Le présent n'est pas un passé en puissance, il est le moment du choix et de l'action
- Simone de Beauvoir -
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1 Introduction

The world is constantly changing. We notice an ongoing increase of the world population and the burden it causes for the environment. The Netherlands is densely populated and will move towards a more sustainable balance the coming years as the large Dutch cities have stated they want to be carbon oxide neutral by 2020. The Dutch central Government has initiated several committees for energy transition and the new energy-saving technologies find their way to the market place. The public has started realizing the necessity to change our lives resulting in successes of Al Gore’s film ‘An inconvenient truth’ and the Toyota Prius of which over 700.000 vehicles have been sold worldwide (Popular Mechanics, 2007).

This thesis project is about the creation of an eco-friendly Dutch vehicle concept.

1.1 Problem description

At the end of 2006 I was called by Femke Markus, managing partner of Spring Newco. Spring Newco is a small Dutch consulting boutique that assists companies in turning innovative ideas into successful operational concepts; sometimes they venture themselves. Femke asked to help her create a new, innovative Dutch eco-friendly car. It turned out to be an idea originated from the work she had done for the scientific institute of the political party CDA. Femke wrote a publication about innovation for the CDA and therefore she interviewed several innovative entrepreneurs about the barriers they face in becoming successful. Two of the themes in the publication were mobility and sustainability. For mobility E-Traction, which is a company that has invented a new electric compulsion system for buses, had been interviewed and for sustainability Nedstack, which is a company that produces hydrogen fuel cell stacks for the conversion of hydrogen into electricity, had been interviewed (CDA, 2006). Spring Newco believed that, among others, combining the two companies could create a zero-emissions vehicle. She asked me to do research on the desired innovation and she wanted me to take everyday-control of the project. Spring named the project ZURBAN, which stands for Zero-emissions Urban Vehicle. E-Traction and Nedstack were the initial partners with whom Spring wanted to cooperate. There was the belief that the project should not only aim for a vehicle, but also for a broader context in which the vehicle would operate in order to attract the public attention. Spring’s problem was how to give direction to the creation of a Dutch zero-emissions vehicle concept. I had no idea where to start...

1.2 Spring’s ambition

At the end of 2006, Femke and the ZURBAN partners had a meeting with the former Minister of Economic Affairs, Joop Wijn. He was interested in the project; he asked Spring to revisit him once they had selected more partners, including a launching customer that would be willing to drive with the ZURBAN. During the formal kick-off meeting, Professor Berkhout and Associate Professor Dap Hartmann advised Spring Newco to adopt a broader view by deselecting the initial partners E-Traction and Nedstack and start with describing the ambition of Spring.
Spring Newco sees a big opportunity for an emission-free vehicle in a Dutch niche market; there is a gap of an expected 10 years in which parties demanding zero-emissions transportation can not be satisfied by the traditional car producers. This gap can be filled by a provider focusing on applications in a niche market. The choice for a niche market should become part of the broader zero-emissions vehicle concept.

The mission of Spring Newco is to create a zero-emissions vehicle for urban distribution purposes. Spring chooses for a zero-emitting solution because they believe that on the long run every other option would be a bypass. The focus on urban distribution vehicles originates in the fact that there is a belief that a launching customer would preferably be a company that is active in distribution because a distributor uses cars rather intensive. Moreover, distribution is the final trajectory in logistics and mainly takes place in Dutch cities, which suffer from polluted air conditions. The development of a Dutch ZURBAN can directly contribute to the improvement of the local air conditions in Dutch cities. By focusing on urban distribution purposes, the niche market had been chosen.

The ZURBAN should be created in collaboration with a diverse group of partners because Spring Newco does not have the capabilities of succeeding in this project alone. Among others, hardware suppliers, platform integrators, capital providers and a launching customer are parties they needed to have aboard.

Spring’s ambition can be summarized the following:
- Spring wants to create a small series of Dutch eco-friendly vehicles that drive in urban areas and that will be de facto a communication means in order to stimulate others to start driving more eco-friendly as well.

