circular system.
3. "Productivity increase", productivity as related to the GNP needs to increase. The Bouwagenda proposes a development from construction sector 1.0 to 3.0. This means according to the Bouwagenda that parties in the value chain have to work together in a network, instead of in a singular client contractor relationship.

These formulated ambitions look very similar to the formulated challenges with the exception that now the costumer values are also included as an important driver for reaching the goals of economic growth and sustainability.

1. The Context, the Bouwagenda

It turned out to be difficult to formulate a clear perspective on exactly what the Bouwagenda was going to do. A structure of road-maps was clear but on how one could actually participate and start working towards the goal of creating a sustainable sector was not mentioned clearly in the document. This could lead to different interpretations of the document so for this thesis the following perspective will be used.

The most important challenge that lies at the basis of the Bouwagenda is that of keeping our world sustainable. Sustainability of the way we are living on this planet is becoming endangered especially with regards to the use of resources. The Paris Agreement is the first time political agendas are aligned to set goals. Therefore changes will also have to take place in the Dutch construction sector. But sustainability is much more than just our dependency on natural resources. In the Netherlands to be sustainable we need to have strong dikes, a good transportation infrastructure etc etc. Sustainability means sustaining a certain amount of broad prosperity. The challenge is to transition this sector in one that is sustainable for the future with an emphasis on environmental sustainability. This means that fundamental change is needed in how the sector works. This needs to happen relatively quickly because 2050 is only about 30 years away and making for example all houses in the Netherlands environmentally sustainable means that if we start now we have to finish 1000 houses a day [Koenen (2018)] Therefore, a "revolution" is needed to transition the Dutch construction sector to a sustainable sector. In figure 6 in overview is given of the challenges and ambitions of the Bouwagenda in relation to the Paris Agreement and the circular 2050 programme. This will be the basis of this thesis and from here on referred to as the Bouwagenda Challenge Model.

1.5 Conclusion

The Bouwagenda is an attempt of the Dutch government to transition the construction sector to become a sustainable sector by 2050. They want to realize this in a revolutionary and not an evolutionary way, because of the urgency in making the transition towards a more sustainable future. The goals for this sustainable future are set, the stakeholders are organised in the form of the Bouwagenda but how this transition is actually going to happen is missing. What is needed to manage transition towards a sustainable future and how can we do this in a revolutionary way?

This thesis is aimed at proposing the first steps of a strategy on transitioning the construction sector by researching the significance and possibilities of a "different way of thinking" in the design of construction projects.

Approach

In order to make a strategy the following things are examined:

- What is transition and how does a transition work
- How can you manage a transition?
- What are currently the barriers to the proposed transition?

From here a design will be proposed for the first steps in a strategy to transition in the sector.

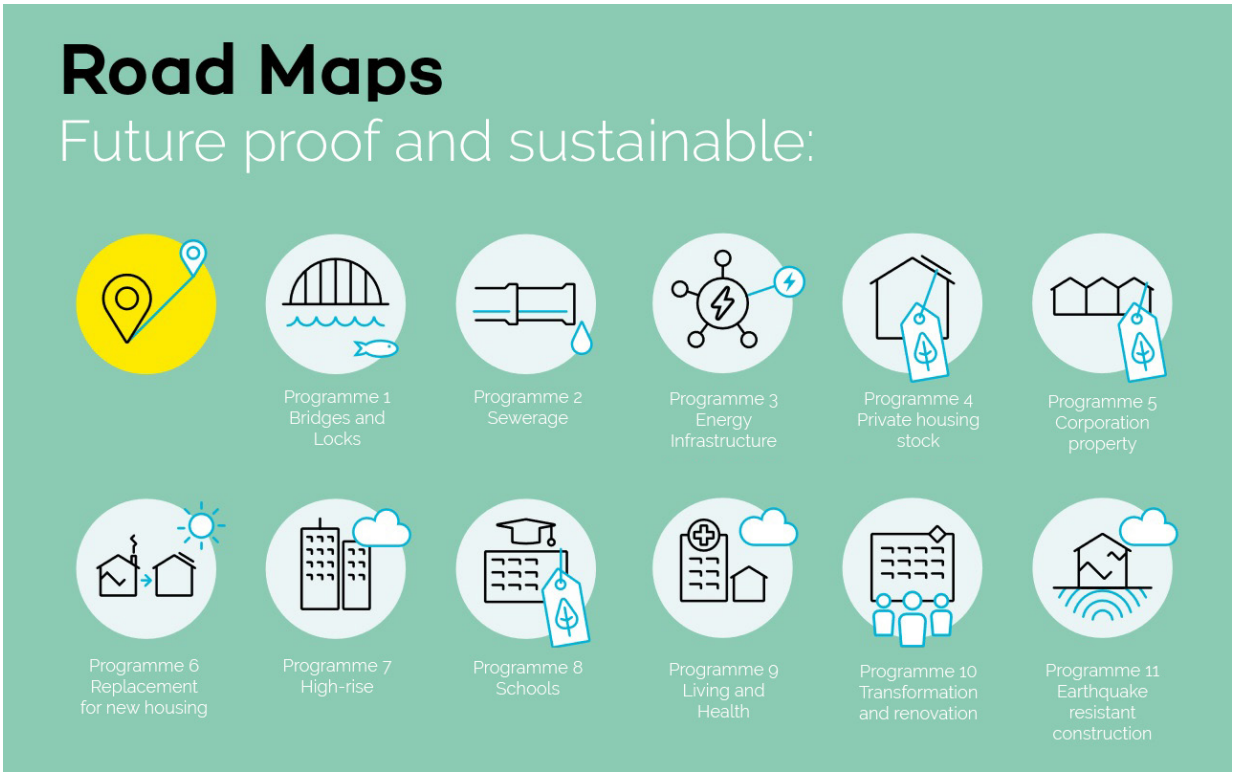

Figure 5: *Road-maps of the Bouwagenda [Taskforce Bouwagenda (2017)]*

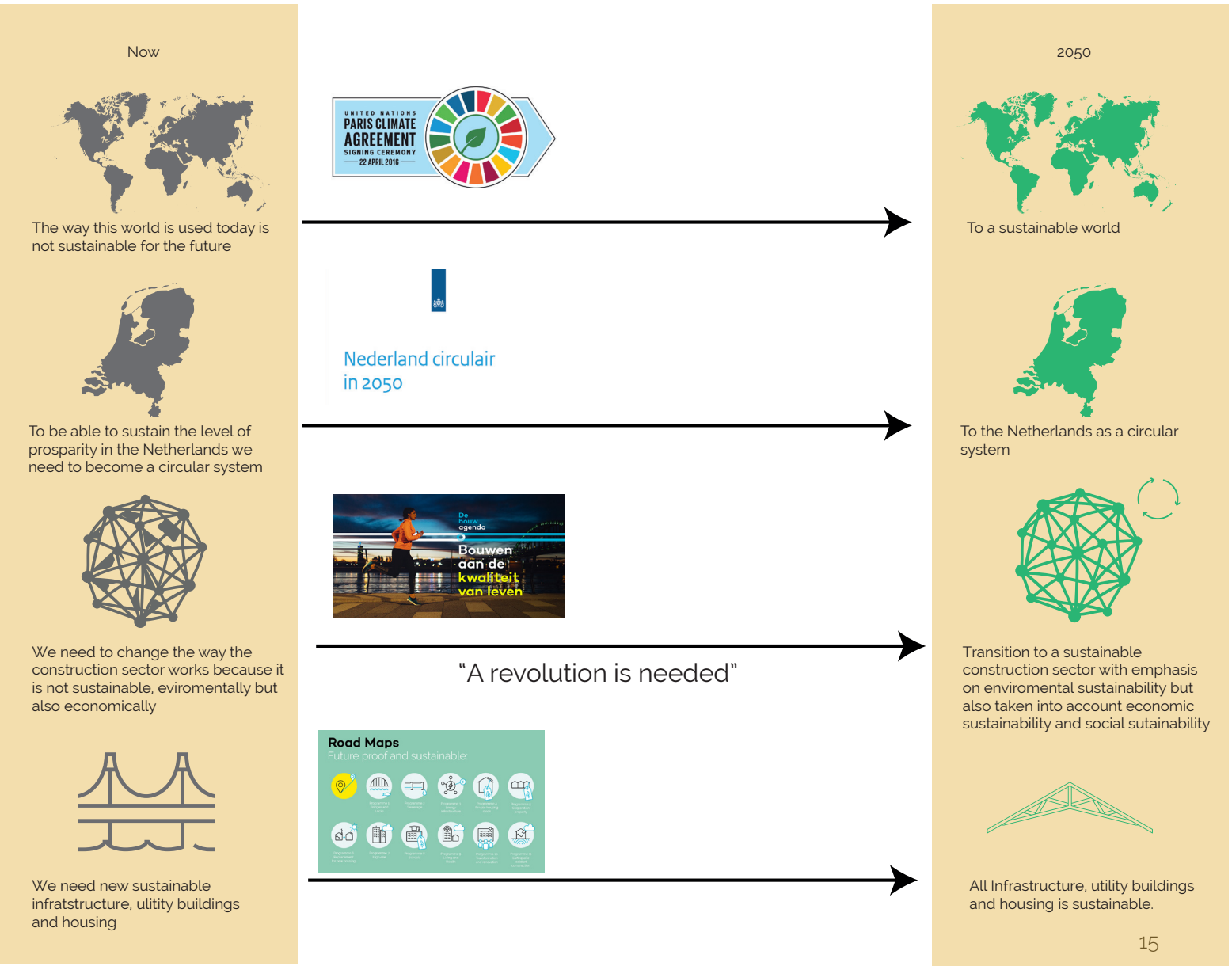

Figure 6: *Visual representation of the challenge of the Bouwagenda*


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2. Literature on change, the revolution in the sector

2. Literature on change: the revolution in the sector

2.1 Introduction

The Bouwagenda is about a transition towards a sustainable construction sector. To be able to understand this process more profoundly, relevant transition literature is examined in this chapter. The aim of this chapter is to find the theoretical basis for a strategy on transition.

2.2 Literature on transition

According to DRIFT, the Dutch Research Institute For Transitions a transition is defined as a process of fundamental and irreversible change in a society's culture, (institutional) structures and practices. [DRIFT. (2018.)]. To get a better understanding of the process of change the DRIFT research institute advised the application of the typology of socio-technical transition pathways model by Geels et. al. (2007). This model uses a sociological approach to explain changes in a society especially in relation to technology.

The following explanation is a simplified explanation based on the paper of [Geels et. al. (2007)].

1.The current situation in the socio-technical regime. The socio-technical regime is described as: shared cognitive routines in an engineering community and explained patterned development along technological trajectories that are influenced by scientists, policy makers, users and special interest groups. In other words, it describes what the conventions are on how we do the things we do. In the case of the Bouwagenda this is described as "the sector that needs to be changed", because how we do things isn't sustainable for the future. The output of the system in other words needs to be changed.

2.The future situation. This is the situations after the transition into new socio-technical regime. The regime has changed and we do things different then we used to do. The ambition of the Bouwagenda is a sustainable construction sector.

Elements 1 and 2 describe the change that is known as a transition. Elements 3 and 4 explain what influences this change of regime.

3. Socio technical Landscape, forms an exogenous environment beyond the direct influence of niche and regime actors (macro-economics, deep cultural patterns, macro-political developments). The socio-technical landscape can be described as the biotope created by humans. It can be described as the pressure on the regime to do things differently. An example for the Bouwagenda is the Paris Agreement, but also the fact people buy more solar panels or and the pressure of new environmental regulations on the regime.

4. Niche innovation, forms the micro-level where radical novelties emerge. These novelties are initially unstable socio-technical configurations with low performance. In other words, these are innovations deviate from the shared cognitive routines. Their "performance" is low because they cannot find connection with the regime. These niche innovations can be seen as puzzle pieces that can be used to build a new way of working.

What happens in a transition is visualised in figure 7. The numbers in the figure correspond with the numbers mentioned earlier in this chapter. A transition is the moving from one regime to a new regime. This starts with the socio-technical landscape pressuring the regime. The conventions of the regime do not meet the requirements set by the socio-technical landscape and a need for change develops. This pressure creates so called windows of opportunity for niche innovations to be used and developed further. If these innovations increase in "internal momentum" by increase in their performance they may change the conventions in the regime. The niche innovations can be the puzzle piece that can rebuild the regime into a new regime that has a preferred output. This process can best be described by a historical back-story.

"Understanding transition"

"The following story is inspired by Geels (2005) that describes the dynamics of transitions in socio-technical pathway from horse-drawn carriages to automobiles.

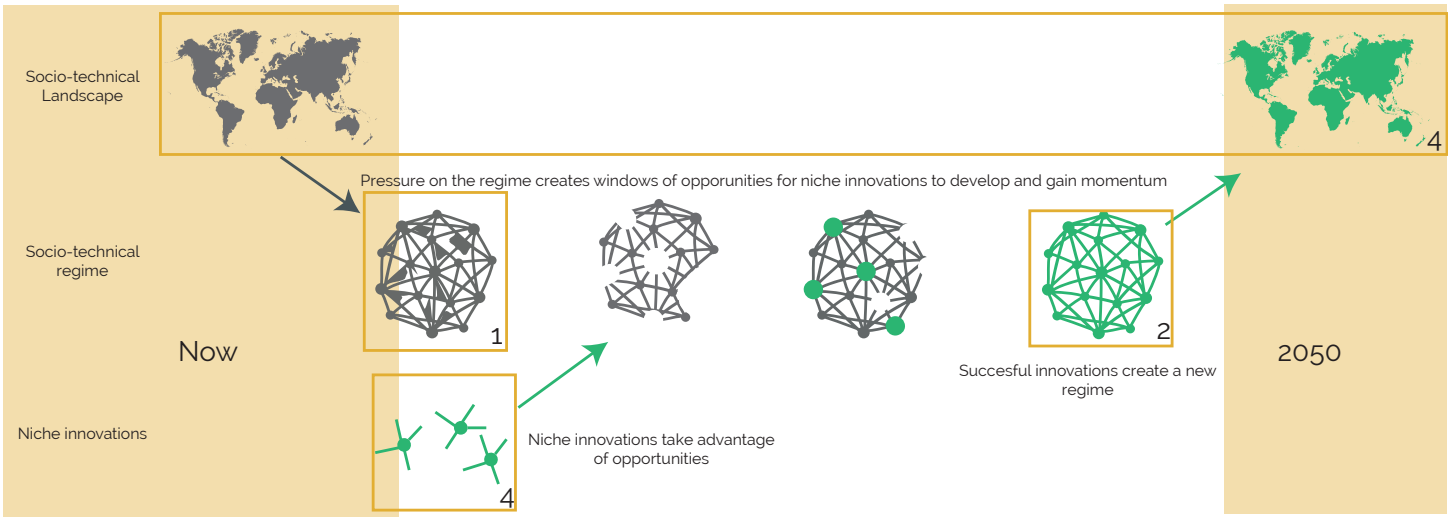

Figure 7: *Simplified model of Multi-level perspective on transitions* Geels,et. al. (2007).

Transitions are not new. A well-known example is the change from horses and carriages to cars. In the beginning of the 19th century cities became larger due to the industrial revolution (socio-technical context putting pressure on cities, a form of socio-techincal regime). This meant in time that considerably more horses came to the cities (more pressure on regulatory regime). This lead to an enormous increase in manure in the streets and the accompanying smell and spread of diseases (more pressure on the regime). There was a need for a substitute for the horses and carriages. This lead to the development of the automobile, the horseless carriages. The first automobiles were carriages with steam engines that proved to be impractical and expensive. Later on automobiles with patrol engines were developed, and even electric engines were tried. Eventually acceleration of the automobile as a means of transportation came from Henry Ford who introduced the mass production of cars, making them affordable for everyone. From here on more car manufactures emerged and especially in the United States the whole American culture became centred around the automobile The car changed the way they build cities today and entire lifestyles emerged around the car. The pressure on the cities created the automobile that eventually changed the way cities are build. These changes are still happening, technology is changing the car industry, from self-driving cars to vehicle data streams and new applications like Uber. This will have some effect on cities, but what these affects will be is difficult to predict since the city is like a complex dynamic organism. [Bouton (2018)]

Conclusion

A transition is a fundamental change in society. These transitions are influenced by two things. Outside pressure from the socio-technical landscape and niche innovations that take advantage of opportunities that are created from this pressure breaking up the regime. In the case of the Bouwagenda the desired result is known. The challenge becomes: how to transition towards the desired outcome and what needs to be done. This is what is called transition management and will be the topic of the next paragraph in this chapter.

Design implications

The first steps in transitioning a sector are about creating pressure on the regime so windows of opportunity are able to arise. These windows provide opportunities for new innovations to grow and eventually become a dominant design. Figure 7 is implemented in the Bouwagenda challenge model in figure 9.

2. Literature on change: the revolution in the sector

2.3 Transition management

Knowing the dynamics of how changes in society may occur can provide insights in a strategy on how to manage transitions in order to come to a preferred outcome. In the case of the Bouwagenda, creating a sustainable construction sector.

The concept of a transition is based on a co-evolutionary approach in which periods of slow change are punctuated by periods of radical change. [Rotmans et. al. (2001)]. This theory is based on the notion that the world is always in motion, but that there are differences in speed of change depending on the alignment of certain subsystems. This idea of a world in motion is not new, the Greek philosopher Heraclitus referred to it as "Panta Rhei". This idea of a co evolutionary approach can be illustrated in the case of the horse drawn carriages. It was not just the industrial revolution or just Henry Ford that led to the automobile, it was the coming together of multiple complex systems that led to the rise of the automobile.. What can be learned from the co-evolutionary approach in regards to transitions is: *"that straight forward planning as well as incremental strategies are insufficient because these are not able to tackle system failures underlying persistent problems leading to suboptimal solutions".* [Kemp (2007)].

What is needed for a strategy on transition is an adaptive strategy that takes into account the co-evolutionary character of a transition. This is where the field of transition management originated from. *"Transition management is built around the governance paradox that 'societal change is too complex to handle in terms of management, but it is possible to formulate relatively simple rules how to influence societal change" [Loorbach (2007), p86] " The major ambition of transition management is to develop effective (adaptive and anticipative) governance systems for transitions through systematically influencing, guiding and structuring governance activities at the different levels over time." [Loorbach (2007), p104]*

Central elements regarding transition management are according to Loorbach (2007):

- Multi-actor policy making. This means that to manage a transition all the stakeholders should be represented in the making of a policy.
- Long-term, collective goal setting and anticipation. The idea of transition management is not to set the future, but to create a shared cognitive frame for individual action to happen within.
- Agenda-building. A shared transition agenda can be defined as a 'societal strategy to work towards shared visions, including a number of sub-strategies and concrete experiments'
- Experimenting and innovation. Experimentation and innovation should happen at different levels of society, on products, processes and systems.
- Evaluation, adaptation and reflexivity. The steering philosophy behind transition management is that of modulation of ongoing developments. So there is a need to anticipate, evaluate and adapt on all levels based on the shared goals.
- Knowledge diffusion and learning. The sharing of various forms of knowledge (expert, tacit, practical, etc) is important.

These elements are captured in a process model for operational management: the transition management cycle. It consists out of the components seen in Figure 8.

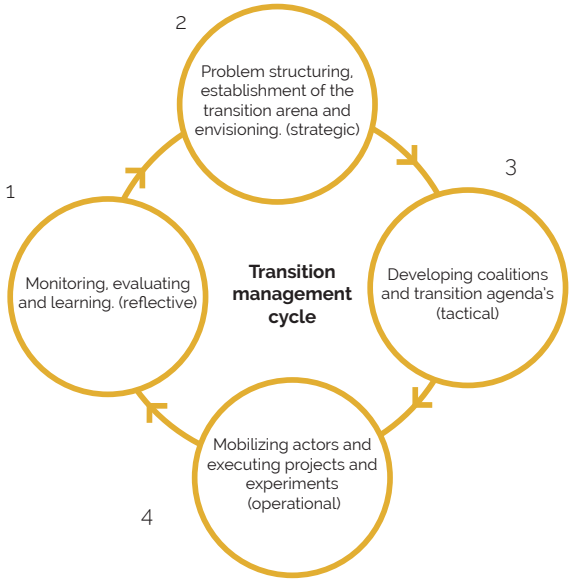

Figure 8: *Transition management cycle [Loorbach (2010)]*

When the transition management cycles is applied to the Bouwagenda, the first steps of the cycle are already shown to be put into effect as seen in figure 9. The numbers in the model correspond with the transition management cycle in figure 8. The reflective and vision for change is already laid down with an international agreement to work on climate change (1). The problem is structured in the "2050 circular" programmes of the government and off course in the Bouwagenda (2). Tactical coalitions are formed to some extent within the road-maps according to conversations with managers from the programme committee (3). The actual act of mobilising actors and executing projects and experiments have not yet happened according to the website of the Bouwagenda (4). These provides cues for the next steps for a strategy on transitioning the construction sector. Providing a way for coalitions to form and experiments/projects to be executed.