1.3 Research methodology

The ZURBAN would be one of Spring’s first innovative projects. In scientific literature, many innovation management models have been proposed. These models are descriptive from nature; they describe the innovation management practices of successful companies. Spring needed a model that could be used prescriptively in order to have a guideline for the ZURBAN project in particular; and future projects in general. By interacting at the border between new products, technologies, and market transitions, Spring can be regarded a spider in the innovation web; connecting left to right and top to bottom. Professor Berkhout proposed a theory that fits the entrepreneurial role Spring wants to play, and that can help guiding the creation of an eco-friendly, innovative proposition. Berkhout’s theory will be used in this thesis (Berkhout, 2000; Berkhout, 2006; Berkhout, 2007a). He has described a three-layered approach that allows companies to put his theory into practice: in layer 1, a new business development framework has been given in which the innovator has the role of ‘the leader’. In layer 2, there is a zoom into the process model of the business development framework; here Berkhout proposes to use the Cyclic Innovation Model in which the innovator has the role of ‘the entrepreneur’ in a cyclical innovation arena.
In layer 3, an operational zoom of the Cyclic Innovation Model has been presented in order to gain insight in the operational field; which actors have which knowledge and skills available. The innovator should have the role of ‘craftsman’. An overview of Berkhout’s theory:

Figure 1: Berkhout’s innovation theory is the guide for the introduction of the ZURBAN innovation
Berkhout's innovation theory is suitable for managing the ZURBAN innovation because it deals with all kinds of market- and technology developments. It provides ‘the leader’, ‘the entrepreneur’ and ‘the craftsman’ a clear insight in the available and needed changes and developments. Furthermore, it regards innovation management as a cyclical, iterative process which fits the desired spider role of Spring Newco. In Figure 1 an overview has been given of Berkhout’s innovation theory as it will be used prescriptively for the creation of the ZURBAN innovation. Spring Newco will have the role of ‘the leader’ in layer 1, the role of ‘the entrepreneur’ in layer 2 and the role of the ‘craftsman’ in layer 3.

1.4 Research goal

This research project is about the creation of the ZURBAN innovation. In 1934, Schumpeter has defined innovation as the introduction of a new good -that is one which consumers are not yet familiar with- or of a new quality of a good. Schumpeter also stated that innovation is the introduction of a new method of production, or the opening of a new market, or the conquest of a new source of supply, or the carrying out of the new organization of any industry. Nowadays, more general, summarizing definitions have been stated, like Rogers (1995): innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. More technically, Herrmann (2007) refers to innovation as ‘the introduction of a new product that incorporate substantially different technology from existing products and that can fulfill customer needs either significantly better than existing products, or address different types of needs which could not be fulfilled with the existing products (Chandy and Tellis, 1998)’. According to Berkhout (2006) ‘the whole idea behind innovation is to successfully place new product-service combinations on the market.’ He states that even the most complex technology development can only be named innovative if it is successfully introduced on the market. In the terminology of Berkhout, a product-service combination can be anything made by human kind; from physical products to non-physical services, which can also be laws, regulations or systems. Spring Newco will successfully introduce the ZURBAN vehicle concept that incorporates new zero-emissions technologies and addresses the need for eco-friendly transportation in urban areas.

Berkhout’s innovation theory has been proven to be successful in a descriptive manner; Berkhout and Van der Duin (2006) have described an innovation of KPN Mobile, named Lucio, with CIM. Kok (2005) has used the model normatively for the Thixomolding innovation cluster. In his thesis, Kok concluded that ‘the Cyclic Innovation Model can be used effectively as a normative model for the Thixomolding cluster’. Berkhout (2007b) has used the model prescriptively in order to prescribe best practices for the ‘revolutionizing chemical production processes’ in the chemical industry. I will also use CIM prescriptively.

Goal of the research:

- Application of the three layers of Berkhout’s innovation theory and analysis of the desired role of Spring Newco in relation to the introduction of a sustainable proposition and thereby identifying possible challenges and opportunities which coincide the innovation process.
In a highly insecure situation it is often difficult to clearly distinguish the drivers of a successful result. However, it is possible to closely manage processes which might lead to success. Strictly using Berkhout’s innovation theory as the guideline for the process management can be seen as providing Spring Newco with theoretical best practices. By analyzing the three layers and the desired role of Spring Newco the chances for success might increase; for Spring Newco a successful ZURBAN project is cost-recoverable, operational in May 2008 and managed in close cooperation with trustworthy partners. Moreover, the ZURBAN concept should be broader than just the zero-emissions vehicle; it should have a stimulating function in society. The time span of the project for Spring Newco is rather short. The ZURBAN project is one of their initiatives; a cost-neutral situation in which five zero-emissions vehicle are driving and ‘communicating’ is equal to success for Spring Newco.

My practical goal is to leave Spring Newco at the end of August, having arranged the following:

- A launching customer
- Technology partners
- Non-technology partners
- Subsidy and funding
- Governmental willingness to cooperate

### 1.5 Research questions

Research question:

- How does Berkhout’s innovation theory contribute to the introduction of the sustainable, innovative ZURBAN proposition?

In other words; in what way can Berkhout’s innovation model be used as a theoretical base which provides best practices for managing the innovation process which leads to the creation of the ZURBAN concept?

The following sub questions will be answered:

- What are the characteristics of Berkhout’s innovation theory?
- What are the characteristics of the desired ZURBAN proposition?
- Which transition path will fit the ZURBAN best?
- How can Berkhout’s innovation theory be operationalized to arrive at the ZURBAN concept?
- How can Spring Newco support the creation of the ZURBAN concept?
1.6 Research scope

The scope of any project for Spring Newco is formulated the following by the company:

- A project should be in the field of energy, sustainability, media or digital interface
- A project should be ‘hot’ and thus have a positive impact on the brand Spring Newco
- The project should have access to a large company that is potentially interested in partnering
- The project should be attractive to a financial partner
- Spring Newco is the booster of the project

The ZURBAN project has extra boundaries:

- Partners are preferably Dutch
- Without a launching customer, the project will not be executed
- The project is not necessarily profitable, it should at least cover costs
- The project should be positioned as a communication means for boosting sustainable solutions
- The vehicle should leave a clear footprint for the cooperating partners

The scope of the research is limited to the case study of the ZURBAN project. As defined by Spring, the ZURBAN project will have a time span of one year; the desired 5 vehicles will have to be operational in May 2008. The creation of next series of ZURBANS, for instance the creation of 100 ZURBANS or 1,000 ZURBANS is out of scope and will not be analysed. Furthermore, the general transition to eco-friendly transportation in the Netherlands is also out of scope.

For the ZURBAN research project, the following parties, have been selected in accordance with Spring Newco as potential ZURBAN partners (they all have different positions in CIM):

- Spring Newco as the initiator of the project and the entrepreneurial project manager
- TNT Post as a potential launching customer
- Van Gansewinkel as a potential launching customer
- City Cargo as a potential launching customer
- Pon as a potential hardware supplier
- Nedstack as a potential hardware supplier
- E-Traction as a potential hardware supplier
- PML Flightlink as a potential hardware supplier
- HeeCon as a potential technological project manager
- TNO Automotive as a potential system integrator
- Spijkstaal as a potential system integrator
- DDB as a potential communication agency
- KC Group as the potential subsidy advisor
- SenterNovem as a potential subsidy supplier
- Value Enhancement Partners as a potential venture capital supplier
- Municipality of Amsterdam as a potential supporting partner
- Municipality of Rotterdam as a potential supporting partner
1.7 Research tools

This research is a case study of the innovation management processes of a sustainable proposition. Several research tools will be used to gain insight in the project; (1) observations will be performed during my daily activities as a member of the ZURBAN project team, (2) interviews and (3) desk research are used to identify market trends, available technologies and the future of zero-emissions concepts. Over 50 people from Governments, the automotive industry, trend watchers, possible launching customers, marketing agencies and professors have been interviewed (see Appendix). These interviewees have been selected in order to have all cycles in the Cyclic Innovation Model covered. I have not used a predefined set of questions; I have kept an open and cyclical view during the interviews. I defined the theme of the questions and then used conversational dynamics to get the most out of the interviewees. Being involved in a thesis project in a company, the graduation process is always a trade-off between theory and practice. My personal capabilities lie mainly in the practical field; theory will therefore be used supportively.