Conclusion

Transition management is paradoxical in the way that it tries to manage complex interactions between systems. Transition management is an iterative process of problem structuring, developing coalitions and agenda's, mobilising actors to experiment and evaluation of processes. In this way it can adapt to changes in society and steer accordingly. Essentialy it is a circular system instead of a linear path. The Bouwagenda -seen as a transition arena- already has mobilised actors. The next step is a difficult one to take: the actual mobilizing of actors and the execution of projects and experiments. These are needed to actually start the transition.

Design implications

Actors needs to be mobilised to start innovation projects and experiments.

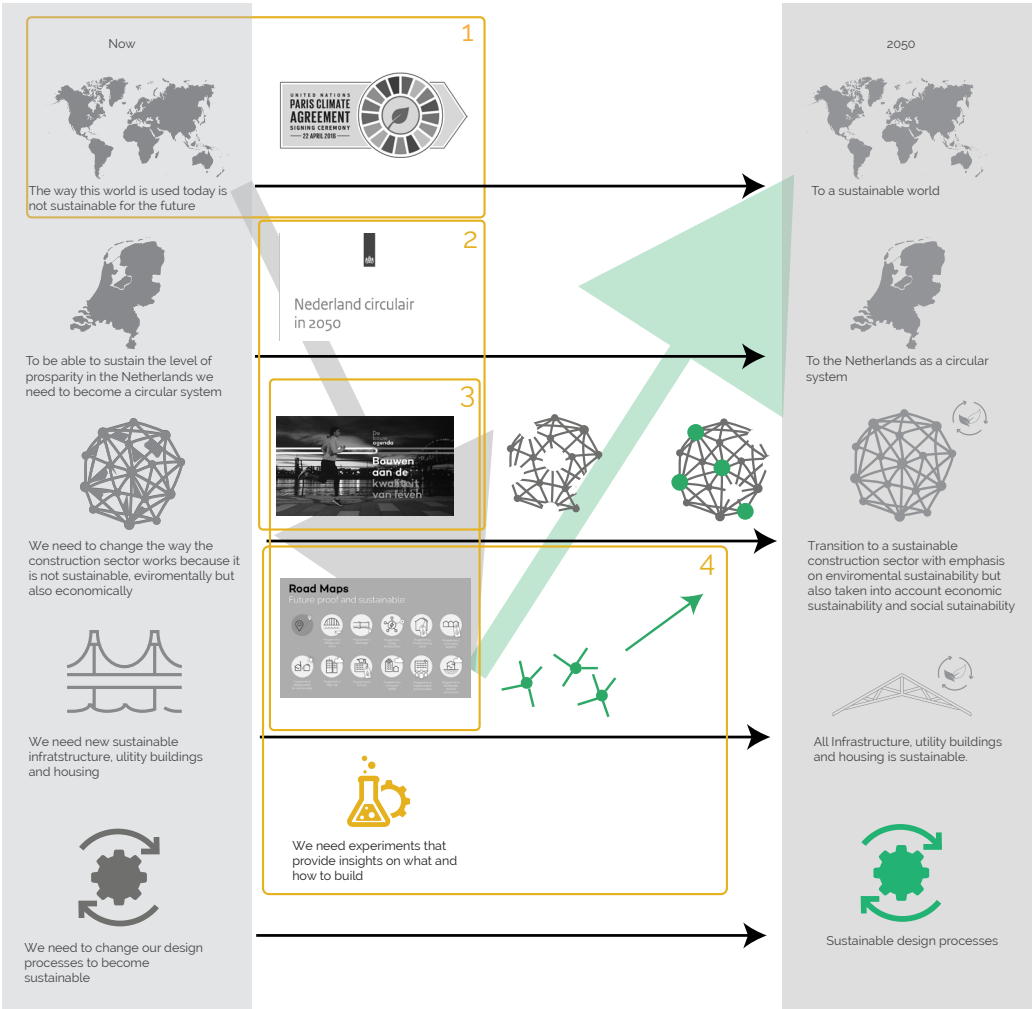

Figure 9: *Visual representation of the transition of the Bouwagenda*

2. Literature on change: the revolution in the sector

2.4 Design in transition

The experimental projects in transition management need to bring solutions that break with the conventions. This means that these solutions can be referred to as innovations to the sector. These innovations are a key driver in transitioning a sector and so understanding of how to create these innovations is needed.

However, first an understanding to the act of creating or designing anything is needed.

"Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artefacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or social welfare policy for a state"
Herbert Simon [Simon (1969) p 130]

What Herbert Simon means by this quote is that the act of creating something is an universal ability that is not necessarily linked to a discipline. This means that the fundamental process of solving a design problem is the same for every discipline. Joore et. al. (2015) used this notion and compared different design and innovation models. It occurred that the following repeating steps are the same for creating anything. (see figure 10 for the compared models):

1. Reflection
2. Analysis
3. Synthesis
4. Experience
5. Reflection

It is interesting to note that the transition management cycle uses the same steps (see figure 10). This model is designing for a transition.

The steps of reflection, analysis, synthesis and experience therefore can also be applied to the process of creating innovation in a transition experiment. In the reflection phase (1) of a transition experiment, a vision or strategy can be formulated based on the goals of the transition. Secondly an analysis (2) of the problem is needed, but this imposes a problem. The paradox of transition management arises where societal change is too complex to be fully structured and analysed. This makes it difficult to chose the right innovation in synthesis that will become the dominant design and will break with the regime. The challenge of successfully managing a transition becomes the challenge of successfully choosing the right solutions in synthesis with an incomplete analysis of the problem. In formal logic this is referred to as abduction.

A design can be seen as a combination of a thing and a working principles that lead to an aspired value according to Dorst (2011) Making the following formula:

Table 2
MDM design phases compared to other design and innovation models.

MDM design phases	Basic design cycle (Roozenburg and Eekels, 1998)	Innovation cycle (Buijs and Valkenburg, 2005)	Double Diamond (Design Council, 2007)	Learning cycle (Kolb, 1973)	Creativity process (Wallas, 1926)	Transition management cycle (Loorbach, 2010)
(1) Reflection		Strategy Formulation	Discover	Reflective Observation	Preparation	Evaluating, monitoring, learning (reflexive)
(2) Analysis	Analysis → Criteria	Design Brief Formulation	Define	Abstract Conceptualization	Incubation	Problem structuring, organizing transition arena (strategic)
(3) Synthesis	Synthesis → Provisional Design	Product Development	Develop	Active Experimentation	Illumination	Develop coalitions, transition agenda's (tactical)
(4) Experience	Simulation → Expected Properties	Product Launch and Use	Deliver	Concrete Experience	Verification	Mobilizing actors, executing experiments (operational)
(5) Reflection	Evaluation → Value of the Design					

Figure 10: *MDM design phases [Joore, et. al. (2015)]*

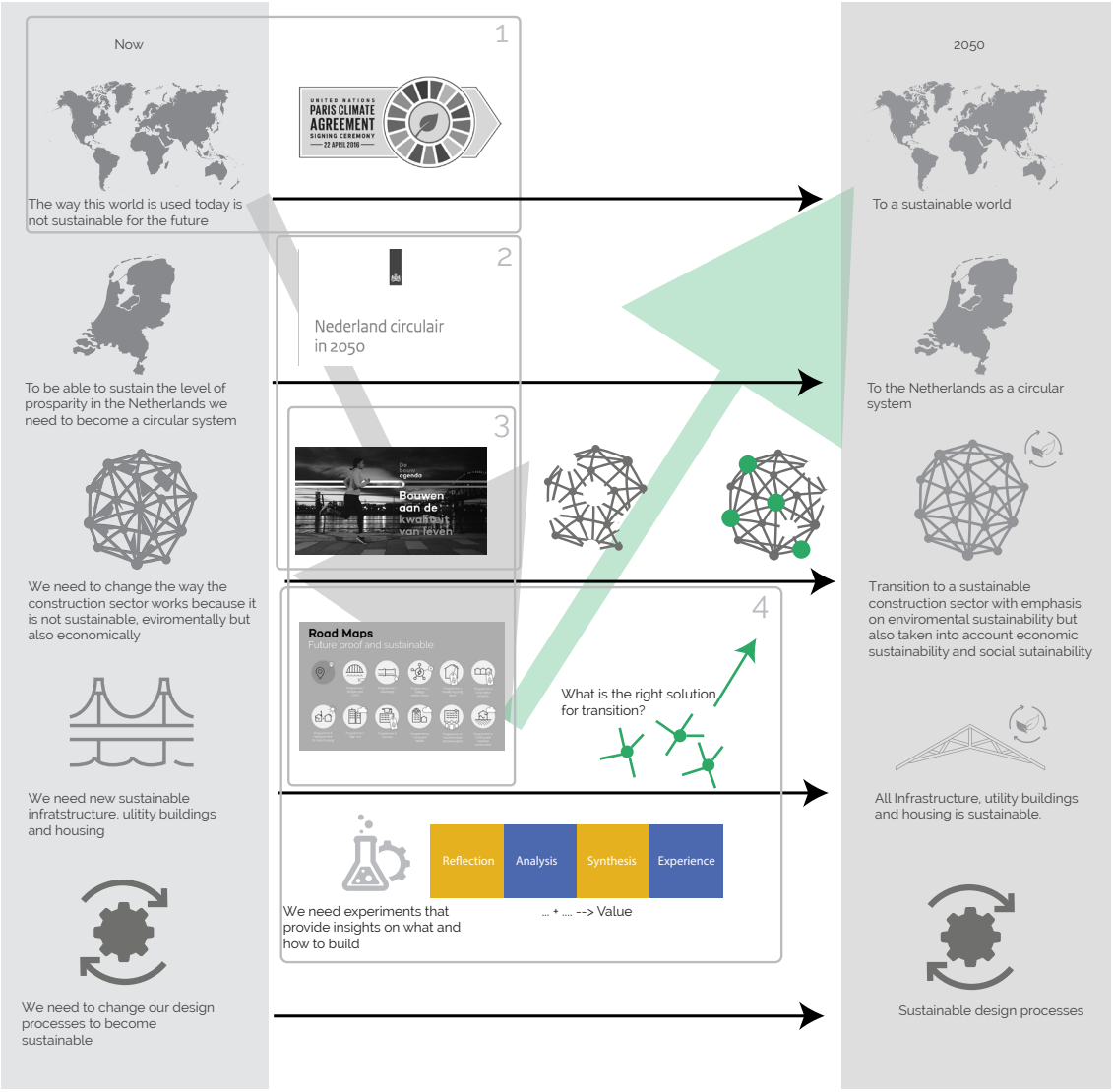

Figure 11: *Visual representation of the importance of the experiments*

What + How --> Value
What = thing, object, service or system
How = working principles, the laws that govern these movements.
Value = the value we want to create for others.

A design problem is when one or two of the elements in the formula is missing. The two types of design problems are identified by Dorst (2011) as open design problems and a closed design problems. A closed problem already has working principle (how) that is known to creating a certain value within a certain scenario. For example: use concrete for good living. You will design a house, or an apartment made of concrete because you know that concrete will lead to good living. Solving these closed problems is called abduction 1 and is often related to the engineering design practice or conventional problem solving. This is because it will use the conventions of combinations of working principles and values (sometimes referred to as the product architecture [Oberdof (2016)] to make an assumption for the future. An open problem is a problem that doesn't have a working principle (how) and a thing (what) known. For example: we just want good living. The solution to this problem might as well be a boat, or a tent as long as it creates a good living space for what is defined as good living. Solving these open problems is called abduction 2 often related to concept design practise. It's about creating a product outside of the regime and outside of known product architecture.

.... + HOW --> Value = closed design problem, often associated with engineering
.... + ... --> Value = open design problem, often associated with (concept) design

In the light of transition experiments the design problems will be more of an open design problem. This is because transition is about fundamental change in society and therefore it is aimed at breaking with the conventions.

Design implications

The steps in the process of creating innovations are similar in every creating process. The challenge of a successfully managed transition lies in successfully solving the open design problems that transition experiments face. Figure 11 visualises this in the Bouwagenda challenge model, where the decision for what innovation to chose is crucial for breaking into the regime.

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2.5 Navigating the open problems "the design expertise"

As a response to the challenge of working in problem situations that require this second, 'open' kind of abduction, designers have developed and professionalised specific ways of working.
[Dorst (2011) p525]

By learning from how the professional designer works, a strategy can be formulated that can help to solve the open problems that face transition experiments.

According to Lawson et. al. (2015) & Dorst (2011) there are seven levels of design experience to be found corresponding with a way of operating:

- **Naïve**, ordinary people that mostly focus on the result.
- **Novice,** use the convention when confronted with a design challenge.
- **Advanced beginner,** is able to study the design situation and respond accordingly. The convention is known and becomes more like a guide.
- **Competent,** knows the dynamics of a design process and creates design situations for themselves.
- **Expert**, has experience in a lot of design processes and responds intuitively
- **Master**, is able to understand it's intuition and creates new schemata
- **Visionary**, creates new schemata redefine the design field as we know it, creating the new convention.

From this it can be derived that the expert designer is the one that seems to be able to let go of the conventions. According to Lawson et. al (2015) his/her designs are based on intuition that is gathered from experience in working with open problems.

The understanding of how expert designers operate and use their intuition may provide guidelines on how to approach the open problems in creating innovations that can transition the sector.

Cross (2004) p439 describes the operations of an expert designer as follows: Expert designers are solution-focused, not problem-focused. This appears to be a feature of design cognition which comes with education and experience in designing. In particular, experience in a specific problem domain enables designers to move quickly to identifying a problem frame and proposing a solution conjecture.

There are a couple of things mentioned in this quote. First of all, expert designers are solution focused, not problem-focused. This means that they focus on creating solutions to a problem instead of just analysing the problem. This ability comes from education and experience that enables them to identify a so called problem frame. The problem frame as [Dorst (2011)] calls it is *"a general implication that by applying a certain working principle we will create a specific value"*. In other words, the design says, if we look at the problem from this way, then we might do …. In this way a conjecture solution is proposed.

Comparing the behaviour of the expert designer to the general design steps, the expert designer accepts that the problem is too open to analyse it completely and tries to frame the problem in a way that a solution can be found. He starts the synthesis without fully completing the analysis [Ahmed, et. al.l (2003)]. Figure 12 shows the steps of the expert designer. These solutions are then proposed and experienced designers tend to be able to intuitively say if something is "good enough" to continue in this part of the process, allowing the iteration to continue and create a more complete solution [Erp (2016]. This more complete solution can now be analysed, structured and tried to be validated. If the intuition turns out to be untrue the process starts over again and new frames are proposed.

This process sometimes seems chaotic from a distance and is often described as the "design squiggle" [Newman (2010)] see figure 13. But actually it describes fast iterations based on experience and research on specific topics to make a better guess at proceeding to the experience phase. As you continue the process the solution becomes more clear and something emerges that can be calculated and tested.

If the process of the designers is successful an effective design is achieved.

An effective design, according to [Buchanan (1992)] is a solution that is the integration of:
-the ideas of designers and manufacturers about their products;
-the internal operational logic of products
-the desire and ability of human beings to use products in everyday life in ways that reflect personal and social values.

Oberdof (2016) refers to effective design as the integration of, the human perspective, business perspective and technology perspective.

Real world experience of the design will tell if a designer has succeeded in creating an effective design.

Design implications

The expert designer's design strategy can be used to finding innovative solutions needed for transition. Their strategy is to focus on the solution instead of on the problem. By framing the problem with different working principles than the convention, conjecture solutions can be created. This is what we could call unconventional thinking. These conjecture solutions are then validated based on intuition to continue the process until a seemingly complete design emerges. This complete design can be analysed and tested. It can be found effective if it integrated human, business and technology perspectives. This means that in the experiment projects the process should facilitate this seemingly chaotic path and promote a designerly way of thinking. The designerly way of thinking involves being able to let go of conventions and a willingness to integrate human, business and technology perspectives.

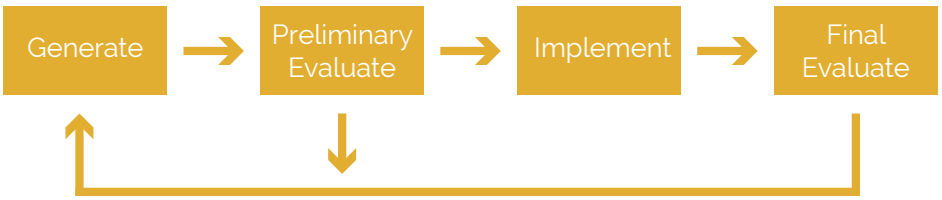


Figure 12: *evaluation process expert designer [Ahmed, et. al. (2003)]*

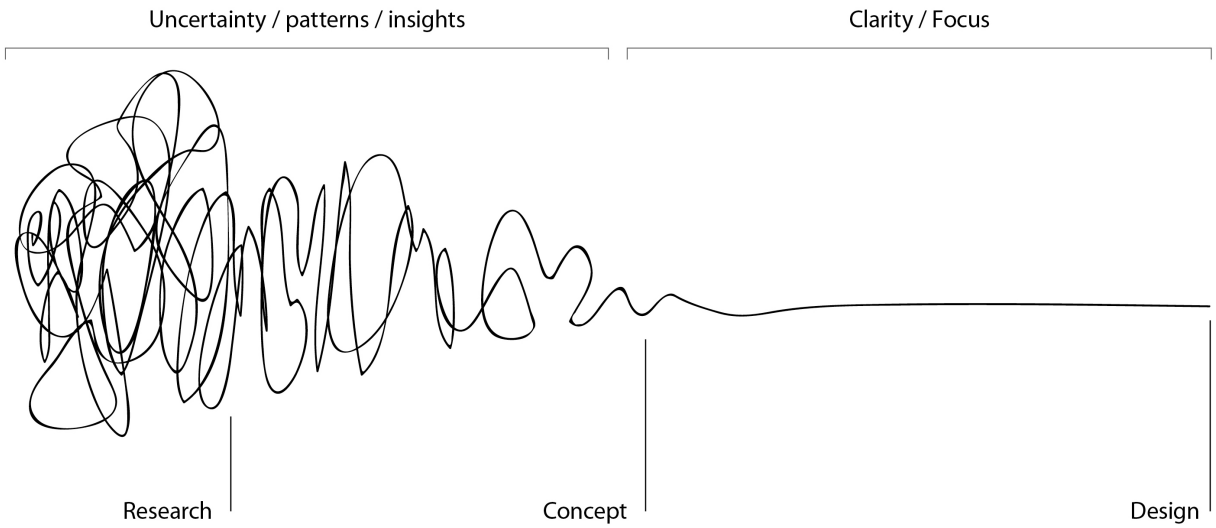


Figure 13 *the design squiggle [Newman (2010)]*

2. Literature on change: the revolution in the sector

2.6 Incorporating the skills of designers

Knowing how a designer thinks doesn't make a good designer. An experienced designer is also educated in certain skills. In literature a lot of skills are mentioned but they can be grouped in the following five activities.

1. Formulating: being able to identify, describing and frame problems.
2. Representing: creating a representation of the design propositions. This can be done via drawings, computer programme's etc.
3. Moving: making of design propositions and that are sometimes developed and sometimes abandoned. Moving is about making decisions to continue.
4. Evaluating: being able to regulate the moves by evaluating them to a set of criteria that are vague or precise. "is it good enough"
5. Managing: bringing the process towards its target. This combining all previous activities and continuously reflect in-action deciding what actions to take to bring the design project to a final solution. [Lawson et. al. (2015)]

These activities provide insight in the process of creating a design in an open problem situation. Expert designers tend to interchange these skills rapidly to come to an effective design.[Atman et. al.l 1999]. Their experience allows them to chose the right activities by preliminary evaluation of the activity. The evaluation process of the designer in this way also work on a process level. [Ahmed et. al. (2003)].

Design implications

The skills of formulating, representing, moving, evaluating and managing need to be present and used in order to improve the process of creating an effective design. Experience in solving open design problems allows someone to train these skills.

2.7 Weakness in the strategy

Although the strategy of the experienced designer seems promising there are also some weak points in this strategy with regards to transition. If this strategy of the experienced designer is used with novice designers, they will use the convection to judge a solution. In this way, always returning to the same solutions that is already known. Using at least proficient designers can overcome this problem. [Albers et. al.l (2012)] has proposed a framework based on the following questions to access the level of design expertise.

1. How is design knowledge disposed? Novice designers can not apply their knowledge about design in a specific context. They cannot explain for example, when to you weld or when to rivet two plates together. Advanced beginners can do this.
2. Is the relevance of the design task detected? Within a specific design task only competend designers can recognise the relevance of their design. Novice and advanced beginners will use for example welding as a method because in similar contexts this was also the case.
3. How are design problems solved? More experienced designers tend to solve problems holistically instead of analytically. Analytically is to solve a design problem piece for piece, where designing holistically is about creating the bigger picture.
4. How are decisions made when designing. The expert designers tends to make design decisions intuitively, where the others tend to rationalise their decisions.

This evaluation scheme (figure 14) can be used as an indicator of the design expertise of the person practicing the strategy of the experienced designer. Note that this scheme only judges novice to expert designers and that competent is divided into competent and proficient. The difference is that competent in Albers' model refers to as competent

within the design task within certain boundaries. Proficient is referred to as to be able to look over the boundaries of the design task, this would be more applicable to the definition that Lawson et al (2015) has given to the term competent. This shows also that this framework is just an indicator and that there is some discussion about how to classify designers.

[Cross (2004)] also notes that experienced designers can become readily attached to single early solution concepts, they will use a certain set of frames that works for them. In the light of transition, if these frames are grounded in the conventions, the strategy could lead to a conventional solution. To overcome these weaknesses, creating a multidisciplinary team of at least proficient designers allows for a joint judgement based on knowledge of multiple experts. Proficient means that the designer is able to understand the conventions of their discipline and is able to holistically create a solution.

<table>
<tr><th>Level of design expertise</th><th>How is design knowledge disposed?</th><th>Is there a detection of the relevance of the design task?</th><th>How are design problems solved?</th><th>How are decisions made when designing?</th></tr>
<tr><td>Novice</td><td>Without context</td><td rowspan="2">None</td><td rowspan="2">Analytically</td><td rowspan="3">Rational</td></tr>
<tr><td>Advanced beginner</td><td rowspan="3">In context</td></tr>
<tr><td>Competent</td><td rowspan="2">Present</td></tr>
<tr><td>Proficient</td><td rowspan="2">Holistically</td></tr>
<tr><td>Expert</td><td>Intiuitive</td></tr>
</table>

Figure 14 *evaluating levels of design expertise [Albers et. al.l (2012)]*

2. Literature on change: the revolution in the sector

2.8 Conclusion

A strategy on transition can be found in transition management. By constantly trying to structure the problem and creating transition arena's coalitions can form and create transition agendas. From these transition agenda's experiment projects should be created. These experiment projects have to create the innovations that will break with the conventions of the regime and lead to the desired transition. These innovations will be reflected upon and new problems can be structured again, repeating the transition management cycle. In this way transition management is non linear.

The experimental innovation projects are key in successfully managing the transition. But creating successful innovation projects is difficult since doing so means letting go off the conventions. This is referred to as an open design problem. An abduction 2 design approach is needed to come up with solutions to these open design problems. This abduction 2 design approach can be found with the expert designer. The expert designers is solution focussed instead of problem focussed. By generating conjecture solutions and judging them based on intuition, complete solutions can be found. These complete solutions can be tested to see if they are effective. An effective design is an integration of human, technology and business perspectives into one solution.

To allow this seemingly chaotic process, often referred to as the design squiggle, to happen, the people involved in the process are key. The experiment team should consist of a multidisciplinary team that incorporates a designerly way of thinking. This means that they understand the conventions of their discipline and have a willingness to integrate human, business and technological perspectives into one solution. Experience in working in such teams can improve the process.

The described strategy on transition would be the ideal situation for a strategy on transition of the construction sector. To create a strategy for the Bouwagenda, the barriers to going to this ideal situation need to be identified. In the next chapter a closer look will be taken at what barriers can be found at system level (ability to create coalitions) and at process level (ability to work together in multidisciplinary teams with a design approach). Figure 15 provides an overview of the perceived ideal situation.

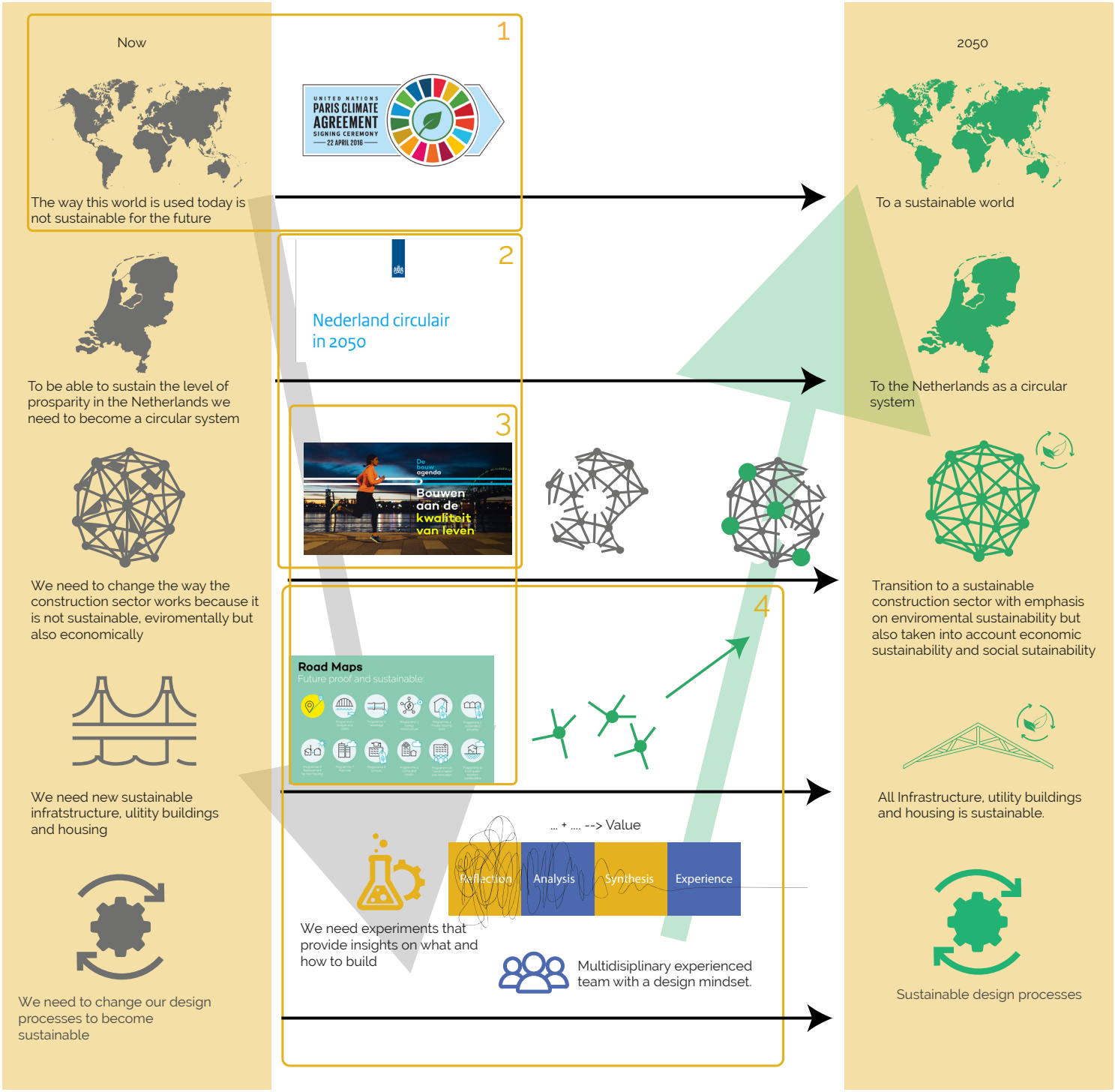


Figure 15: *Visual representation of the desired transition strategy*

3. The context, designing in a construction project

3. The context, designing in a construction project

3.1 Introduction

A strategy on transition in the construction sector is found in transition management. Transition management creates coalitions of actors that execute experimental projects. The application of a multidisciplinary design approach in these experimental projects can improve its success. To be able to apply this strategy for the Bouwagenda the current situation of the construction sector needs to be examined in order to see how these 'coalitions of partners" and "multidisciplinary experimental design projects" can be integrated. What are the enablers and what are the barriers to overcome to implement this strategy successfully? Therefore this chapter will examine the current construction sector on project processes and system level (see figure 16). We will take a closer look at construction processes within construction projects and how a multidisciplinary design approach is different from a traditional approach. For the same reason the context of the construction sector will be examined.

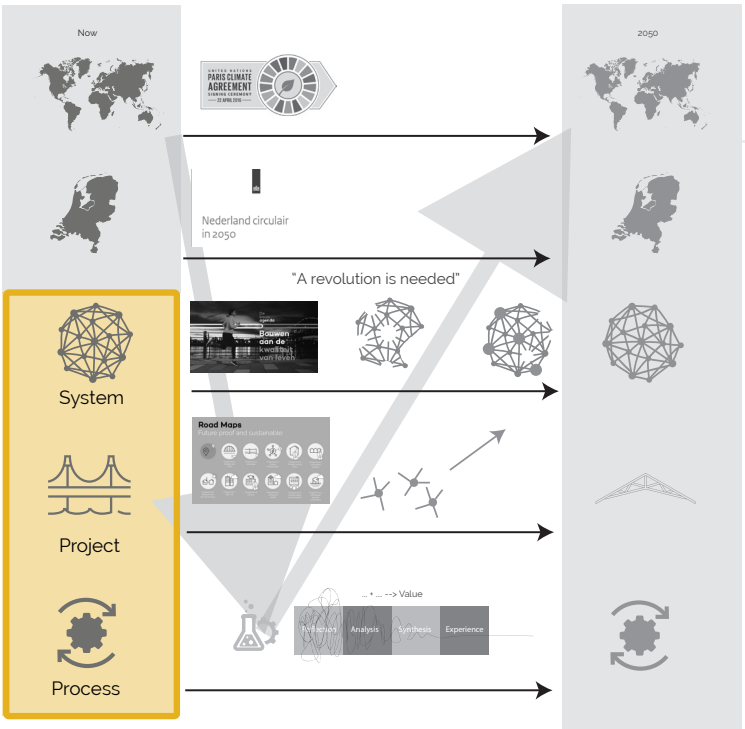


Figure 16: *Focus of this chapter*

3.2 The construction project processes

First of all, the definition of a construction project:
a construction project is an endeavour in which human, financial and material resources are organised in a novel way to undertake a unique scope of work, of given specification, within constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives. [Bakker et. al. (2015) p3]

Beneficial change means a certain value to be achieved within time and cost for this value to be beneficial. A construction project is therefore business driven, where the exchange between value and cost needs to be in balance. This is also described as: quantitative and qualitative objectives derive from alignment with business.

The process of a construction project is often divided in stages. Figure 17 shows an overview of the different stages as these are called by Ridder (2009) & Bakker et. al. (2015). The process steps of Joore et. al. (2015) are also plotted in the process to indicate where in the process certain activities happen.

Further on the process becomes more and more defined. This means that influence on the project is dropping as the project advances. For example, you can imagine, it is very difficult to add an extra floor if the foundation of the building is already there. Also, construction projects are costly because as soon as construction starts expenditure will rise rapidly [Bakker et. al. (2015)]. The graph in figure 18 shows this in relation to the process. The graph shows that the front end of construction projects is key in defining the project and that this is the place where changes to the project can happen.

Conclusion

The early phases of the construction project (appraise and select) are of great importance when it comes to the ability to make changes in the design of a construction project.

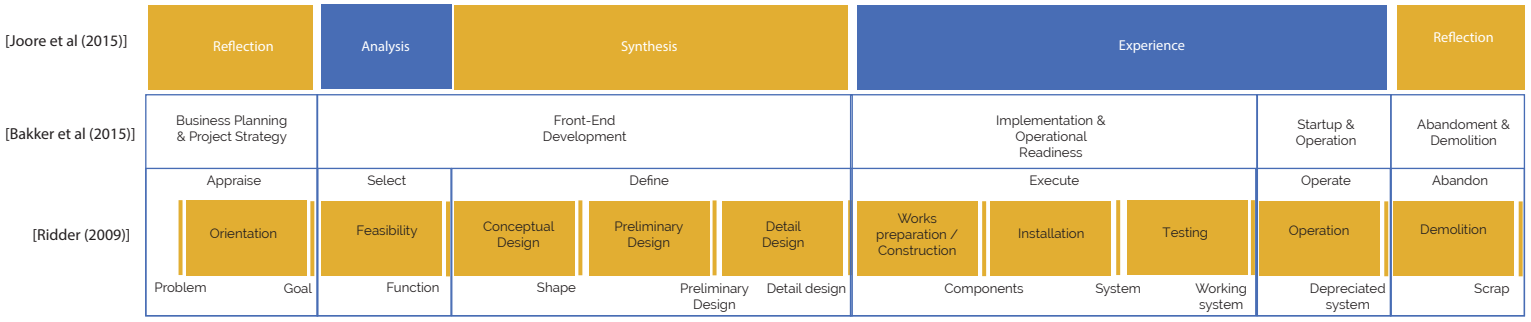


Figure 17 *Life cycle stages* (Ridder (2009), Bakker et. al. (2015) and Joore et. al. (2015))

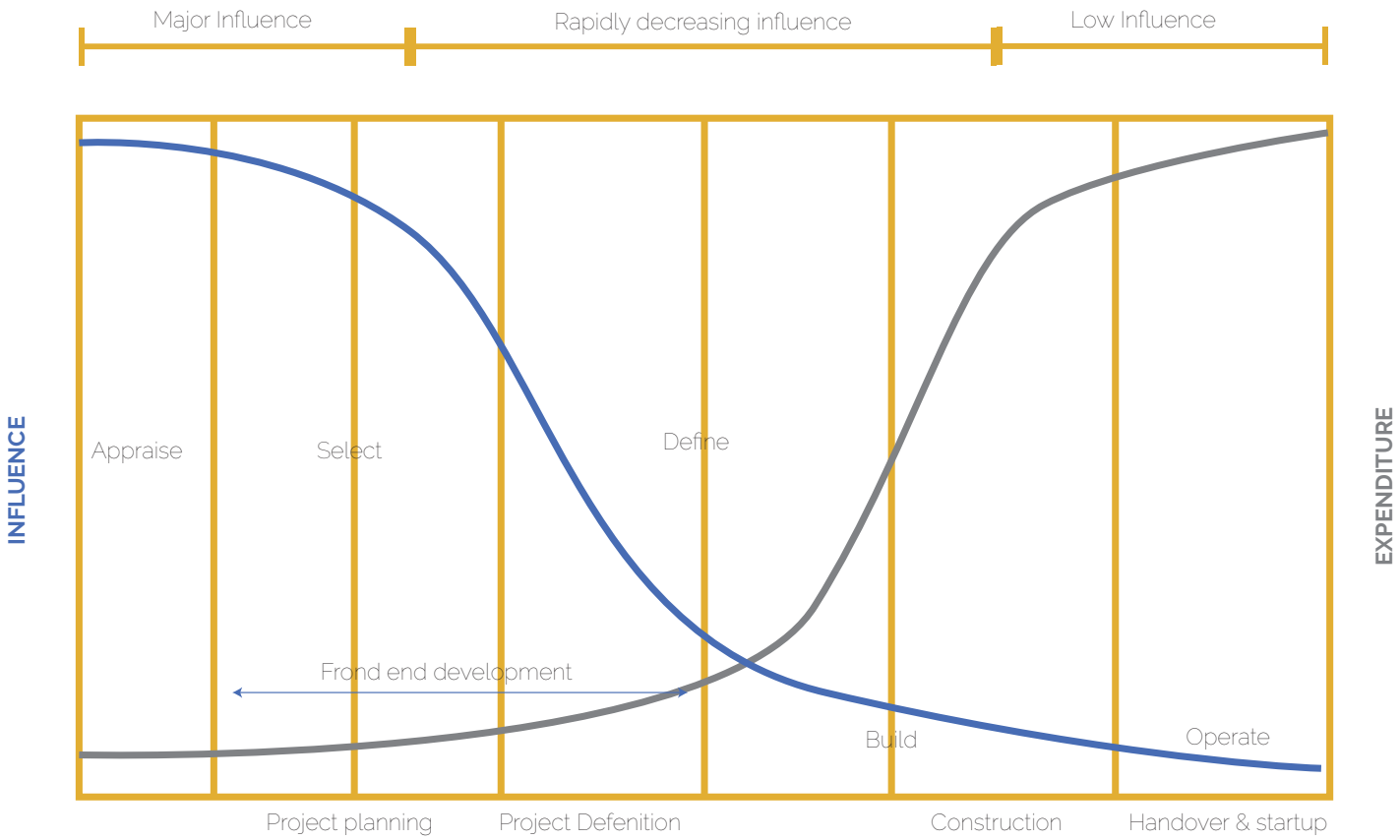


Figure 18: *Relation between time and value Bakker et. al. (2015)*

3. The context, designing in a construction project

3.3 The Contracts

The different stages of a construction project are often divided between client and contractor. Understanding the construction design process means also understanding the contracts that have been concluded between the client and the contractor.

According to Ridder (2009) there are three characteristics that are important in settling an agreement in its simplest form: value, price and cost (see figure 19 for a visual representation of the relationship between these elements). The client is the one that demands a certain value and the contractor is the one that should meet this value for a reasonable price.

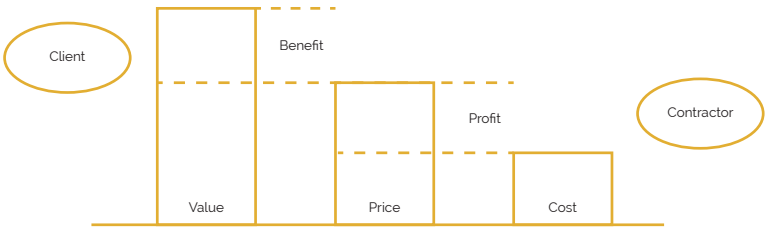


Figure 19: *Relation between value, price and cost [Ridder (2009)]*

The client is satisfied if there is a positive difference between the value and price and the contractor is satisfied if there is a positive difference between price and costs. For expensive projects this means that there should also be a lot of value created. Constructions projects can range from several thousands to hundreds of millions Euros. For expensive construction projects this also means that the risks are higher if it fails to attain the promised value. Later on in this chapter a closer look will be taken at value creation in construction projects.

There are several contracts possible that show the division between tasks for the client and for the contractor. We will discuss the most common contracts and a few contracts that allow for collaboration in the early phases of a construction project (see figure 20). The description are based on [Ridder (2009)]

Bid-Build (BB)
This contract model is one of the oldest forms of contract and is still the most-used form of procurement. In this contract form the client is responsible for creating the design and a contractor is responsible for building the design. The advantages of this model are the clear division in tasks and the good checking possibilities. The disadvantage is a strict division between client and contractor that make it difficult to use the knowledge of the contractor in the design process. This sometimes leads to high costs of additional work that needs to be done, occasionally leading to a to conflict between client and contractor.

Design-Build (DB)
In this contract form the contractor is also engaged in the design part of the construction project. This contract form is second most used in the Netherlands. The advantages are that client and contractor work together earlier in the process and that knowledge of the constructor can be used in the design. Some disadvantages are that the client is already bound to the contractor in a phase of the project when some aspects of the build are not clear. And because DB contracts are not that often used there aren't as many companies that can execute DB contracts. DB contracts can also be extended to DBM (Design Build and maintain) or DBMO (Design, Build, Maintain and Operate) contracts, in these cases the contractor also maintains and or operates the works.

Design Team (DT)
In this contract form the disadvantage of being bound to a certain client is solved by having two contracts. One that allows the client and one contractor to work together during the preliminary design and one that allows for the works to be build by another contractor if preferred. This form of contract is hardly present in the Netherlands.

Alliances
Alliances are relatively new and also hardly used in the Dutch construction sector. These contracts enable various parties with their own individual interests to work for a common goal.

Figure 20 *Overview of common contracts in the Netherlands [Ridder (2009)]*

3. The context, designing in a construction project

Private clients are free to choose whatever partner is suited for them to start a contractual relationship with.