1.8 Report Structure

This report is divided in 5 Chapters:

Chapter 1 is the introduction in which setup of the research has been sketched as well as the problem of Spring Newco.

Chapter 2 reveals the ins and outs of innovation management and the reason why Berkhout’s innovation theory will be used for the creation of the ZURBAN. External trends that have created Spring’s view of the future will be described. The following sub question will be answered in Chapter 2:

- What are the characteristics of Berkhout’s innovation theory?

Chapter 3 presents the internal ambitions of Spring which interacts with the view of the future. The desired ZURBAN proposition that fits this future will be described. Several transition paths which can lead to the physical realization of the ZURBAN have been described. In Chapter 3, layer one of Berkhout’s innovation theory will be used as the guide (see Figure 1). Spring Newco has the role of leader. The following sub questions will be answered:

- What are the characteristics of the desired ZURBAN proposition?
- Which transition path will fit the ZURBAN best?
**Chapter 4** is the second and third layer of Berkhout’s innovation theory. The Cyclic Innovation Model is used in order to align market transitions and technology developments. This Chapter is the operationalization of the research project. The following sub question will be answered:

- How can the Cyclic Innovation Model be operationalized to arrive at the desired ZURBAN concept?
- How can Spring Newco support the creation of the ZURBAN proposition?

**Chapter 5** holds the conclusions that are drawn based on the research and the results of the case study are generalized to other innovations in the sustainability era if initiated by Spring Newco. Recommendations for the continuation of the ZURBAN project in particular and future innovative sustainable propositions in general will be provided and the main question of the research project will be answered:

- How does Berkhout’s innovation theory contribute to the introduction of the sustainable, innovative ZURBAN proposition?

In Figure 2 the structure has been visualized:

![Figure 2: Report structure](image)

**Figure 2: Report structure**
2 An introduction to innovation management

This Chapter is divided into five paragraphs; the historical development of innovation management models (2.1), the characteristics of Berkhout’s innovation management theory (2.2), the prescriptive role of Berkhout’s theory in the ZURBAN project (2.3), the external trends that contribute to the view of the future (2.4) and the conclusion of the Chapter (2.5) in which the first sub question will be answered: What are the characteristics of Berkhout’s innovation theory?

2.1 The development of innovation management models

Tidd et al. (1997) have described the necessity for innovation management. They argue that innovation must be managed right to gain competitive advantage in the current economy. Managers should apply a strategic approach to innovations and align it with their company’s objectives. The whole trajectory need to be managed; knowing ‘why’ and ‘how to’ should be geared towards successful implementation in the marketing of new product-service combinations. They emphasize the importance of technology, R&D, and collaboration between several actors in innovation processes. In history, an evolution of innovation management models can be observed. These models are often descriptive from nature; they describe the way in which entrepreneurs brought inventions to the market place where they might become successful. Less successful companies used the models in a prescriptive manner. Often, four generations of innovation management models are distinguished. The first and second generations are linear models, and while the world’s complexity increases, the third and fourth generations become less linear. Please note that the shifts from one generation to another did not occur suddenly; such transitions move smoothly. In literature, one can find several theories on the evolution of the innovation management models. I have used the theory that is used at the department of Technology, Strategy and Entrepreneurship of the faculty of Technology, Policy and Management of Delft University of Technology, an overview:

2.1.1 First generation innovation management, 1950 – mid 1960

In this traditional model innovation is presented as a linear pipeline. The pipeline starts with technology research and ends with a product. Until market introduction, it remained unclear whether the invention would become successful in the market. In the innovation process, there was a lack of influence of the market. Their needs and desires weren’t quite listened to. Innovation was mainly technology push. Van der Duin et al. (2005) argue that in the period of the first generation Governments stimulated R&D because the cold war demanded technological leadership in terms of military products and because R&D created a competitive advantage for their industries in general. They state that companies were technology focused and that innovation took place in structured surroundings. Disadvantages they describe are the lack of overall steering of the innovation process; it was just a way of one department handing over their results to another department. Scientific freedom became more important than the potential market success. Because this scientific approach in which technology became of key importance, it often happened that a new product was technological superior, but did not became successful in the market; a waste of time and money. Examples of successful first generation innovations are the steam engine and the television.
2.1.2 Second generation innovation management, mid 1960 – beginning of 1970

In this linear model innovation is still presented as a pipeline, but with the market as the start point. The market is the source of innovation and market research creates the ideas. In the time period of the second generation, the economy slowed down compared to the first generation period. One can imagine that if demand is becoming more equal to supply, sellers will pay more attention to the needs of the buyers. Fitting their needs became important in obtaining a competitive advantage. Innovation management shifted from technology-driven to demand-driven. The market made the rules. Public’s wishes became the norm in innovation. Van der Duin et al. (2005) argue that ‘the approach of the second generation lead to a primary focus on small improvements of existing products’. The market turned out to be unable of foreseeing future product needs. The second generation innovation management model caused innovations to be incremental of nature. Examples of successful second generation innovations are the fuel-efficient cars and healthy drinks.

2.1.3 Third generation innovation management, beginning of 1970 – mid 1980

The third generation is a non-linear model. The time period of the third generation is one of low economic growth. During the oil crisis of 1973 there was a worldwide shortage of oil caused by several actions of Arabic oil producing countries. They raised the oil price by 70% and decreased their production with 5% per month. These measures hit the American and the Dutch economy. The world ended-up in stagflation, which is a combination of zero economical growth, defined as stagnation, and price inflation. In 1979 the second oil crisis occurred. Supply of goods exceeded the demand of goods and the unemployment rate grew. Companies focused on strong cost control policies (Olson, 1982). If one looks back at this period, one observes some positive effects of stagnation. According to Van der Duin et al. (2005) it made companies more efficient. Large hierarchical structures needed to disappear and change into more flexible business unites. R&D and innovation management became linked with corporate strategy. There was no more money to be wasted. The third generation innovation management combines market-pull with technology-push. Projects become interlinked in programs which got connected to strategic goals. There is a feedback loop and constant interaction between the inventions in the R&D departments and the needs from society. Communication networks arise.
Miller (2001) describes the main disadvantage of the third generation innovation management model as the lack of focus on market and organizational innovations. The third generation just covers product and process innovations. Examples of successful third generation innovations are mountain-bikes and the business model of Dell computers.

![Third generation innovation management model](image)

**Figure 5: Third generation innovation management model**

### 2.1.4 Fourth generation innovation management, mid 1980 – now

The fourth generation model has emerged in a period of economic prosperity. It is the rise of high technology products. The market place is becoming transparent for all actors thanks to information and communication technologies. In literature, among others, three leading theories have been postulated. Chesbrough (2003) describes the fourth generation as ‘open innovation’, Von Hippel (2005) describes his ideas as ‘democratizing innovation’ and Berkhout (2000) introduces a new business development framework which includes the ‘Cyclic Innovation Model’. It needs to be mentioned that Chesbrough and Von Hippel have proposed a theory that can be regarded to be more a transition path than a process model. It still is a model in which phases are present, which de facto creates a transition path. Berkhout's theory does not have phases, but cycles. An overview of the three leading models will be given.