For public authorities there are rules about contracting a construction company. The European tendering laws state that:
public authorities:

- *may not discriminate against businesses registered in another EU country*
- *may not refer to specific brands, trademarks or patents when describing the characteristics of products & services they wish to purchase*
- *may not refuse to accept supporting documents (certificates, diplomas, etc.) issued by another EU country, as long as they provide the same level of guarantee*
- *must make all information regarding tenders available to all interested companies, regardless of the EU country they are registered in. [European Union (n.d.)]*

These rules apply to a threshold of 443.000 Euro for central governments and 221.000 Euro for other public authorities. [European Union (n.d.)]. This means that almost all construction projects are above this threshold. These rules are there to allow for a fair competition for publicly purchased products. There are standardised procedures for tendering and special tendering procedures. These special tendering procedures can only be used in specific circumstances and also allow early involvement for collaboration between government and the market. [PIANOO (2018)]

Conclusion

In this process client and contractor are often separated and only in rare cases they work together from the start of the project. These are not optimal conditions under which innovations can take place. For example, if a contractor has an idea of replacing a sewer in a different way it's almost impossible to execute or test, because of the detail design that he has to tender to. Visa versa the client doesn't know what the contractor could build. This creates a lock in.

Barriers to transition

There is often a separation between client and contractor in construction processes. The contractor is therefore dependent on the client for buiding a sustainable construction project. Also experience in working together in multidisciplinary design teams is probably very low, since these kinds of projects are hardly conducted.

With expensive construction projects the risks for the participants also rise, for there is no proof that experimental projects will succeed.

Standard European tendering procedures make early collaboration between public clients and contractors impossible, but there are non-standard procedures that can be used for early collaboration between public clients and contractors.

Enablers to transition

There are tendering structures and contracts possible to work together with constructors early on in the design process.

3.4 The stakeholders

The client and contractor model shows only two stakeholders in the process, but in reality there are more actors involved in the construction process.

To start with the client, this can concern different actors. These can be municipalities, hospital owners, school boards, directors of companies, real estate developers etc. Some clients are used to the construction process, like municipalities or developers but others are new to the process, like school boards for example. Depending on the client they could involve a construction advisor or architect early on in the process that helps them to formulate the value that they want [BNA (n.d.)]. Municipalities that often use bid-build contracts have an engineering department that designs the project themselves. [Gemeente Rotterdam (2018). In construction projects there is often a project manager appointed on the client side to manage the stakeholders. In complex projects a construction team is formed, the team consists out of a project manager, risk managers, engineers, architects, consultants, advisors etc. [Bouwend Nederland (2018)]

As a client you are not totally free to build whatever you want. Building in the Netherlands means adhering to the Bouwbesluit. This is a collection of technical regulations that are mandatory in construction projects [Ministerie VROM O&M (2018)].

On the contractor side there is the main contractor that signs the contract with the client. He is often the one that does most of the work, but that is not necessary. The contractor often hires subcontractors for several parts of the construction project, for example installers of ventilation, facade suppliers, cement factories, window suppliers etc. All these subcontractors deliver parts in the process of the building of the construction in the form of finished products, semi-finished products and raw materials. The team of the contractor consist out of project manager, engineers, planners and workers. [Nicolas et. al. (2017)]

Conclusion

The clients can be divided into two groups, inexperienced clients and experienced clients. Inexperienced clients are often single time clients and are for example school boards, hospitals, etc. Experienced clients have multiple projects that need to be build and are for example municipalities, governments and real-estate developers. What can be concluded is that a construction project is a complex undertaking that involve a lot of stakeholders to actually realize it. Some stakeholders have general knowledge about the product to be build and some have very specific knowledge about certain products. The challenge is to bring everything together to create a solution that is satisfying for the client, meaning that there is a positive relation between the value and the price.

Barriers to transition

Barriers in the construction process with respect to stakeholders can be found in the diversity of clients. Some clients make just one building (like school-boards, hospital boards, director of companies) where others are more recurring clients (governments, municipalities and real estate developers). This makes creating coalitions of similar projects difficult for inexperienced clients but more likely for experienced clients.

Enablers for transition

Experiments with new solutions might be easier to conduct with inexperienced clients since they are also the user of the product that they buy and you only have to convince one party. Whereas in a municipality for example there are multiple stakeholders that need to be convinced. An example of this is Circl, the worlds first circular pavilion build by ABN AMRO.

3. The context, designing in a construction project

3.5 Value Creation in the construction process

The process steps, contracts and stakeholders involved provide an overview of what happens in a construction project, but the steps don't provide insights on how a solution is formed and the value for the client is achieved. To better understand what happens in the front end of a construction project process we will focus on value creation in construction projects.

The way a project starts is often with the framing of an opportunity. [Bakker et. al. (2015)]. Crucial at opportunity framing is:

- *Define the project scope*
- *Involve stakeholders*
- *Define when the project will be successful*
- *Create value drivers*
- *Identify risks: threats as well as opportunities [Bakker et. al. (2015) p 103]*

What opportunity framing suggest is finding a solution that creates the value that accounts for the cost of a construction project. A successful opportunity is found when more value is created for the money spent on the project. According to Bakker et. al. (2015) opportunity framing is something that should occur throughout the project and not just in the beginning.

Opportunity framing is best described with an example. The Green Carpet in Maastricht. For years a highway ran through the city of Maastricht but creating just one tunnel was too expensive. The opportunity was created to stack two tunnels upon each other, one for regional traffic and one for passing traffic. On top of the tunnel a park was created and houses were build. This integral design made it possible to create enough value for the tunnel to be build. [A2 Maastricht: A single plan for the city and the motorway. (n.d.)]

Opportunity framing is not always easy according to an international research. A significant share of projects fails with respect to both producing the intended effect and addressing the expected business results [Shenhar et. al. (2007)] . Also Mc Kinsey reported an international productivity lag in the construction industry [Barbosa et. al. (2017)]. In a research of six large infrastructure projects 14 critical events for opportunity framing were examined and premature convergence was found at 10 of these 14 events because of insufficient interaction with other stakeholders. [Hertogh, Westerveld, (2010)]. Premature convergence is that a solution is chosen too early, thereby killing off many other options at that point.

Value Engineering

A systematic method to invoke opportunity framing is found in value engineering [Bakker et. al. (2015)]. Value Engineering aims to optimise the value of a system throughout its lifespan. In a Value Engineering workshop stakeholders are brought together to come up with a solution to design problem. In 2 to 3 days the value engineering team tries to find answers to the questions:

- What are the needs of the stakeholders?
- Why is there investment in these needs?
- How can we create solutions that meet the needs of the stakeholders as profitable as possible without losing quality and performance? [Rijkswaterstaat (2018)]

In figure 21 an example of a value engineering workshop is shown. The following phases are used:

1. Preparation phase, the facilitators prepare the workshop and gather all the needed information
2. Information phase, information about the project is shared in the group so there is a shared understanding of the problem.
3. Function analysis a, using a method called FAST the group tries to find out what the system should do and why the system should do certain things. Function analysis b is trying to formulate a central need. This need is described and made concrete.
4. Creative phase, as many ideas as possible are

generated to create a wide range of solutions

5. Evaluation phase, ideas are prioritised and selected based on the set criteria from earlier on in the workshop.
6. Development phase, the idea is tested on viability and feasibility.
7. Presenting phase, the result of the session is presented to other team members
8. Reporting and implementing phase, a value engineering report is made that describes the steps and the conclusions found. *[Rijkswaterstaat 2018])*

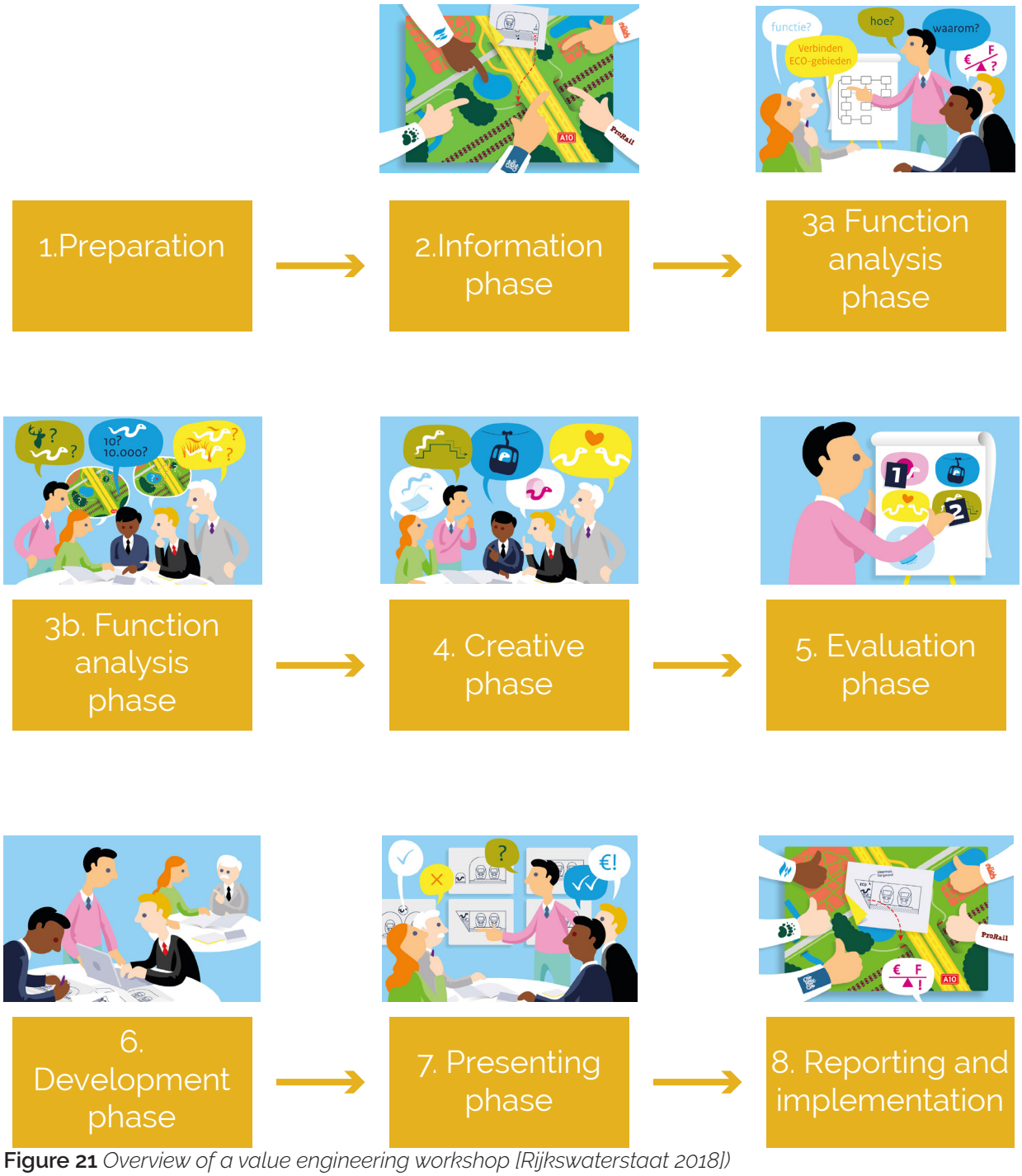


Figure 21 *Overview of a value engineering workshop [Rijkswaterstaat 2018])*

3. The context, designing in a construction project

Interview

To better understand value engineering an interview was conducted with a value engineer of Movares (engineering agency). Robert Jan Lenselink has worked for some time at Movares and is a certified value engineer also responsible for selling value engineering workshops in the sector. The goal of this interview was to get better insights in what happens during a value engineering workshop and to find how this is used within a construction project.

Value Engineering is developed by General Electric (GE, Digital Industrial Company). ProRail and Rijkswaterstaat are both using this method to develop their projects at the plan phase (early phase of the project). An example of a design problem is: how to make train stations accessible for disabled people. The reasoning behind Value Engineering is that the solutions are in the heads of people and that if you bring them together you can create the best solutions. The "art" of value engineering is facilitating such a session so that this is happening. ProRail and Rijkswaterstaat demand that such a value engineer is certified. The process of finding a solution is spread out over the course of two days or sometimes longer. For example at the Zuid-As Dok (large infrastructure project in Amsterdam) they needed about 6 or more sessions to find a solution. The first steps of value engineering are about collecting information on what a good solution should be, what are the boundary's. If this isn't clear, more exploring of the problem is done. For example, in the session of one of the train stations they actually went to the train station and visited the places where the changes needed to happen. Once boundaries are set, there is a brainstorm where ideas are being generated. At the end of the first session promising concepts are chosen by the team. This is where the first day of the two-day value engineering session stops. In between the days a cost owner calculates the cost, the architect visualised the ideas and the engineer calculates the construction of the promising concepts. A multi criteria analysis follows to determine which of the ideas has the most value. In the second meeting the ideas and ranking of the multi criteria analysis is explained. After the presentation there is a discussion and the stakeholders have to reach a group consensus. It sometimes happens that they don't reach a consensus and they have to brainstorm again. The solution is dependent on the input of the people that participate, they are responsible for providing correct information to the table. The selection process of the participants is therefore very important to be able to get the best results. *"It seems that sometimes when key people are missing the quality of the solution is less"* Lenselink says. There is a solution when there are no loose ends and all the stakeholders say *"yes this is what we are looking for!"*. The costs of these sessions are often paid for by governments (clients) because they know it will help them in the end to reduce costs. At Movares there are 10 people that are certified value engineers. Lenselink says that he doesn't need them that much. Selling value engineering seems difficult, he only acquires small assignments from companies. This is a pity because the technique can be used throughout the entire process. At Rijkswaterstaat and Prorail most of the value engineers are also system engineers or cost engineers because they do not full time practice value engineering. To keep the knowledge in this discipline up to date there is a value engineering school. The value engineering school is a close community that keeps annual meetings. They keep each other up to date and learn new brainstorm techniques. Twice a year there are classes and you learn from the people in the field.

Learning from the interview

Value engineering is a method that allows for solution focussed designing and offers a standardised process for this. Important learnings from the interview are the importance of the "right" stakeholders in the process, they make or break the solution. Finding and bringing together the "right" stakeholders is not easy. Especially when it comes to finding good representatives for the neighbourhood or future users of the product. These representatives need to have a deep understanding of the needs of these people.

Another learning is the importance of documenting the decisions that are made. A value engineering workshop looks similar to the process of the expert

designer in the way that they use the ideas of the people and judge them together to find a solution to the problem. Depending on the creative phase (there are multiple way of executing the creative phase) framing of the problem is used to come up with solutions.

Conclusion

Value creation in the construction sector happens via opportunity framing. Solutions are proposed that are tested with stakeholders to determine if value could be created. Opportunity framing isn't always going well as literature suggests leading to high costs and an overall productivity lag in the sector. Two reasons are found in literature, the quick choosing of a solution (premature convergence) and insufficient collaboration between stakeholders. Value Engineering as a systematic approach to opportunity framing tries to overcome this but also has some drawbacks. The right people need to be present for a successful value engineering workshop, and that is not always easy to determine. Furthermore as seen in chapter 3.3 and 3.4 there can be a lot of stakeholders that can also often be separated from each other. More information abouth the interview can be found in Appendix I.

Barriers to transition

Opportunity framing is found to be difficult in the sector. Insufficient collaboration between stakeholders and premature convergence seem to be the causes for this.

Enablers for transition

Value engineering provides a tested systematic approach to design in multidisciplinary teams.

Picture 2: *The new Zuid as station [Zuid as dok (2018)]*

3. The context, designing in a construction project

3.6 Discussion about the separation between client and contractor

That the division between client and contractor is not ideal has also been noted by the sector. There have been several initiatives started in the past few years that focus on improving client and contractor relationships. Two initiatives that stood out and are also mentioned by the Bouwagenda are the Marktvisie and the foundation "Rondom GWW".

Marktvisie

In 2015 the "Marktvisie" was launched by Rijkswaterstaat, het Rijksvastgoedbedrijf, ProRail, Bouwend Nederland, NLingenieurs, de vereniging van Waterbouwers, MKB Infra, Uneto VNI and Astrin. These initiative leaders are representatives of experienced clients and the market. The Marktvisie are guiding principles to a goal as:
"builders of the Netherlands" we excel by being reliable, approachable and inspiring. We work together for citizens and businesses on a safe, liveable and accessible Netherlands. [Rijkswaterstaat et. al. (2015)]
Already a lot of companies have signed this document and thereby have signed for change in the sector. The Rijksvastgoedbedrijf and Union of Water Boards have responded by creating vision documents together with the market on how they want to work together in the future.

Foundation Rondom GWW (Ground, water and roadworks)

An initiative from several SME (small/medium enterprises) infrastructure construction companies in the area of Rotterdam have united themselves in a covenant. Their shared aim is to together create better, faster and cheaper projects without fuss for the municipality of Rotterdam. The municipality of Rotterdam also works together with this initiative. Inspired by this initiative 5 similar initiatives started in other regions.

Conclusion

Coalitions are formed to actually change the relationship between client and contractor in the construction sector. Yet these coalitions are very recently formed and thereby indicate that collaboration between client and contractor isn't always the case.

Enablers to transition

These initiatives bring clients and contractors closer to each other in order to facilitate the process of starting experimental projects together.

Picture 3: *Launch of the Marktvisie [Rijkswaterstaat (2015)]*

3.7 Case studies

Especially the front end of construction projects are important when it comes to creating innovations. Literature about the process provides the steps that are taken, but do not provide a deeper understanding about the context.

To find out how the construction process is currently experienced, case studies are used. There is especially looked at the front end of the construction projects and the possibilities to do things differently in the front end. There is chosen to look at experienced clients, because they are part of the Bouwagenda coalition and therefore lie closer in reach for a strategy and have a bigger influence on the regime. Also as mentioned in chapter 3.4, a one time client can probably not say something about the process in general, since they only have seen one construction project. Processes and experiences may differ from project to project making it difficult to say something about the process in general.

For this case study Rijkswaterstaat and the Municipality of Rotterdam were selected. as experienced clients. Rijkswaterstaat is a large client when it comes to special infrastructure projects, where the municipality of Rotterdam is known more for repetitive work on the cities infrastructure. Both the Municipality of Rotterdam and Rijkswaterstaat are especially interesting because both of them are working on creating better relationships with their contractors, which is important for innovation teams.

Goal

The case studies are aimed at gaining an understanding the early phases of a construction project. Where do the decisions in the early phases come from and what are the barriers in innovating in construction projects. The case studies will provide insights in what is actually happening in the sector and what barriers they encounter.

Method

A semi structured interview. Topics were established on forehand and were used to lead the conversation. The structure was to first get a general understanding of where construction projects come from within the organisation and then to focus on innovation projects and struggles that they encountered in trying to change things in the organisation.

Documentation

A voice recording was taken of the conversation

Processing:

The recording is used to transcribe the parts of the interview about how a construction project emerges and the struggles that are encountered. Combining the quotes from the interviews summaries were created for both organisations on how construction projects emerge and what struggles were found in doing so.

More information abouth the interviews can be found in Appendix II.

3. The context, designing in a construction project

3.7.1 Municipality of Rotterdam

The municipality of Rotterdam is trying to shift towards a more civilian focused organisation. This in part due to changes in the "Omgevingswet" [(\Waterstaat,(2017)], This law describes that the municipalities should let civilians participate in creating value in the community. The department of "City Development" is responsible for everything that is being built in the city and is involved in the front end of the construction projects to create value for the civilians. To understand the process of how a construction project is created a senior project leader and a manager of procurement and maintenance were interviewed. The case was chosen because the municipality is trying to change their ways of creating value for their citizens.

The first thing that is mentioned upon asking about the front end of construction projects in the municipality is an explanation of the structure of the 10.000 employee organisation. It is noted that not every municipality is as big as Rotterdam. The organisation has many branches that are created with a focus on repeating maintenance needs. Asset managers are responsible for a specific part of maintenance in the city, for example the lighting of streets, maintenance of playgrounds or city safety etc. This makes that if a construction project is started there are a lot of stakeholders that have a say in what is going to be designed. All these stakeholders have a certain way of working that they need to cohere to, there are different strategies per stakeholder often focussed on maintaining the current state (maintenance). This division in tasks makes that general city strategies for innovations are difficult to implement in the daily work and are easy to dismiss since they don't provide concrete guidelines on how to do things differently.

"The visions are sometimes seen as flights of fancy"

An example that illustrates the task division in the municipality is: if you want to try to change a construction project to use less resources, all of the stakeholders need to do their part and work together to do so. This very difficult to coordinate.

"I have to try really hard if I want to add some sustainability to my project, even the question if the sewer would be a GVK or PE tube was impossible to find out".

This leads often to a feeling of working on an island within the organisation. Furthermore the amount of stakeholders creates a chaotic process with continually changing project scopes.

With regards to experiments between the municipality and the market there have been experiments with EMVI (economically most beneficial tender) tenders that were found successful. EMVI is the way how a contractor is chosen in a bid-build tender process, EMVI allows to rate contractors also on things like user participation and sustainability in the tender, besides just the cheapest solution. They were perceived successful when it came to collaboration.

"When 9 out of 10 projects are controlled by money you just get fights about money".