#### 2.1.4.1 Open innovation

The open innovation model of Chesbrough is still based on linearity. New in his model is the approach that innovation is collaboration. Innovation should not be behind closed doors. Statistics show that most of the needed knowledge and resources are positioned outside the company's boundaries. Be open en transparent, search for partnering and chances of being successful increase. A disadvantage described by Van der Duin et al. (2005) is the fact that this model is not really applicable for high technology surroundings. There are industries, like the chip producing industry in which it is impossible to implement an open innovation system. These industries are too much patent or technology-driven. The same holds for pharmaceutical companies which suffer high sunk costs. Open innovation aims at the use of internal ideas in combination with external ideas to create high value innovations. The linearity of the open innovation model can be visualized by a funnel with holes in it. Ideas flow from the left of the funnel in the research phase to the right of the funnel in the development phase. They need to get influenced by knowledge through the holes in the funnel. At the end this will create the best possible product-service combinations according to Chesbrough. It is also possible that ideas from inside the funnel find their way to the external environment; this creates spin-offs or licensing agreements. It is not just about outsourcing, it is about making fully use of resources.
inside and outside the company. A company that owns a large stock of patents can sometimes be better of selling or licensing some of these patents to other parties. Chesbrough believes, just like the other leading scientists who have researched the fourth generation innovation model, that that innovation takes place in networks.

**Open ‘ZURBAN’ innovation**

For the ZURBAN case study it would not be very useful to prescriptively apply the open innovation funnel of Chesbrough for guiding the innovation process. The funnel of Chesbrough is too high-level and mainly useful for companies which have their own internal research projects. A great part of the content in the funnel is produced by the company itself. Lacking parts are obtained from external surroundings and spillovers are given back. Spring is not able to produce content in the open innovation funnel themselves; they want to be a spider in the innovation web by connecting the right parties for the ZURBAN project. The lesson Spring Newco can learn from Chesbrough is that modern innovations are not achieved alone; cooperate. Furthermore, the funnel of Chesbrough is de facto a transition path which represents just one of the activities that are needed by Spring for a successful innovation process.

**2.1.4.2 Democratizing innovation**

In his book ‘Democratizing innovation’ Von Hippel (2005) describes the fact that innovation is becoming democratized. He states that users more and more have the ability of developing products themselves. A user-centered innovation system gets introduced for which Von Hippel uses the term ‘lead users’. Lead users are ahead of the marketplace and -if being heard- are able to innovate according to their private needs and concerns; they can even be the ‘source of innovation’. For every new product-service combination a group of lead users can be defined and asked what they want the innovation to be like. Von Hippel even describes the possibility for companies to actively provide lead users with tools which make them innovate themselves. A situation in which ‘user-innovators’ will help the development of new products will have a positive effect on social welfare. In the book, ‘innovation user’ and ‘innovation manufacturer’ are the two general functional relationships between innovator and innovation mentioned. Users benefit directly from the innovation; other actors sell innovation-related products or services to these users. In the history of product development, according to Von Hippel, statistics show that the higher the level of ‘lead-user-ness’ the higher the success in the marketplace. Well known companies that have worked with the lead user theory are Philips, 3M, Verizon, Kellogg and Nestle.

**Democratizing the ‘ZURBAN’ innovation**

For the ZURBAN case study, the theory of Von Hippel can be useful to some extension. The lead users of the ZURBAN vehicle are de facto the drivers of a large Dutch fleet owner. One can imagine that every driver has its own needs. However, some general characteristics can be defined by looking at the lead user on a higher level; the owner of the fleet which will preferably be a distribution company. According to Stef Bouwhuis from the Platform Express Vehicles, Jean-Paul Duurland from DHL and Michiel Cusell from TNT Express a standard distribution vehicle does not drive at a speed higher than 120 kilometers per hour with a daily range of maximum 150
kilometres. Spring needs to take these characteristics into account in the development process of the vehicle. Design requirements will be setup with the help of the launching customer; the development process is an iterative process.

Democratizing innovation is in fact the result of the rise of technologies which have made the world transparent. Consumers get more and more influence; improvements, complaints or other feedback is just one mouse click away. It should be evident that therefore the theory of Von Hippel is applicable for the ZURBAN proposition; however, it does not provide a whole and complete framework to guide the innovation process.

It might be interesting to mention that if the theory of Von Hippel would be ignored in the ZURBAN process, the chances for subsidy would be considerably lower. According to Coen Faber, advisor innovation policy of the Ministry of Transport, subsidy will only be granted to this kind of innovative projects if a launching customer is included in the application. Moreover, the influence of the launching customer or the potential group of launching customers should be evidently processed in the application. The Government forces subsidy-driven innovators to adopt the lead user theory of Von Hippel.