Working in a small team with a clear goal was a factor that made innovations in collaboration or product successful. For example, the "Half Time projects". This was a test to let the municipality, contractor and neighbourhood work together for a construction project of replacing an intersection. The integral approach this project was successful as it was on time, within budget and without complaints. Everyone praised it, yet transferring this way of working to the rest of the municipality was considered to be difficult..

"Do we learn from such a project? Well... next year maybe.. but it is again within the same group of people that say, this was so good we need to do this again"

Another innovation was a new water permeable paving. This was first tested in a new neighbourhood

in Rotterdam and improved after some of the tests went wrong. But when they figured out how to use this new way of paving it spread through the municipality quite fast. Now what used to be the innovation had become the standard practice.

Conclusion:

The municipality of Rotterdam has the ambition to do things in a different way and small experiments prove that they are working on this. One strategy is the creation of a so called "special project". A small team of actors works together to try to find an innovation that if found successful will be implemented in the conventional way of working. It turns out to be difficult to change the organisational structure for it has also has to learn and adjust itself to the innovation. This is logical since the structure is build for maintaining and not for innovation. Successful products seem to be easier to implement in the routine then new ways of working. In the light of transition management, the experiments with a new way of working should be continued with more projects until a new standardised way of working emerges.

Barriers to transition

There is still division between the municipality and the contractors in regular projects.

Experimental projects with a closer contractor relationship aren't always spread across the municipality. The organisational structure makes it difficult to spread learnings from the experiments.

Enablers to transition

The experimental projects with small teams of actors are found to be a pleasant way of working and are perceived as successful by the participants and the organisation.

Picture 4: *"The Rotterdam" building of the municipality of Rotterdam [OVG real estate (n.d.)]*

3. The context, designing in a construction project

3.7.2 Rijkswaterstaat

Rijkswaterstaat changed his organisational structure because it wanted to become more entrepreneurial. This happened in 2013 and since then the organisation is adjusting to a new way of working. To get to know how projects currently are developed at Rijkswaterstaat an advisor for purchasing strategy and innovation and an advisor on the circular economy at Rijkswaterstaat were interviewed.

The process of a construction project at Rijkswaterstaat starts with a mobility problem in the infrastructure. These problems are signalled in the so called BO-MIRT meetings. These are meetings with the minister of "infrastructure and environment" and the municipalities. During these meetings budgets are divided. With a budget and problem description defined, value engineering is used to start the project by making a plan. It sometimes happens that the result of the plan is that value should be found elsewhere then at Rijkswaterstaat. The advisor signals one major problem in this phase of process, Rijkswaterstaat sometimes is in doubt if the assignment that they acquire is the right assignment. It is difficult to go back in the project and change decisions. Eventually the minister makes the call to continue a project.

From here on there is an exploration phase that leads to a preferred solution. Within the organisation there is often chosen for the conventional solution because there is a feeling that other solutions aren't viable. This problem was encountered a lot by the advisor circular economy.

"It's very often talking about what feels right, not what is proven to be right".

The result is a narrowing of the possible solutions that leads to less freedom and less possibilities for new solutions to be used in the final solution. Especially when it comes to the circular economy this is problematic because often a solution is chosen based on conventions where an unconventional solution would be needed to make the structure ready for the circular economy.

"It's just the way that we are organised"

The specific knowledge is missing at the moment of that the decision is made. This has to do with the complexity of the projects, to come to the final preferred solution for example also a lot of stakeholders (internally and externally) need to be managed. Although value engineering is often used there sometimes still is a feeling of separation between actors in the project.

"The maintenance manager gets its money from someone else then the project manager".

The knowledge of the contractor is used more often these days in this process, but these are mainly market consultations. This enhances that the contractors don't always share all their knowledge during these consultation because of competition interests. Tendering laws demand that all information used in the pre commercial phase is shared before the tendering procedure.

The struggle for Rijkswaterstaat is also the balance between letting the market come up with a solution to a problem or to provide the solution themselves. The interests of civilians are key in this.

"A project is found to be problematic if the minister gets complaints"

For example, if you get a highway through your backyard you want to be certain that there will be a noise barrier. But the problem may be that a constructor has a better solution that now can't be used because we already settled on a noise barrier. It's a balancing act of how much innovation do you want and what risks you can handle. Trust in the market is important for Rijkswaterstaat to accept the risks. There is sometimes some distrust between Rijkswaterstaat and the market because of mistakes that happened in the past.

To keep an overview of the processes a diagram of how a projects are designed is made. The diagram (see appendix) shows all the factors that are taken into account to create a project. The part of the diagram that involves "chances and challenges' hasn't been worked out very well yet. Rijkswaterstaat doesn't know how to tackle these, but it is trying to work on that. Also sustainability is on the agenda, but it still needs to be integrated in the mind-set of the people working at Rijkswaterstaat.

There are also experimental projects at Rijkswaterstaat that try to overcome the problems with the stakeholders and client contractor relationship. Project DOEN for example is a project initiated by the Director General of Rijkswaterstaat, where contractor and client are working close together in a small team. Together they managed the stakeholders and created the solution early on in the project. Project DOEN is still running but already there are a few spin-offs of the project at the Rijksvastgoedbedrijf. [Eitjes (2018)]

Conclusion:

Finding the right solution for infrastructural problems is a very complex problem. The difficulty lies in the complexity of the project from a technical perspective as from a stakeholder perspective. This all needs to be integrated into one solution where every stakeholder is satisfied. Several problems are mentioned that make this difficult: The separation between Rijkswaterstaat and the contractors, although there are market consultations this is found difficult. Sometimes decisions are made to soon in the project shutting the door for innovative new solutions to be tested (premature convergence). A risk of public opinion that can shift and cause delays in the project, if a project fails the Dutch citizens can get angry. Experimental projects like project DOEN are trying to overcome these problems by having a small team and an early collaboration with a contractor. This experiment is still running but it is already copied in other government organisations.

Barriers to transition

The organisation of Rijkswaterstaat makes it difficult to get. al.l the stakeholders and the right information together, even when using value engineering.

Decisions are often based on traditional frames.
There are high risks regarding dissatisfaction of Dutch citizens, making failing not an option.

Enablers to transition

Experimental projects that are initiated top down seem to be successful in changing the relationship between client and contractor to together work on a construction project.

Picture 5 *Head-office of Rijkswaterstaat [Linders (n.d.)]*

3. The context, designing in a construction project

3.8 Concluding about the processes and context

The current way of working in construction projects creates barriers and enablers for transition in the construction sector. The following barriers were found.

Separation between client and contractor makes it difficult to validate new innovative solutions in the early phases of construction projects.
This is the most important barrier when it comes to creating innovative solutions. If in the design process it isn't possible to make quick iterations by validating with all the stakeholders it's very difficult to create an effective design. Tendering laws does allow for early collaboration, but these forms of tendering aren't used very often.

There is not much experience in early involvement collaborative design
There is an ambition to bring contractor and client closer together. Yet this ambition isn't the standard and there are mostly just "special cases" where cooperation occurs between client and contractor in the early phases of a construction project. This means that people working in the sector are not familiar with early involvement collaborative design teams. This might lead to a lot of practical problems. (division of tasks, planning, responsibility etc)

Design decisions are often based on conventional frames
The case studies and literature show that often there is chosen for a conventional frame in finding solutions to design problems which had led to premature convergences.

There are experienced and inexperienced clients
Transition is about changes over long periods of time by creating coalitions of organisations and experiments. In the case of an inexperienced client it is difficult to let him join a coalition since there is no strategic advantage for him to do so. On the other hand, inexperienced clients might be more inclined to create experimental construction projects since it might have other strategic advantages (like Circl).

Large experienced client organisations aren't organised for collaborative early involvement design projects
Large experience client organisations that create the design are very fragmented. This leads to a lot of different stakeholders that are optimised for one part of the process and that are difficult to bring together.

If construction projects become more extensive the risks for the stakeholders involved also become larger. This also demands higher levels of certainty which is difficult to provide in an experimental project.
Large infrastructure projects can cost billions of Euro's. If such a project fails, this could lead to bankruptcy of the clients and contractors involved.

Enablers to transition in the sector were the following:

There are tendering structures and contracts possible to work together with constructors early on in the design process.
Although commonly thought to be impossible it is actually possible to work together early on in the design process.

There are initiatives to bring client and contractor closer together
These initiatives like the Marktvisie and Rondom GWW can spark coalitions between client and contractors in order to start together an experimental project.

Experimental projects with small teams of actors are found to be successful creating innovations.
Experimental projects that are initiated top down seem to be successful in changing the relationship between client and contractor to work together on a construction project. Both at the municipality of Rotterdam and at Rijkswaterstaat similar teams proved to be successful

Value engineering provides a tested systematic approach to design in multidisciplinary teams.
This provides a method on a multidisciplinary design approach that proves to be useful in construction projects.

4. The Design Challenge

4. The Design Challenge

4.1 To a solution

A literature research on transition has provided a desired situation for a transition in the construction sector. Literature research on the design process of a construction project together with cases studies provided barriers that prevent us from reaching this desired situation. The design challenge is found in overcoming the barriers in order to reach the desired situation.

4.2 The desired situation

The Bouwagenda wants to transition the sector to a circular system by 2050. It wants to achieve this not by using an evolutionary way, but a revolutionary one. A strategy on transition is found in transition management. Transition management creates coalitions of actors with the same goals that execute experimental projects. The application of a multidisciplinary design approach in these experimental projects can improve the success of the experimental project.

The desired situation is:
A construction sector that has formed coalitions of actors with the same goals. Within these coalitions experimental construction projects are initiated that have a multidisciplinary design approach. This leads to unconventional solutions that are sustainable. These unconventional solutions are the example projects for others in the sector creating a new dominant design.

4.3 Problematic situations

The following problematic situations can be found that prevents the desired situation to occur.

Separation between client and contractor
This separation is the most important barrier when it comes to creating unconventional innovative solutions. This barrier prevents quick iterations by validating the concepts with all stakeholders. As these iterations are essential in the process of creating an effective innovative design. It is clear that the lack of iteration opportunities hamper this process or even makes it impossible to create an effective innovative design. Tendering laws and contracts do allow for early collaboration, but these forms of tendering aren't used very often.

There is an almost lack of experience in early involvement collaborative design
The separation between client and contractor resulted also in a minimal experience with collaborative design in this early phase.. There are ambitions to bring contractor and client closer together. However these ambitions aren't yet standardized. Only in 'special cases' you can see this form of cooperation applied in the design process.

Design decisions are often based on conventional frames
The case studies and literature show that often a conventional frame is used in finding solutions to design problems. This has often lead to premature convergences.

Inexperienced clients may be potential participators in coalition forming.
A transition is about changes over long periods of time by creating coalitions of organisations that create experiments. In the case of an inexperienced client it is difficult to let him join a coalition since there is no strategic advantage for him to do so, because in general they only participate in a single project. On the other hand, inexperienced clients might be more inclined to create experimental construction projects since it might offer other strategic advantages. (like circl was for ABN AMRO)

4. The Design Challenge

Large experience client organisations aren't organised for collaborative early involvement design projects
Large experience client organisations that create the design are very fragmented. Because of this fragmentation a lot of different stakeholders are involved, that are optimized per part of the process. Therefore it is difficult to bring them together.

If construction projects become larger the risks for the stakeholders involved also becomes larger
This demands higher levels of certainty. This certainty is more difficult to provide in an experimental project. Large infrastructure projects can cost billions or Euro's. If such a project fails, this could lead to bankruptcy of the clients and contractors involved.

4.4 The Design Challenge

Provide the Bouwagenda a strategy on creating innovative construction projects, that have the means of starting a sustainable transition in the construction sector.

Strategy for the Bouwagenda
The Bouwagenda needs to know what it can do today to start the transition towards a sustainable sector. To its opinion a revolution is needed which means that the barriers need to be overcome fast. The barriers and enablers are recognised by the case studies and literature and those need to be taken into account when creating this strategy.

Creating innovative construction projects
Transition theory shows that in order to actually make a transition happen, innovative solutions are needed that break with the conventional way of working. If these solutions are performing well they will break with the conventions and become the new convention. A multidisciplinary design strategy for innovative construction projects is found to be a promising strategy to create the unconventional solutions needed for a transition. Within the current way of working there is little chance of a multidisciplinary design strategy to be integrated. So called "special projects" need to be created that allow for this different way of working to be used.

The means of starting a sustainable transition
To execute the multidisciplinary design strategy know how about the multidisciplinary design approach is needed and implemented in the project.

5. Designing, finding a frame

5. Designing, finding a frame

5.1 Introduction

Finding a solution for the design challenge a frame needs to be created that captures the value to be used. To find a frame and to better understand what is meant by innovative construction projects that work together in a multidisciplinary team several of these projects were visited. That were either innovative or had a close collaboration between client and contractor.

5.2 Projects Visited

The following projects were visited

- Municipality of Amsterdam "finding solutions for replacing the quay walls" One of the first times that an innovation partnership tender structure is used in the Netherlands. This allows for early involvement of the market to create innovative solutions.
- Project DOEN. The first time that Rijkswaterstaat involved a contractor early on in the process. This project is seen as the Marktvisie in practice.
- Circl. The first 100% circular build pavilion for ABN AMRO.

More information abouth the interviews can be found in Appendix III.

5.2.1.Municipality of Amsterdam

The municipality of Amsterdam is one of the first to make use of a new way of tendering called the innovation partnership. This new way of tendering allows governments to purchase products that aren't yet available on the market and allows for market and governments to work together in designing the new product [Piannoo (2016)]. In this case the municipality of Amsterdam was looking for a partner that could help them with replacing the 500 km of quay walls that define the city of Amsterdam. This is not an easy task since the quay walls are in the historic city centre of Amsterdam. The municipality wanted a new solution that could: speed up the process of replacing the quay walls, lengthen the life expectancy of the quay walls and would reduce nuisance for the surroundings [Gemeente Amsterdam (2018)]. To get to know more about the project an interview was conducted with one member of the project team from the Municipality. At the time they were planning their first session together with the market in a so called market consultation. The process of the innovation partnership starts with a lot of different parties, diverging from start-ups, construction companies and other people of interest that are funnelled (figure 22) to three parties that actually will tender for a pilot.

Talking about the procedure there are some doubts mentioned. They have to compare all kinds of different solutions in one tender, that makes it difficult to choose if there aren't some limitations. In

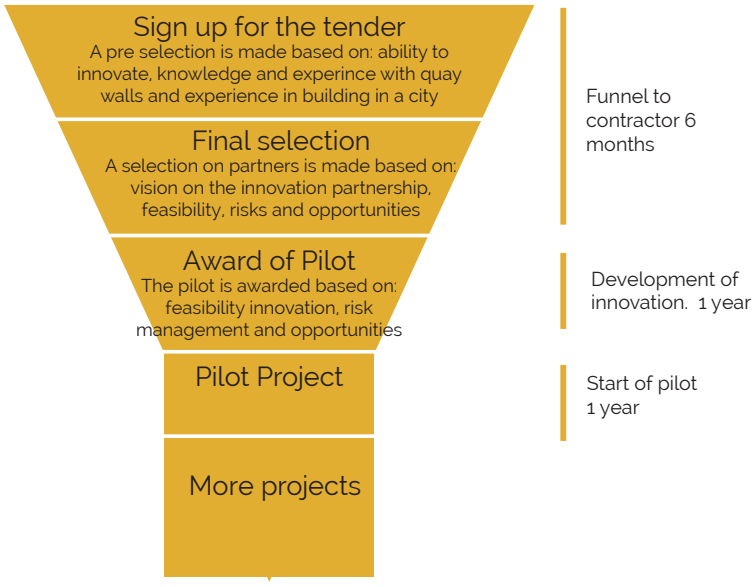


Figure 22: *Tender funnel used for the Innovation Partnership [Amsterdam (2018)]*

their opinion the project is still defined too general and should be more focussed. As a result, things like sustainability are starting to fade out of the tender request because of the perceived complexity of the problem. Also the team does not expect a solution that will attain all of their problems but that only partial solutions will be handed out. There are many ignorances with respect to finding solutions and how to tackle such a process. This leads to uncertainty about the process.

The project team, is a young and ambitious team that is backed up by a team of experts for some "realism" as they call it. These experts are experienced people from the municipality.
To get an understanding of how the market consultations went the documentation of the day was examined. From this documentation it became clear that de market demanded for more clarity on the approach to the tender. For example there was a discussion about if there should be tendered based on collaboration or based on concrete solutions. Innovators mention that they want to tender on solutions and construction companies like to tender on collaboration. Looking at the tender strategy that was published online [Gemeente Amsterdam (2018)] it is seen how a funnel is created to come to a pilot project.

Concluding

Creating value in the innovation partnership tender is perceived as difficult and uncertain. It's a new process and a clear idea or structure on how innovations are created is missing. There is an enthusiastic team that believes in the new way of working but there is a lot of doubt whether the final product is actually suitable. This doubt translates itself in a narrowing of the scope, for example sustainability issues are taken out of the boundary conditions.

Learnings

Creating a small team of enthusiastic people is important to actually make steps towards a different way of working. It is noticed that the inexperience of the team in working with open problems created doubt and uncertainty. This led to a troubled vision and an unclear process for the market. A design coach could help the team navigating in this openness by providing tools or instruments to help them managing the process. This would also provide more clarity for the market.

Picture 6 *Poster to promote the new innovation partnership [Gemeente Amsterdam (2018)]*

5. Designing, finding a frame

5.2.2 Project DOEN

Project DOEN is an experiment of Rijkswaterstaat in early involvement of the market in the construction process. The project was initiated by the director general of Rijkswaterstaat Jan Hendrik Dronkers. The idea was to create projects that would be without prejudices on rules and relationships and that would be all about the customer. The aim was a good collaboration between client and contractor, a happy customer and applying the basic principle money for fair work. The renovation or replacement of Nijkerkerbrug was chosen as a pilot project. To get acquainted with this project an "open day" was visited. This "open day" was meant for spreading experiences and knowledge about the project to the market. The programme consisted of presentations with discussions in several small groups. There were about 50 persons present. The following description is based on notes from this meeting and information available from www.doen.nu They can be found in the attachment

The name project DOEN originated from the director general of Rijkswaterstaat. He wanted to start a project that brought client and contractor relationships closer together.
Between 2013 and 2015 preparations were made to actually realise the project and from within Rijkswaterstaat a team of young enthusiastic people assigned to the challenge. The relatively inexperienced team gathered a team of "critics and inspiration" around itself that they could use if they needed knowledge about certain things.

To find a collaboration partner a competitive dialogue tender was used. This is a "special" form of tendering that does not relate to price. The funnel that was used to come to a contract and a collaboration partner can be seen in figure 23. This tender funnel created a project team of 5 people from Rijkswaterstaat and 5 people from the constructor. At first the task division between the members of the team was at very open. Teamwise they started the process defining who the end user would be. From there ideas needed to be developed. Did the bridge needed to be replaced or renewed or should there be another solution? The early phases of the design process were considered very vague and it was sometimes difficult to uncover the backgrounds of the demands of the stakeholders involved. Also stakeholders from the region like the province and municipality wanted a lot of certainty in the project. This limited the freedom in the design. It was remarkable that sustainability wasn't a demand of the clients. Furthermore, the team members felt pressured in this phase because they had to learn a lot of new things in a really short period of time. Eventually they managed to come up with a solution. The decisions were made to restore the bridge in a different kind of way, by strengthening the bridge from the underside so nuisance for the surroundings were kept to a minimum. In the process towards the actual realisation of the project the tasks within the team became more divided into the roles of client and the roles of contractors, although they still felt like one team. Continuous reflection on the process led to a lot of learnings from the process that were documented and shared during the "open day". Although the project isn't finished yet (the bridge is still under construction) the team is very positive about the project and the collaboration. Because of this positive experience the same approach is applied in other projects as well The Rijksvastgoedbedrijf is planning a second project DOEN in the station area of Arnhem.

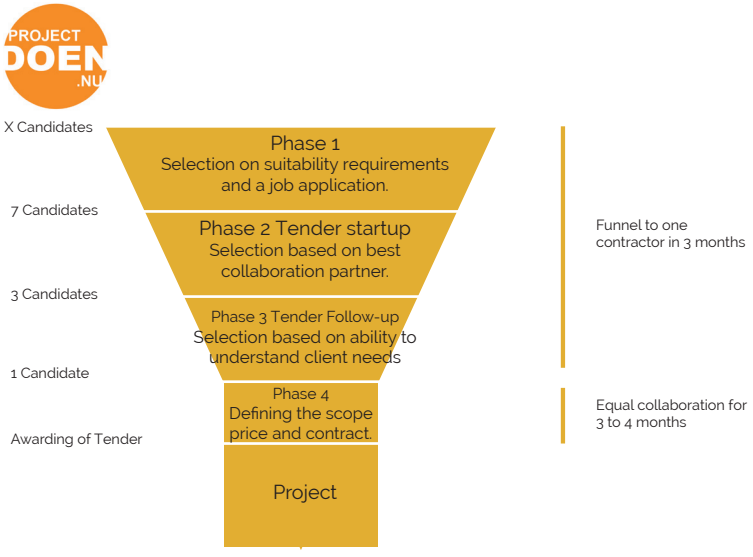


Figure 23: *Tender funnel used by project DOEN [Project team DOEN (2015)]*

Conclusion

Project DOEN is a great example of an experimental project that was initiated out of top down commitment for the goals and bottom up freedom of process. The front end of the construction project was found to be difficult and vague but the team managed to come up with a solution. This solution is not necessarily really innovative, but this is in part due to demands from the stakeholders involved and the goals set out for this project.

Learnings

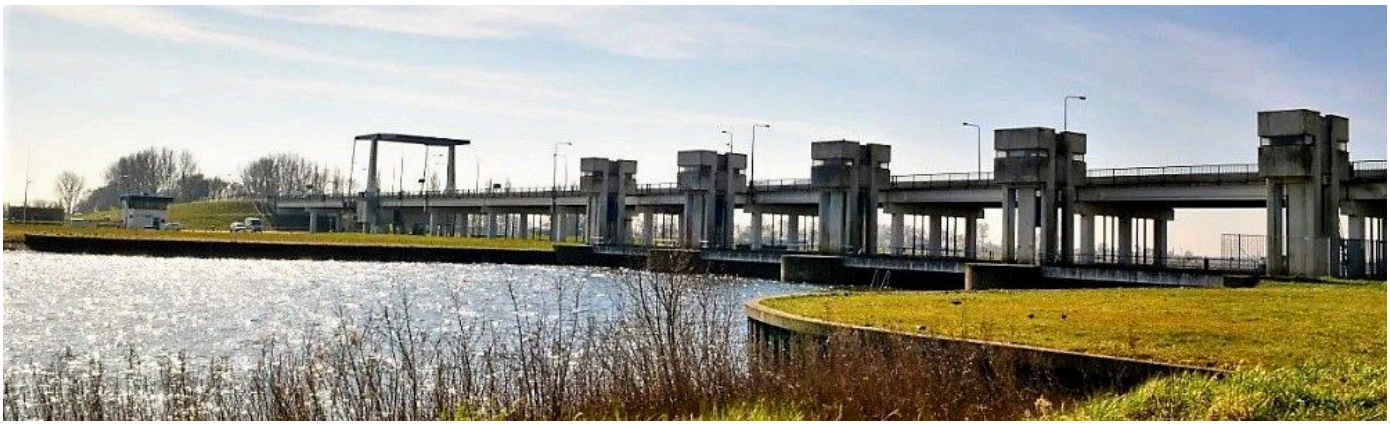
A small team of young enthusiastic people that believe in the cause is really important. This team needs to be supported by their organisations in the way that they can organise themselves.

They should be able to break with the organisational structure. Project DOEN is perceived as a success and is copied in other projects, showing already a possible start of a transition.

Stakeholder are also important to be aligned in creating an innovative solution. If they are not open to try new things, it's difficult to innovate.

It is possible to select a construction partner early on in the process and define the solution that needs to be created together with the client.

Picture 7 *Project team of project DOEN [Project team DOEN (2015)]*



Picture 8: *Nijkerker bridge [Project team DOEN (2015)]*

5. Designing, finding a frame

5.2.3 Circl

Circl is the world's first circular build pavilion. The client was ABN-AMRO a large bank in the Netherlands. To get more information about the pavilion an interview was taken with the TU Delft advisor in the design team responsible for making the building circular build.

The TU Delft advisor got involved in the project as a student. There was an assignment to make an assessment on the circularity of the building that ABN-AMRO wanted to build. This report ended up at the management board of ABN-AMRO and they decided to change the building completely and redesign the building from the ground up to be circular build. This decision was made because it was more in line with their new business strategy. A team was assembled with people from ABN-AMRO (client), Architects (advisor), BAM (contractor) and the TU Delft (advisor on circular design).

The whole building needed to be redesigned taking into account circular building principles. This wasn't always easy and the people from ABN-AMRO and the TU Delft needed to collaborate closely on making BAM actually design in this new way. It was found that especially older people working at BAM were having trouble adjusting to the new way of designing. The vision often needed to be enforced as sometimes other solutions were demanded from BAM. Internal stakeholder management was a crucial factor in the success of the project. During the project the advisor on circular economy in the design team had created a personal manual for the team members on how to approach persons who were not circular based and make them change their ideas. Eventually the building was created and only the interior needed to be selected. This was after the advisor of the TU Delft had left and according to him you can really see it. The people from interior had a strong idea of what the interior should be about and it doesn't fit the building. They weren't managed to cohere to the whole.

During the process team members mostly encountered cultural barriers. People working at the contractor found it difficult to work in a different way and having to design things using new working principles. This often led to resistance. There was a shared vision but not all the people designing the building fully understood or didn't want to understand the vision

Conclusion

Creating a circular build pavilion is possible. It takes a strong vision about what is needed and people that are dedicated to making it happen. The strategic vision of ABN-AMRO was important to create this team. This made it possible to experiment with new ways of constructing.

Learnings

It's possible to create a circular building, but you have to take it into consideration from the start.

Top down support for the vision is important to be able to steer towards this vision.

There is a cultural barrier where people find it difficult to design things in a different way. This can lead to resistance.

Picture 9: *Circl [Cie(n.d.)]*

5.3 The Frame

From the interviews and from the meetings with people working in experimental projects, we may conclude that a strong team with a clear supported vision is important. This team should have the courage and drive to do things differently and is supported by their organisations.

These teams are similar to competitive student innovation teams. In these teams, students from different faculties organise themselves around a central challenge. For some this is creating the fastest solar powered boat (TU Delft Solar Boat team) or car (Nuon Solar Team) and for others a sustainable solution energy neutral housing (pret a loger). These teams come together based on the notion of a challenge and attract sponsors and suppliers for their project. These sponsors and suppliers all agree with the goals of the project and the challenge that they want to overcome. The team works really hard to find a solution to the challenge and are willing to go the extra mile.

The frame of the competition that attracts people to organise themselves to work for a clear goal together with the experience from the experimental projects is used as a guidance to creating a strategy for transition.

Picture 10: *Christening of the TU Delft Solar Boat [Streekbladzoetermeer (2018)]*

Picture 11: *Pret a Loger, a second layer on top of a house [Inhabitat (2014)]*

Picture 12: *The Nuon Solar Team [Nuon solar team (n.d.)]*

Picture 13: *The Dutch Hyperloop team [ANP (n.d.)]*

6. The Solution, The National Bouwagenda Challenges

6. The solution: The National Bouwagenda Challenges

For the construction sector to transition towards a sustainable sector, innovative construction projects are needed that break with the conventional way of working. A strategy of creating "challenges", makes that a clear vision is articulated that encourages organisations in the sector to actually take action and align based on a common goal that breaks with the convention.

The Taskforce of the Bouwagenda can manage the transition by creating challenges based on the already defined road-maps and by directing the design processes of solving the challenges. These design processes are key in the creation of innovative solutions. By offering coordinators to manage this not often used process, chances of successful innovation will rise.

The strategy consist out of two parts. A management tool for the Bouwagenda to influence the transition process, and a design process to create innovative solutions. Together they form the strategy to transition in the construction sector.

Management Cycle

The management cycle for the Bouwagenda is inspired by the transition management cycle of Loorbach (2009). It is a cyclical process model since a linear approach to transition is found to be insufficient [Kemp (2007)]. The cycle visualizes the need to connect activities and represents some logical connections but does not suggest a strict sequential order of the activities. The cycle consists out of the following components. (see figure 24) 1. Reflect on the goals set in the road-maps in relation to current experimental projects that are happening in the sector. 2. Formulate a challenge for the roadmap and create a network of organisations that support the challenge. 3. Derive experimental projects from the network of organisations. 4. Carry out the experiments and support spin-offs from the experiments.

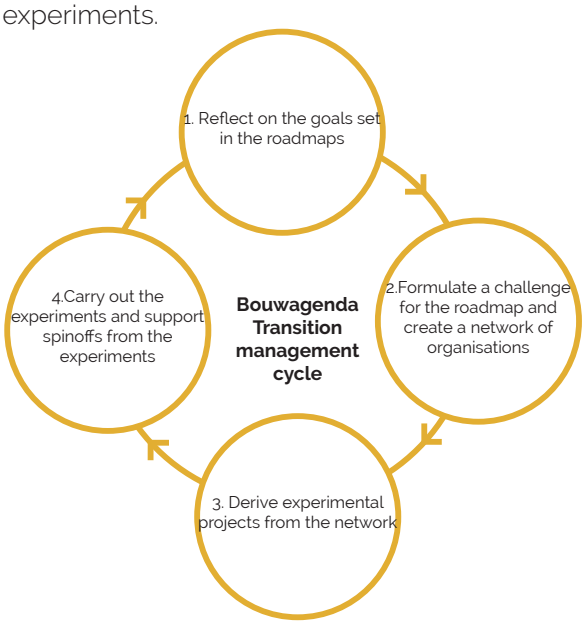
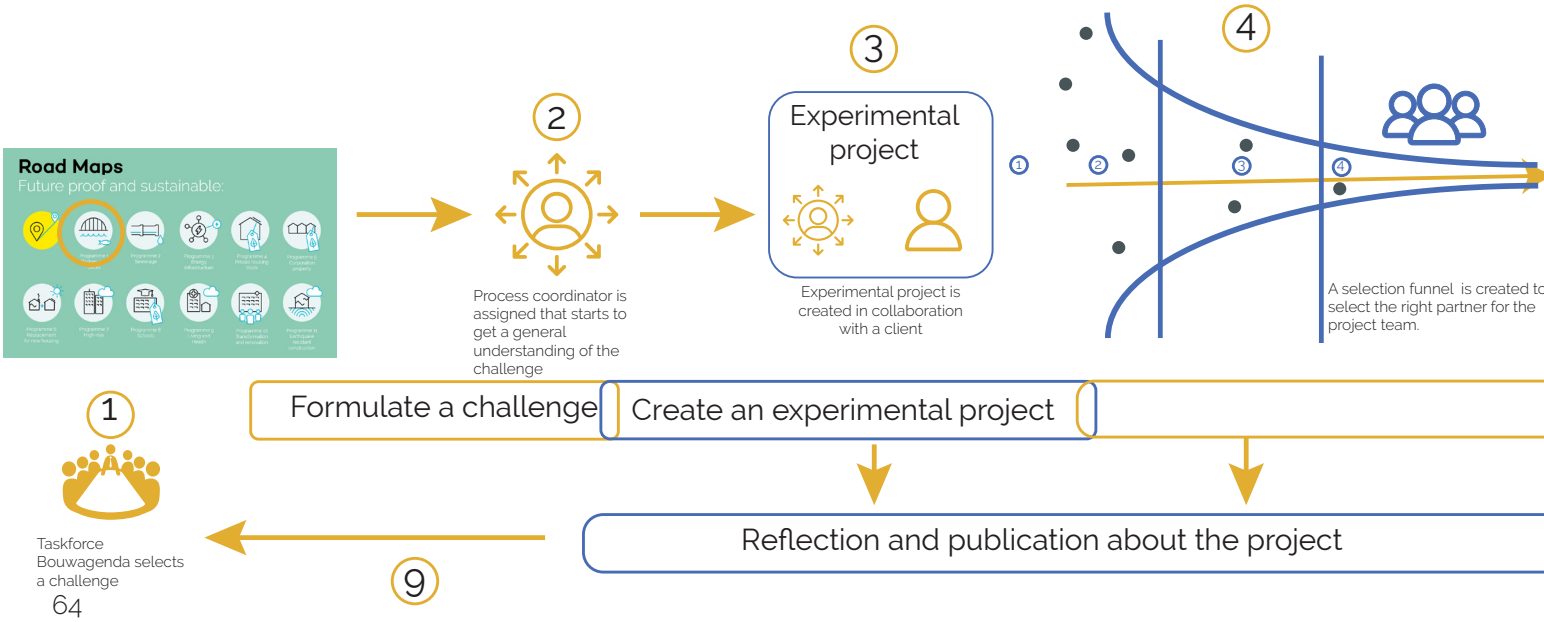


Figure 24: *Management tool*



The process

The success of the transition derives from a successful outcome of the design process as seen in chapter 2. Figure 25 shows the new proposed process for experimental construction projects and its interaction with the management cycle. The numbers correspond with the following sub-chapters.

1.Formulating a challenge

A concrete challenge needs to be formulated. The road-maps have structured the ambitions of the Bouwagenda and provide inspiration on creating the challenge. The challenge should be as concrete as possible. That makes it easier to find partners who are really willing to take part in the actual project.

Examples of what challenges could be:

- Create a scalable circular build lock
- Create a fast and circular way of replacing sewers
- Create a circular build affordable house in urban areas.
- Create a circular build bridge that is produced for the same cost as a regular bridge.

2. Assigning a process coordinator

Once a challenge is created a process coordinator is assigned that is responsible for the challenge. This process coordinator can be someone from the Bouwagenda programme committee but it can also be an external consultant. It is important that he or she is independent of the clients and contractor. The process coordinator should have experience in facilitating the creation of innovative solutions with a multidisciplinary team and has some experience working in the construction sector. This is an important feature since there is not much experience in the sector regarding the creation of innovative solutions in multidisciplinary teams.

When the process coordinator starts it's his or hers task to get a basic understanding of the challenge and to create a network of actors, clients and contractors that are willing to work on the challenge. Pre commercial sessions at the Bouwcampus can be used for this, examples of this are the Circular Infra Community or the Dutch Coastline Challenge [Bouwcampus (2018)]. The following questions need to be answered with respect to:

- The stakeholders : who are possible clients and who are possible contractors?
- The general overview of the size and specifics of the challenge: how many of the products are there, what are the general costs etc.
- The solution of the challenge: what makes the challenge so difficult to solve
- Example challenges: what are examples of projects that are already in line with the challenge.

In this way the process coordinator can get an overview of the challenge and can find actors that

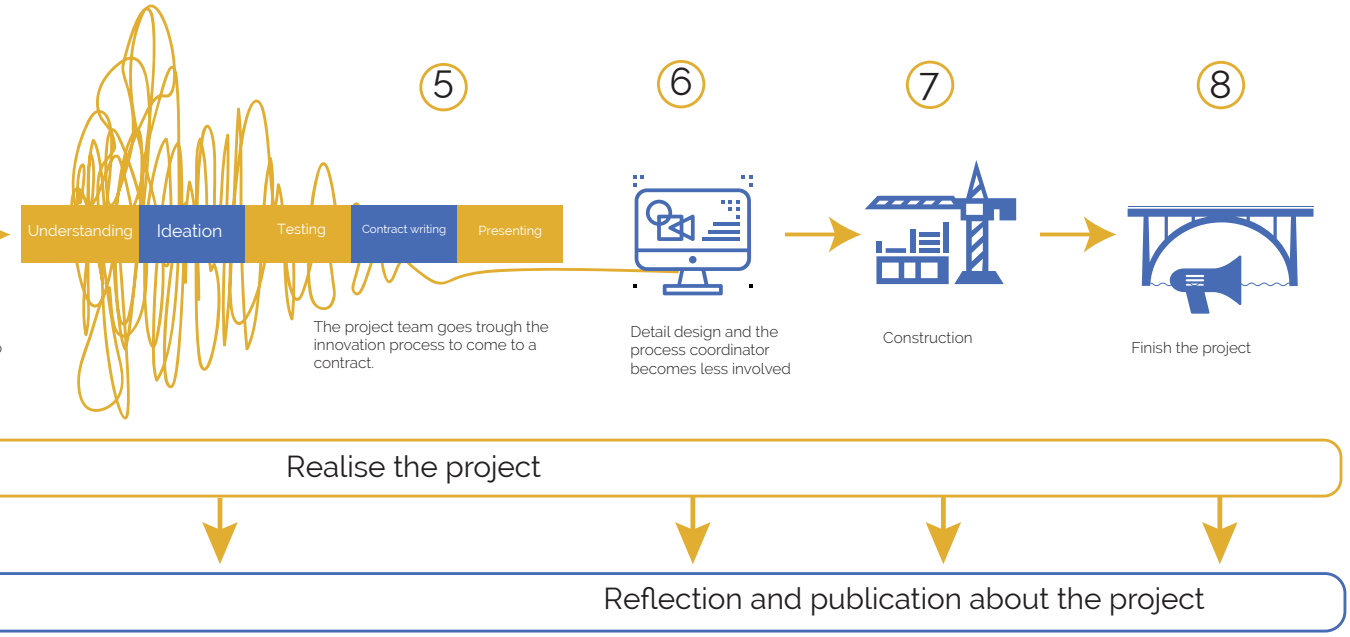


Figure 25: *Innovation process*

6. The solution: The National Bouwagenda Challenges

are willing to experiment within the challenge.
For example, in the case of creating a circular lock, the process coordinator identifies the amount and sizes of the locks in the Netherlands. The process coordinator will talk to several lock builders and experts on circular economy about the difficulties on making a circular lock. Also an event at the Bouwcampus will be organised to bring together market, experts and governments. All the findings are published on the Bouwagenda website and will provide an overview of the challenge.

3.Creating an experiment project

With a general understanding of the problem a client willing to take on the challenge is looked for. This can be municipalities and provinces, but also private parties that want to create something unique and are willing to try new things. The conditions for participating are a willingness to share information with the sector and a willingness to accept the risks of creating something new. If multiple clients want to participate a series can be created of similar projects and the risks can be shared. Once the project is chosen the challenge becomes concrete. The ideal situation is that many clients want to participate and a programme of multiple projects can be started. However, it's important to be aware that such a large programmes can have a slow down effect on innovations. A lot of stakeholders can complicate the process, design freedom for the project team needs to be guaranteed to allow them to come up with the a solution that is not conventional. If there are enough clients that are willing to take a risk, multiple teams can be started simultaneously to try out different solutions to the challenge.

For example, in the case of creating a circular lock the challenge becomes: create a circular lock for the "Keersluis Boezemgemaal Gouda". If more clients have indicated that they also want to participate the challenge can be specified to: create a circular lock for the "keersluis Boezemgemaal Gouda" that will become the example lock for similar locks in the area or in the Netherlands. This also increases the willingness for contractors to participate in such programme's since it will be interesting for future business.

4. Selecting a collaboration partner

Once a specific project is decided a collaboration partner needs to be chosen. This partner needs to be capable of creating innovative solutions in collaboration with the client and needs to be capable of actually realising the project. In the selection of a collaboration partners, public institutions should work on the basis of a tender procedure that is conform the European tendering laws. This allows for a fair choosing of a collaboration partner. But private clients are also advised to go through a selection process since it will improve the chance of finding the right collaboration partner.

Selecting a collaboration partner or consortium of partners should occur based on the following criteria:

-Ability complete the challenge
- Does the partner have experience in creating solutions that break with conventions? (reference projects)
- Does the partner have experience in creating the solution? (reference projects about creating a lock)
- Does the partner have in-house knowledge about the challenge? (circular economy experts, digital technology experts etc)

-Ability to collaborate
- Is the partner able to collaborate with the client on equality and without prejudice?
- Is the partner able to create a full time team for the project?

-Ability of the team to design
- Is the partner team proficient in the design expertise?
- Is the partner team able to understand the needs of the client and stakeholders?

Note that a partner is not chosen based on their design ideas about the challenge. This would limit the amount of solutions before sufficient interaction between client and contractor.

Depending on the challenge a competitive dialogue tender structure or an innovation partnership tender structure can be used in order to find the right

partner. These structures are approved according to EU tendering laws. These structures both contain a funnel that can be used to find the right collaboration partner. The following selection funnel can be used to select the best collaboration partner. (This funnel figure 26 is inspired by the funnel of project DOEN)

Phase 1. Start with a public tender announcement and a presentation of the challenge. Contractors can meet each other and create collaborations to meet the requirements. Also stimulate consortia between contractors by facilitating a list of interested organisations and facilitate meet-ups to discuss the challenge.

Phase 2. Contractors can apply (in consortia if wanted) by writing an application letter which will be rated via on criteria that are published by the client. This letter should contain a motivation on why they want to participate in this tender and why they think they can come up with innovative solutions. Furthermore, reference projects and capabilities need to be indicated. A selection is made based on a multi criteria analysis. 5 contractors are selected.

Phase 3. The 5 contractors need to be reviewed on collaboration with the client. This can be done via a collaboration assessment. The teams of the contractor need to perform a collaboration assignment that can be assessed by a team of independent observers. These will select the best 3 contractors

Phase 4. The best 3 contracts are going to be selected based on their ability of the team to come to an effective design. In order to test this ability a case study is performed with the people that are actually going to work in the project if it is awarded. The team is judged based on their ability to integrate.

- the ideas of client and contractor about the project;
- the internal operational logic of products (the engineering)
- the desire and ability of stakeholders to use product.

At the end of the funnel there is a pre-award for the partner that is most capable of starting the design process. If the contract is signed at the end of the innovation phase the contractor will be paid for the innovation phase. In this way motivating both parties to come to a solution.

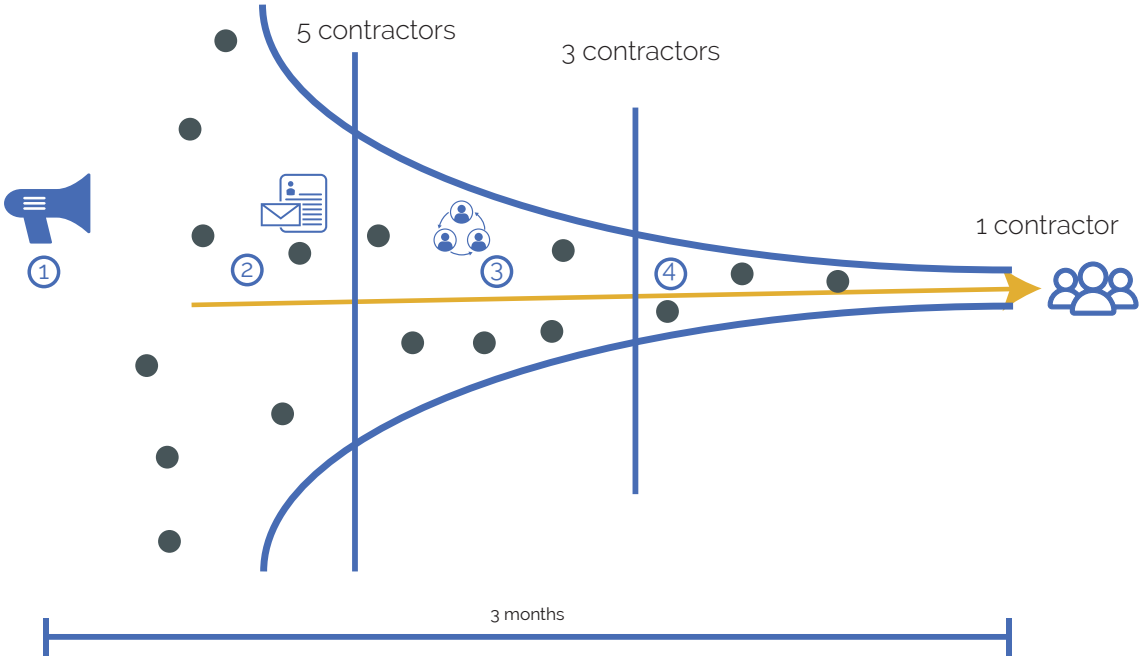


Figure 26: *Selection funnel*

6. The solution: The National Bouwagenda Challenges

5. The innovation process

When a collaboration partner is chosen, the multidisiplinary design approach will start. The process consists out of five phases based on the steps in the design process of reflection, analysis, synthesis and experience. These phases form the framework for the innovation design process, structuring the activities needed to create an innovative solution. Inspiration for the activities within the process steps are taken from different design methods:

- Design Thinking [Brown (2009], because of the increasing popularity of the use of this method in other sectors for creating innovative solutions, and the importance of empathy (human perspective) in this method.
- ViP [Hekkert et. al. (2011)], because it offers a method on envisioning the future and bringing future visions back to a product. (Creating a vision in the reflection part of the process)
- Strategic Design [Calabretta et. al. (2016)], because of the practical design practices to facilitate a strategic design process, thereby taking also business into account.
- Systems Engineering V model [Cadle et. all. (2008)], because of the familiarity of engineers to work with the method. Systems engineering offers a way of breaking up the problem to a system, subsystems, elements and components, thereby taking technology structures into account.
- Value Engineering [Kelly et. Al. (2015)], because of the found successes in the case studies to combine business and technology perspectives.

The process coordinator can also use his or her experience in designing innovative solutions in multidisciplinary teams to provide the team with tools that help the team to go through the phases. By sharing tools between different process coordinators a toolbox can be created consisting of tools that are proven to be useful. This can improve the efficiency innovation process . Creating a centralised toolbox that is also publicly available allows companies to also start working on innovative solutions themselves.
The following phases are defined (see figure 27):

- Understand (Reflection and analysis), creating a shared understanding and vision of the project and defining a scope for the project.
- Ideate (synthesis), a wide collection of ideas is generated based on the shared vision. And a selection is made based of the best ideas.
- Testing (experience and synthesis), the ideas are calculated, tested and restructured.
- Contracting (experience), the contract is written with the team of contractor and client via an open book structure.
- Presenting (reflection), the design and contract are presented to the sector

1. Understanding

This phase is about creating an understanding of the problem and the challenge and to set a vision and scope for the project.

Understanding the past
To be able to create a design for the future a shared understanding of the current situation is needed. In this way the team members are aligned into what the current challenge is. The goal is to find changing patterns or trends regarding the product, interaction and context. To do this the team visits the location, interviews the people using the product and interview stakeholders of the project. These patterns and changes are discussed in the project team and are documented. This creates a shared understanding of the current situation.

Understanding the future
The project is created to challenge the future of a sustainable construction sector. This means that a shared understanding and vision about this future is needed. To do this the team can get a crash course on circular economy, visit already circular constructed buildings, visit technological companies etc. The goal is to find trends and create a shared understanding about what the challenge means.

Making a statement
The shared understanding of the past and the shared understanding of the future allows the team to create a design statement for the project. The statement is how the team sees the challenge. This statement should not be to generic since it will be hard to find a solution and not too specific since it will then narrow the range for solutions. It's the task of the process coordinator to help the team define a statement based on experience in other design projects. Creating a statement is a group activity since everyone in the team should agree on the statement.

2. Ideation
The statement provides the basis for the ideation phase. Depending on results the pre-commercial sessions early ideas should be gathered by the process coordinator. In this way also innovative development in the sector can be used in the ideation session. The ideation phase is about creating as many as possible ideas on the challenge. These ideas can be sub systems or products but they can also be integral systems. The idea is to create concepts from the integration of the products, subsystems and systems. These concepts can be combined until the group finds concepts that are found interesting to proceed with. The process coordinator is responsible to make sure that there is a diversity of ideas and that people don't fall back into conventional patterns. Different creative techniques can be used based on the challenge and the group, it's the task of the process coordinator to choose the right tools based on his experience.

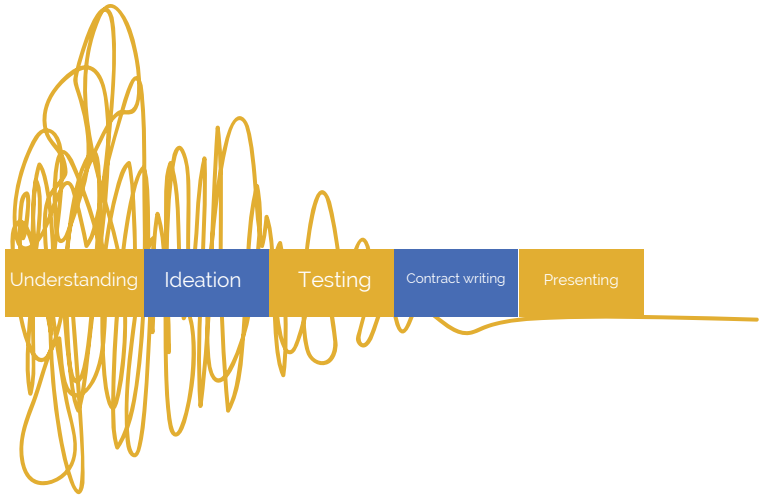


Figure 27: The innovation process

3. Testing
In the testing phase the most promising concepts are de-constructed using a systems engineering approach. The most important assumptions are identified and a plan is made to validate these assumptions. Prototyping, computer simulations, renderings, user testing techniques and expert interviews can be used to validate the most important assumptions. The validations are discussed by the team and adjustments or combinations to the concepts are made. More concrete concepts can be validated with stakeholders outside of the team, if there is too much conflict between the stakeholder a value engineering workshop can be used to align stakeholders. At the end of the testing phase a concept is created that is agreed upon by all relevant stakeholders.

4. Contract writing
A formal contract needs to be written and signed. Risks are identified and a price is agreed upon. By writing the contract together the client and contractor can come to a fair contract. An open book approach for the costs is important to also create a contract that is based on trust (see project DOEN). The process coordinator can help in this process by helping the team finding experience in writing a contract. Furthermore the process coordinator can be the neutral party to facilitate negotiations between parties if discussions would arise (the goal is off course to not having discussion about the contract).

5. Presenting
This phase is all about showing the sector what is possible. The concept design of the project is presented to the market and the contract between client and contractor is signed. The launch of the project should be as public as possible preferable attaining as much media as possible. It creates a strong signal to the sector that changes are happening. Furthermore, the design decisions are documented and published on the Bouwagenda website. Especially information found in the testing phase can be used other projects that don't have the time to validate all assumptions. In this way already the project can inspire others to take action to adjust their designs to be more sustainable.

In chapter 7 an example case has been elaborated.

6. The solution: The National Bouwagenda Challenges

6. Detail design
The process coordinator will become less involved after the signing of the contract and the client and contractor will have to further detail the design until it can be build. A system engineering approach can be used to create the detail design. The shared vision about the project should lead to sub design decisions that are in line with each other. Once every few weeks the process coordinator can drop by to see how things go and mediate if there might be discussions about the direction of the project. Sometimes if a team works on the details too much the vision can become blurred. Practical design stories on for example creating circular sub parts are also gathered by the process coordinator and presented on the website of the Bouwagenda. This can help other projects to overcome similar challenges.

7.Construction
The construction is started. Continuous evaluation is still happening, learnings are shared on the project page of the Bouwagenda.

8.Delivery
When the project is finished there is a public opening of the project. The main learnings from the projects are presented and people from the sector can ask questions to the team. These events can also inspire clients to also try new forms of collaboration to create similar results.

9.Evaluation and sharing
Evaluation and knowledge sharing is crucial in the experimental project. The following information is interesting:

- Discovered insights from the testing phase. These insights can be shared and used in other similar projects.
- Information on design decisions, from the concept design to the detail design. An reasoning behind the design decisions can help designers in other projects that might have the same goals to improve design decisions.
- The innovation process, which tools are used and how effective these are. This can improve the design process for other challenges.
- The division of tasks in the detail design phase and construction phase. This provides insights for the decisions makers of organisations to redesign their organisational structure.

Evaluation by the Bouwagenda is also important. They have to evaluate how the challenge is affecting the sector. It might be that other problems are found in the design process that can't be solved with knowledge currently available. Further research on the topic might be needed, the Bouwagenda can stimulate knowledge institutes to generate knowledge on certain topics.

To make the sharing of information available for everyone in the sector a website is created that shares the information created with the challenges.

Process coordinator
The process coordinator is responsible for the process of creating solutions that are innovative and are in line with the ambitions of the Bouwagenda. He or she can be seen as the person who guards the process and who guards the long term strategic goals of the challenge. Responsibilities for the process coordinator are:

- Facilitating the forming of experimental projects.
- Facilitating in the execution of the innovation process
- Facilitating the transferring of learnings to the sector
- Reporting on the progress to the taskforce of the Bouwagenda
- Integrating the long term goals of the Bouwagenda, in this case creating a sustainable construction sector.

Capabilities of the process coordinator are:

- Experience in the construction sector and knowledge of where to find the decision makers in the sector that can assign projects. Furthermore, a knowledge of innovation indicators in the sector like the Marktvisie and the Bouwcampus.
- Experience in facilitating and managing innovation projects. This doesn't necessarily have to be innovation projects in the construction sector. More important is that they are also experienced in creating a shared vision and in creating a shared understanding of the problem, ideation and prototyping/testing.

- Knowledge on the design process that allows to strategically implement long term goals in the process.

The most important skill of the process coordinator is to understand the design process and manage the process in order to come to an effective design. The capabilities of knowledge transfer to the sector and reporting can also be outsourced.

Time

Urgency to the projects is key since construction projects often take a long time to develop. The aim is minimizing the time from the start of the challenge to the start of the construction process to 1 year. This is very ambitious since the selection of a partner takes about 3 months. This leaves 9 month to find an experiment project, publish a tender process, create possible coalitions of clients and create partnerships between contractors. The process to create a concept design and a contract takes about 4 to 5 months. From here the detail design and the actual construction of the project can take about two years. This leads to a total time of 3 to 5 years to finish one challenge. Offcourse it doesn't take 5 years for the design to be copied. Because of early publishing of the design decisions simple adjustments can already be copied by other projects. In the case of multiple clients wanting to create an innovation programme it is advised to start early with a concrete project. In this way it can be the example project for the rest of the programme. In the same way project DOEN is seen as an example project of the Marktvisie, where project DOEN was started before the signing of the Marktvisie.

Costs and risks

The costs of the project should be paid for by the client. If there is a group of clients that will create a series of projects it might be advised to share the costs of the projects. Ideally the last project is much cheaper allowing the first experimental project to be more expensive. The cost of the process coordinator is paid for by the Bouwagenda to remain a neutral actor in the process between client and contractor. Risks for these experimental projects will be higher then for traditional projects. This is because in doing things differently it is difficult to predict the outcome. On the other hand, by doing things differently the chances are that more value is created.

Evaluation and sharing platform

A website by the Bouwagenda is the portal to where information about the projects can be shared. The aim of the website is to allow information about the projects to be shared across the sector. This information can be accessed by clients and contractors that want to participate in developing sustainable construction projects.

Why would clients and contractors participate in this process?

In taking on a project that have high risks and are more expensive, one could wonder why people would want to participate in such a project. First of all a belief in the transition direction is important, with this comes an understanding that continuing on the same path is not a feasible option. Clients and contractors should make a decision on whether or not they want to participate in making the transition happen. As seen in the case studies changing an organisation is a slow process, so by already starting projects will ensure that the changes within the organisation will be more gradual. The ambidexterous organisation is a great example of how organisation can be adaptive to outside change.[O'Reily et. al (2014)] Furthermore knowledge that is gathered in these projects is useful for future projects. The goal of the experimental project is that they will be an example for future project. This means that if your organisation has acquired experience by working in these projects, future projects will become better manageable. Participating in the experimental project can be seen as an investment for the future.

Concluding

The challenges offer the Bouwagenda a way of creating a seres of goal driven construction projects. The succes of the challenge is dependend on the project team. This team needs to be a multidisplinary team that is willing to let go of conventions and create something unconventional. A process coordinator can facilitate in the design process of a solution that takes into account business, technology and human perspectives. The sharing of successes to the sector is important to inspire more people to do the same slowly moving towards a more sustainable construction sector.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7. Example challenge, Bridges and Locks

7. Example challenge, Bridges and Locks

7.1 Introduction

The following example for a challenge was created based on information on the road-maps provided by the Bouwagenda. This information can be found in appendix IV.

The Roadmap bridges and locks focusses on the replacement of bridges and locks in the Netherlands. Most of the locks and bridges are built just after the Second World War and are now entering the end of their life-cycle. The problem is that the managers of the locks and bridges in the Netherlands have no clear indicators when the bridges and locks need to be replaced. The ambition is to get a better understanding in the future of the current state of the locks and bridges by standardizing smart measuring technologies. Furthermore, innovative solutions are needed to minimize nuisance during the replacement and on top of that the bridges and locks need to be sustainable built. This is the starting point for the "Bouwagenda Challenge".

7.2 The process

Step 1

Create challenges: "build a sustainable smart lock that can be installed without too much nuisance for the surroundings", "build a sustainable smart bridge that can be installed without too much nuisance for the surroundings". These two challenges emerged from the problem description the Bouwagenda provided. There was chosen to divide the bridges and locks in two challenges, since they are different products, and although they might learn from each other in the construction the concept is different. Because of this it is interesting to let these challenge work in parallel, in this way they might learn from each other later in the process. These challenges should be accepted by the taskforce Bouwagenda and presented to the sector via publications. These can be published in the CoBouw, the website of the Bouwagenda and via the companies that are connected to the Bouwagenda.

Step 2

Two process coordinators are selected before publication of the challenge. The process coordinators are selected based on the criteria described in chapter 6. The process coordinators start by creating pre commercial sessions in collaboration with the Bouwcampus. The goal is to get clients, contractors and experts together and discuss the challenge. Information that is needed is an indication of the size of the challenge and how difficult the challenge is perceived and why. A similar session was once organised at the Bouwcampus with the community circular infra [Bouwcampus (2017)]. Together with some research on the topic by the process coordinator and overview is created of the problem. There is a general overview of the amount of locks and bridges in the Netherlands. They are grouped by similarity based on size or other specifics that emerged from the pre competitive session. An assessment is made on the difficulty of the challenge with the according risks. It is important to choose a specific group of bridges and locks, for example if the challenge of creating a circular build lock is perceived as almost impossible it would be risky to challenge vital locks in the Dutch waterways.

Based on the following criteria the challenge is specified more:

- Amount of bridges and locks that are similar
- The resemblance of the group for the sector, is it very specific ore are there more similar projects
- The risks involved in the challenge

For example for locks this can mean:
Circular locks are never build before, therefore there can't be too much risks taken in having an experimental project with locks that are of vital importance to the safety of the Netherlands. There are however around 150 small locks in secondary rivers that need to be replaced. The challenge becomes: "build a sustainable small smart lock that can be installed without too much nuisance for the surroundings". This is reported back to the people involved in the pre-commercial session and also presented on the Bouwagenda website. If there are already several circular build locks known, a more high risk project can be selected.

Step 3

Organisations can apply to the challenge to indicate that they want to be involved. Clients to locks (provinces, municipalities and water-boards) can submit projects to the challenge. A selection is made of the most promising project based on interviews with the clients. The assessment is based on the willingness to take on the risks, support from the organisation, willingness to share information about the project and ability to create a full-time project team. These criteria are the boundary conditions for the innovation process later on in the project. If there are multiple clients also a consortium of client can be made to create a series of projects that are set in sequence. At the end of step 3 a project is selected.

Step 4

A purchasing plan is created in collaboration with the client and the process coordinator. The goal of the purchasing plan is to select one contractor to collaborate with. Since in the case of a lock or a bridge the client will always be a public client it is advised to also get advice from Pianoo (expertise centre of procurement) to test the purchasing plan. For now, there is chosen for a competitive dialogue process to select a partner. The steps to this process are described in chapter 6. A collaboration partner emerges from the funnel.

Step 5

Client, contractor and the process coordinator start the collaboration.
The process coordinator is responsible to create a planning for the coming 4 months. This is discussed with the team to also incorporate ideas of the team in the process. This creates a shared ownership about the process. The process coordinator needs to use his knowledge about tools and the effect of tools to make a balanced programme. The following programme on the next page is an example plan for a challenge for a lock. Steps 6 to 9 are similar as explained in chapter 6.

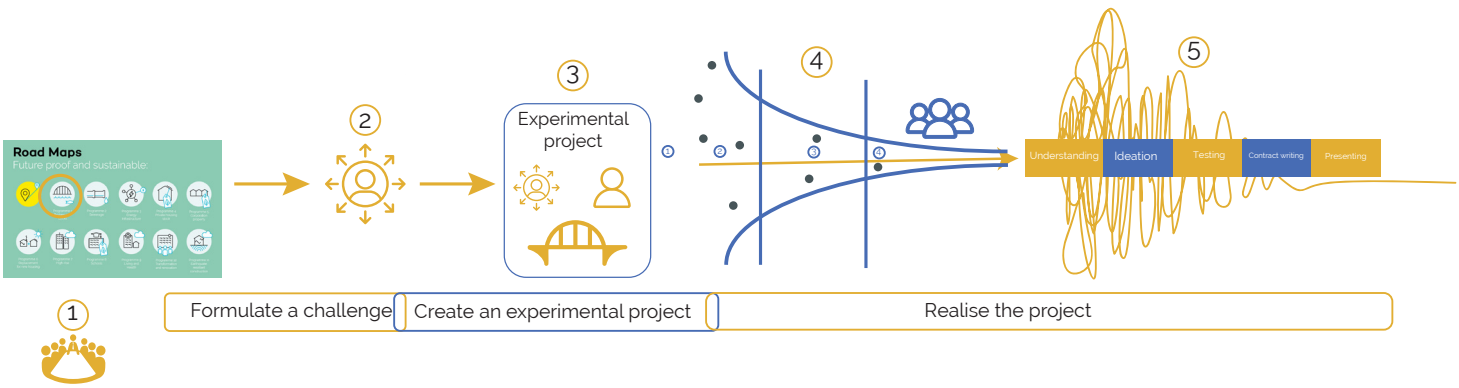

Figure 28: The steps in the process

7. Example challenge, Bridges and Locks

Days

Start

1

A team-building exercise that involves getting to know each other a little bit better on a personal level. The team-building should also include together building something (a raft or a lego house). The goal of the team-building is to get familiar with each other and to get familiar with the design cycle in a team.

2

Creating a plan for understanding. The group together creates a plan on how they can best create an understanding of the problem. Interviews with stakeholders and a visit to the location is planned and prepared (the process coordinator can already arrange appointments beforehand). If possible do this at the location of the project. The goal of making a plan together beforehand makes the team think about what information they already have and what information they need from stakeholders.

Understanding

3-4

Get out of the building! The team splits up and starts to gather information about the current situation. By splitting the team more information can be gathered

5

Creating a shared understanding. The findings of the research are shared with the group and documented. By together sharing information and discussing the information a shared understanding of the current situation is created.

6-7

Understanding the future. The challenge is about building something that is based on circular principles. A crash course circular building principles is provided. If possible also try to do a mini assignment for a circular building. This crash course will provide a shared basic knowledge about circular design. The same is applicable for understanding smart technology. Understanding the basics of smart buildings and sensoring is important to be able to make a smart lock.

The promising concepts are validated with cost experts, construction experts etc. In this way executing a feasibility study on the concepts. Also desirability is tested with the relevant stakeholders, the process coordinator can help to create simple user testing techniques. From this information the most promising in concept is chosen.

21-25

Testing

17-20

The themes of ideas are looked into closer and combinations of conjecture ideas are made and combined to create concepts that are in line with the statement. This is where the intuition of the group is essential, because this will decide what ideas to further investigate to make an estimation of the feasibility and viability. Eventually at day 20 a couple of promising concepts are chosen to continue with. Bringing the group together frequently is important, this is where new frames can be proposed and ideas can be judged.

The most promising concept is further defined into system requirements and a high level design is created. This is the last step before the detail design phase that will happen after the signing of the contract.

26-60

Contract writing

61-80

Once the high level design is finished a contract needs to be created together. By identifying the risks with the group and working with an open book, fair agreements can be made about, price and risks. The goal of the experimental project is not to make as much money as possible but to create an example that benefits both client and contractor. The process coordinator can be the mediator in these negotiations where he or she is independent from both groups.

he future context, what will the uture of transportation bring and hat will the ships of the future look ke? By visiting start-ups, trend atchers and future experience entres that are working on these novations a view into the future is rovided. The goal of visiting these laces is to change the perspective f the group to a more future rientated perspective

8

9

Create a future vision. This day the team discusses what the future is going to look like. A shared understanding of the future is created. By discussing the experiences a shared understanding of the future scenario for the lock is created.

Documenting and drinks! The past weeks were very intense, providing a Friday to document allows people to create a perspective on the project for themselves.

10

Making a statement. A creative session is facilitated by the process coordinator to together create a statement on the project. Making a statement in the fuzziness allows the team to continue with a shared goal. The statement summarizes everything that the group experienced in the past two weeks. This statement sets the scope of what the lock of the future should be.

11

11-13

Testing the statement with stakeholders. Interviews with stakeholders outside of the team can improve the statement. Although permission is given to innovate, it improves on the process if stakeholders outside of the process are also kept up to date. In this way creating support for the statement, also outside of the project team.

Brainstorm days! A brainstorm is organised by the process coordinator to generate as much ideas as possible. They are grouped by theme to organise them.

Ideation

16

14-15

Documenting and fine-tuning the statement. Probably not all information that was gathered is documented well, allowing for this to happen makes the statement stronger. Also minor adjustments to the statement can be made based on the respons of stakeholders.

Documenting and presenting, all the information that was gathered in past months need to be documented, to be used by others. This information will be shared via the Bouwagenda website. The design also need to be presented publically and preferably for a large audience. In this way inspiring others to do the same. The public signing of the contract also marks an important milestone committing both parties to actually realize the innovation that they created together.

81-90

Presenting


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8. Validation

8. Validation

8.1 Introduction

Because validation of the complete solution is difficult validation is done in multiple ways.

First of all, via the Bouwcampus, they have experience in step 2 of the plan and can provide insights on the feasibility of the strategy. A meeting with a process coordinator from the Bouwcampus was conducted to discuss the strategy and the process. Secondly a pr- competitive meeting was attended that brought together client and contractor to discuss the future of the Dutch Shore line. Observations were used to see if clients would come up with experimental projects or that contractors would form coalitions. These two validations provide insights on the viability and feasibility of the strategy.

Secondly the strategy is presented to the programme committee of the Bouwagenda. They can say of the strategy is usefull for them. Finally a interview with a project manager from a consultancy was conducted. Because of the distance from the proejct he can evaluate if this strategy would be fit for the market and if the process could be viable.

More information on the interviews can be found inappendix V

8.2 Validation process coordinator Bouwcampus

The process coordinator at the Bouwcampus was responsible for the pre-commercial process for housing for the Dutch National Police. During this process they also applied an innovation challenge (different then proposed in this thesis) to challenge the sector to come up with innovative solutions. With over 70 submissions it was considered a great success.

The validation was conducted in the following way; starting with a short evaluation of the current process that was used for the Dutch National Police challenge. The process was drawn on paper and discussed. Once the process was clear the new process was shown to the process coordinator and compared to the Bouwcampus process. In this way some information could be found on improving the process and validating feasibility and viability.

When comparing the two processes, the process coordinator noticed that the essence of their process was captured in the new proces. The Bouwcampus process took however more than a year, because it was difficult for the process coordinator to get the right people at the table. Especially at the Dutch National Police a lot of people had a say in the strategy. It is noted that the Dutch National Police challenge concerned all police stations in the Netherlands and the proposed process is for an experimental project.

The project coordinator doubted if the new process could motivate companies to participate in this process. The economy is strengthening and builders already have more than enough projects to work on. This could make it difficult for companies to have a full time team working on a project that doesn't necessarily will be really profitable. This would especially be the case for smaller companies. The big construction companies may have the ability to make time available but smaller companies will probably have a shortage of time.

Furthermore a doubt was about the organisations that would be participating in the process. Especially governments would need to be able to work much faster than regular. Finding an experimental project creates a lot of pressure on the bureaucratic system and will probably need strong support from upper management. If the bureaucracy slows down the process, a result could be that innovators will lose patience and that eventually the process loses momentum. Furthermore if there aren't adjustments made to the organisations the project will be on its own and it will be "just another pilot".

Conclusion

It can be concluded that the sequence of steps is viable and feasible but that the execution of the process is depended on the different organisations. Leadership from management is needed to bypass the bureaucracy and to create a pass for the experimental projects. But also the experimental projects should be used by management to evaluate their own organisation and adjust it to be able to recreate success from the experiments.

Picture 14: *Validation at the Bouwcampus*

8. Validation

8.3 Visiting the Dutch Coastline Challenge

The Dutch Coastline Challenge was originally initiated by dredgers who wanted to see if there were alternative solutions then just moving sand from one place to another. At first Rijkswaterstaat didn't want to cooperate. But when the Director Procurement at Rijkswaterstaat found out about the initiative it was seen as a way of putting the Marktvisie into practise. Four meetings were organised by the Bouwcampus to create joint initiatives for the Dutch coastline. Twelve ideas were created and presented. The last of the four sessions was visited to see if experimental projects would emerge. The decision makers of Rijkswaterstaat and several dredging companies were present at the session. The afternoon started with presentations of Rijkswaterstaat and several initiatives that were developed and ended with group discussions to find paths to the future.

The presentation started with a reflection on the past year by Rijkswaterstaat. They admitted that there should have been done more in the challenge. The main reason was that they needed time to fully understand the problem and to discover what the possibilities of looking at the Dutch coastline in a different way would be. Furthermore they thought it was difficult that the process of the Bouwcampus was different and outside of the current way of working. It appeared that the people from Rijkswaterstaat working on the Dutch coastline challenge also had other tasks. This made them struggle to leave behind the current way of organising things and this took quite some time. When confronted with new ideas Rijkswaterstaat considered it difficult to think outside the regulations. It was uncertain to whether these new ideas would be possible and how these would fit in a larger vision. What they wanted to prevent were pilots that didn't make any sense and didn't form a coherent whole. It was not clear how they wanted to continue. What was clear however was the ambition of Rijkswaterstaat, 100% co2 reduction by 2030. But there weren't any concrete plans yet on starting an experiment project. On the other hand, the contractors were very eager to start working on the challenge, even willing to cooperate with each other to create shared knowledge on creating innovative solutions. Several directors of dredging companies agreed to be willing to do this in open discussions. Eventually five tracks for the future were presented by Rijkswaterstaat. These consisted of creating plan a for the future and investigating collaboration possibilities but no concrete promises could be made. Talking to several dredging companies during the drinks afterwards it was found that they think that if Rijkswaterstaat wants to have a 100% energy neutral coastline by 2030 they will have to start today with planning for this. New machines need to be build and tested and investments need to be made.

Conclusion

Pre-competitive sessions at the Bouwcampus are found to bring client and contractor closer together. Also some forms of coalitions were formed but it was hampered because a clear plan was missing. Dredgers wanted to work on the challenge but Rijkswaterstaat as a client didn't know what to do. A plan for continuing and actually completing the transition was needed.

Picture 15: *visiting the Dutch Coastline Challenge*

8.4 The programme committee Bouwagenda

To validate the strategy with the Bouwagenda a meeting was scheduled with a programme manager of the programme committee of the Bouwagenda. During the meeting the results of the research and the strategy were discussed. The goal of this validation was to find out to what extent the strategy would be applicable for the Bouwagenda.

First of all the conclusions of the research were mostly agreed upon. The importance of bringing client and contractor closer together was something that also had high priority in the Bouwagenda and they agreed with the barriers identified in this thesis. Also a non-linear approach to transition management was found in line with their strategy of "act small and scale up fast".

The strategy of starting challenges to encourage experimental projects was something that really appealed to them. In fact, they were also working on a similar approach to create challenges within the roadmaps. They already contacted the Bouwcampus on making a plan on how to start the challenges, and they were interested in what they would come up with. The information in this thesis provided them with more substantiated arguments on demanding certain requirements on the innovation process that the Bouwcampus would propose. In this way they were not depended on just one source of information about what the challenges should look like. Awareness for the importance of the innovation process in transitioning the sector and the requirements that were needed for a successful innovation process where the two main findings that could actually help the bouwagenda.

Improvements on the design could be found in the fact that it was focussed on a single project. They would rather see more emphasis on the creation of a series of challenges. Although this thesis does mention a series of challenges as a possibility they would expect that this would have been more elaborated in the process.

Another point of improvement would be found in the representation of the strategy. The idea of the "challenge strategy" was very clear to them but a more bolt statement was expected to what extend the innovation process would be actually different from what they were already doing. To my opinion the the new innovation process is actually different, but however has a lot of similarities with the current process. This emphasis on the differences in processes is something that will be taken into account during the public defence and poster of this thesis.

Conclusion

The strategy of creating challenges to transition the sector was found to be desirable by the Bouwagenda. Simultaneously they had come up with the same idea of creating challenges, showing a desirability for them to use such a strategy. This thesis has created awareness for the importance of the design process in creating innovations that can actually start a transition. The proposed strategy was found to help the Bouwagenda in demanding requirements on how challenges should be set up.

Picture 16: *visiting the Bouwagenda programme committee*

8. Validation

8.4 Project manager 4Building

To validate the process and strategy with someone from outside the direct influence of the Bouwagenda a meeting with a project manager from 4Building was planned. 4Building is a consultancy that advises public and private clients in developing construction projects. This means that they are familiar with the sector and have a clear view of what is happening in the market at this moment.

The validation consisted out of an introduction to the Bouwagenda and the challenges that they face. From here the barriers were discussed and eventually the strategy to overcoming these barriers.

The first thing that was agreed upon was that the current system was very difficult to change. What is needed is strong leadership with clients that can provoke responses from the market according to the project manager. What was noticed was that a lot of other project managers do feel that they have to do things differently but that they don't have the freedom to actually change something. This freedom is often hampered by large investment costs in relation to higher risks to do something different. Furthermore clients often have to commit to a lot of reliability when they create something, this limits the space for innovation. The project manager suggested that the strategy had to start with smaller projects before taking on a bigger project. For example to start with making a hundred circular bridges for bikes and use that knowledge to take on larger infrastructure projects. The downside to this is that smaller projects are often carried out by smaller organisations. These smaller organisations often have a lot of work and often lack the knowledge needed to make the changes that are necessary.

Looking at the new strategy, the idea of changing the tendering request from a functional request to a goal driven request was found an important step. It changes the perspective of the project form the start and therefore allows for new ideas to emerge.

That client and contractor needed to work close together during a challenge was agreed on. But besides a competitive dialog also a competition was suggested. The winners of the competition could all try their own way of constructing and successes would be copied into a new design. This way of working on the challenge would be more applicable for small project like divers, sewers or small bridges. The downside to this way of working is that there is less close collaboration between client and contractor.

Information sharing about the design of the project was considered to be possible. The project manager mentioned that companies would probably want to share their design, but not exactly how they created the design. For example, they would say what kind of concrete was used, but not exactly what the structure of this concrete is. So the exact details would be hidden.

Concluding

The success of the strategy is dependent on the willingness to accept risks. To achieve this strong leadership is needed and goal driven requests to the market need to be made. The new strategy does invoke this in the form of challenges. A more programmatic approach is also suggested starting with smaller project. Yet this is again dependent on the willingness of clients to take on risks. This approach could be used if there can't be any clients found to participate in the challenges.

8.5 Conclusion

Looking at the validation interviews and visits the most important doubt that people have about the strategy is the willingness of clients to take the risk of doing something new. This was also found as a barrier in the research in chapter 3. The next step would be to test with clients if they would want to participate in such a project before trying to lower the risks of a project. Chances are that there are some clients that see potential in this new way of working and see benefit in trying to build something innovative. A change to the strategy could be to set up a fund by the Bouwagenda. This fund could be like an insurance for clients to lower the financial risk of creating an innovative construction project.

With contractors there was a willingness to start working on new projects as seen with the Dutch Coastline Challenge. Also with project DOEN it was found that 11 companies were attending the first round. This shows that there is a willingness from companies to start working on new projects.

Further validation is difficult because it will be necessary to create a project team and a real project. The next thing would be just to test the strategy. The Bouwagenda was already working on creating challenges so this could be the place to test the process and see if it actually results into innovative solutions. If it will actually change the sector will always be difficult to say, but as transition management is circular constant evaluation allows for adjustments along the way.


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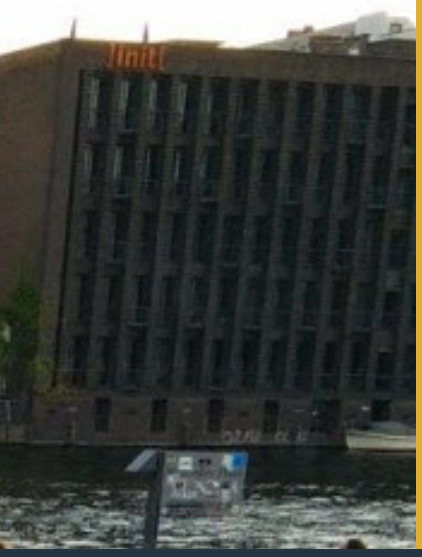

9. Discussion and conclusion

Discussion and conclusion

9.1 Discussion

This thesis investigated the Bouwagenda and their plan to transition the construction sector in a revolutionary way. Transition management was found to be an effective governance framework to manage these transitions. This governance framework is based on the idea that innovative experimental projects need to have opportunities to break the system. Actually creating innovative solutions in these experimental projects is quite a challenge since it asks for a different kind of thinking. This different kind of thinking was found in a design approach. This resulted in a challenge based strategy for the Bouwagenda on creating innovative projects. This contained a management tool and an innovation process that can be used in the construction sector. In this way answering the question raised in the beginning of this thesis.

Transition management and governance is a theoretical framework that is based on the paradox that transitions are too complex to manage. Consciously transitioning a sector is something that hasn't been done before and in this way the Bouwagenda in itself is also an experiment. Design led transitions are becoming more common with for example an ING that now has design thinking at the core of its organisation [ING (2016)], but this is within just a single organisation. There are also examples like the "pass me" project that show a collaborative approach between organisations to work on a common goal. In this case developing a better air travel passenger journeys [pass-me (2015)]. Both of these examples are still in progress and time is needed to see how they resulted. In other words, managing transitions is for now mostly a theoretical approach.

Future research can be conducted in monitoring the transition and see how certain governance systems have an effect on speeding up or slowing down the transition. Also the innovation process needs to be tested with an actual project to see if this approach will actually result in a successful project. Project DOEN already showed some progress in working in a small team of client and contractor, but they still didn't make a sustainable bridge.

This thesis looks at transitions from a governance perspective, since the Bouwagenda is a way of governing the transition. But further research can also be performed looking at the transition from a construction company perspective. There are for example construction companies that invest in niche innovations themselves, like Heijmans who is developing a tiny house [Heijmans N.V. (2018)] or BAM who is collaborating with the Ellen Mac Arthur foundation on creating solutions for the circular economy [Ellen Mac Arthur Foundation (2017)]. A company strategy on transition can also inspire companies to take a more bottom up approach to transition to a sustainable sector.

9.2 Conclusion

Creating a strategy on transitioning a sector is not an easy task. The complexity of stakeholders, problems and challenges can be overwhelming and confusing. The aim of the strategy proposed in this thesis is to provide more clarity in the chaos and by doing so increase the chances of a sustainable transition to happen before 2050. An important learning from transition theory is that to actually make a transition happen you have to start doing. Risks need to be accepted and new solutions need to be discovered. Only when we set out to find these new solutions we can break with the conventions and make the change that is desired. In the light of the long periods of time that transitions take and the goals that are set for 2050 it is important to start today on working for tomorrow.
The strategy in this thesis structures the process of creating innovative solutions, but the actual innovation must come from the people participating in these projects. The people working in the projects are the ones that can make the difference in a project.

9.3 personal reflections

Although it is the task of the designer to be able to look beyond the different disciplines, for this thesis this task was stretched quite a bit. First of all the construction sector needed to be understood, which was a sector that I knew something about, but far from enough to say something useful about it. Secondly fundamental knowledge about transitions and design needed to be acquired. Especially fundamental theories take time to comprehend and to correctly apply them to a sector takes even more time. This made it difficult to scope the project from the start and to find a solution that could be useful for the Bouwagenda. This scoping was made even more difficult by my natural tendency to be more divergent in research then convergent. In this way creating a very broad view of what should be included in this thesis. I was driven by a personal drive to get a deep understanding of what was going on in the sector and to fully understand the problematic situation. Unfortunately as also described in the paradox of transition management this is an almost impossible task. The challenge was to accept that you can't fully analyse the problem and you have to switch from analysis to synthesis. I found this switch difficult to make in this project. I think this had to do with the construction sector being very problem focussed. This made me feel that I had to know about everything in order to proceed with the project. Also since this was the last project that I would be making at the university, I wanted to do a good job. This slowed down the process and sometimes I would get lost in literature. It's interesting to see that the willingness to do something very well stops you from being a good designer. Stepping out of the research phase and into the synthesis phase helped me a lot. By writing down solutions the literature study also improved. The co-evolution of problem and solution space as Kees Dorst would call it. I learned from this experience that it is okay to sometimes continue the process even when you don't have all the information that you need.

During the end of the process I had to face the challenge of report writing. Writing a thesis is something that is not' practised a lot in industrial design engineering and this was something to get used to. A lot of writing, rewriting and reviewing helped me to get the story across. I learned that the process of writing also really helps in structuring your thoughts. Although it takes a lot of time, it allows you to get it out of your head, freeing space to think of other things. During the report writing it all fell into place and even found some joy in report writing.

From report writing back to presenting is again an interesting transition. In presenting you have to get your point across and tell people in a few sentences what your strategy is about. I found that by continually explaining my thesis to people helped me to better formulate what my thesis was exactly about. A strategy is only useful if you can explain it to someone.

If I look back at the whole process I could have made it a lot easier on myself. I could have found a subject that was scoped well and was within a sector that I knew. Yet I didn't and I'm glad I did. Graduation is (at least for me) the only time in your life that you can really take the time to look into something that interests you and to use the knowledge of the TU Delft to find an answer. I think challenging myself eventually made me a better designer and that is eventually the goal of doing a masters in Delft.

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