2.2 Berkhout’s innovation theory
In order to explain Berkhout’s innovation theory, I will feel free to quote texts written by Professor Berkhout, the founder of the model. The essence of the theory will be given in Paragraph 2.5 which is the conclusion of Chapter 2 and provides an inventory of the essential characteristics of Berkhout’s theory.

2.2.1 The evolution of the economy
In his article ‘Connecting Technical Capabilities with Societal Needs, the power of cyclic thinking’ (2007), Berkhout describes the evolution of the economy; economies used to be based on the production of goods for local markets, using the two traditional factors of production, capital and labour. The rise of industrialization and globalization has caused growing competition which forced companies to be innovative in order to cut costs; these innovations were knowledge based and knowledge became the third factor of production. In the article, the current economy is referred to as the ‘innovation economy’ in which creativity is the fourth factor of production. In order to keep the competitive edge for modern companies, imagination is one of the key drivers; processes are not only more efficient, they should also be more effective with the help of creative solutions. Berkhout cites his colleague Florida (2003) who describes the need for ‘management of ideas’; creativity as the main force for sustainable economic growth. Berkhout (2000) adds that it is the combination of creativity and knowledge and entrepreneurship that makes the innovation economy so powerful in generating added value.
2.2.2 New business development framework

Berkhout (2007) points out the complexity of innovation models and the need this complexity creates to view such models at different layers of abstraction. The theory proposed by Berkhout asks for a stepwise approach. It starts with a new business development framework for modern leaders as visualized in Figure 6 (layer one). According to Berkhout a leader should be future oriented in order to cope with changes. The leader should give direction to an organization by formulating a vision and by describing the strategy that builds up to the transition path. The process model shows the way how new business can be generated best; the leader allocates available capabilities.

This new business development framework has been used as the guide for this research project. In Chapter 3, Spring’s vision on the automotive future has been described and the internal ambitions are aligned. Furthermore, the available transition paths which could lead to the satisfaction of Spring’s ambition have been described. After assessing these paths, the most appropriate one has been chosen and used as input for the process model in Chapter 4. Like others, Berkhout emphasizes the need for ‘open leadership’ to make sure that external and internal influences will be adopted and used to reset minds and ambitions.

Figure 6: Layer 1 of Berkhout’s innovation theory, a business development framework
### 2.2.3 The Cyclic Innovation Model

In Figure 6 the 'process model' has been placed in another colour because more will be elaborated on the process model in this thesis; layers two and three of the innovation theory of Berkhout are to be found in the process model which is known as the Cyclic Innovation Model (CIM) because it describes innovation as a dynamical cyclical process in which there is no end and no beginning. Innovations build up from previous innovations and innovations can start in every cycle of the model. Layer 2 of Berkhout's theory is visualized in Figure 7; layer 3 of Berkhout's theory is visualized in Figure 8.

In layer 2 of the theory we see two movements leading to product creation; the technology driven upside and the market driven downside. Innovation is presented as a game between market transitions and technology developments; the entrepreneur is the player. Innovating is bringing together the technically possible (upside) with the socially desirable (downside). In layer 3 of the theory we observe the operational zoom of CIM in which craftsmanship is leading in the middle in order to make sure that the right knowledge and skills are available for the continuous, cyclical innovation process. The craftsman is the player.

Please note that on the first layer 'the leader' is the spin in the web, on the second layer 'the entrepreneur' and on the third layer 'the craftsman'. The leader has the vision and motivates others; the entrepreneur does the rough work in the innovation arena; endless pulling and dragging for market success; the craftsman combines the right knowledge and skills.

In an 'innovation economy', it is value creation by continuous renewal of products and services that is the source of economic growth (Berkhout, 2006). An important basic for renewal is scientific progress. The rate of knowledge adoption and creation is high in an innovation economy. Knowledge lies at a higher aggregation level and is directed towards new technology, new product design, new methods of production, new forms of service provision and new insights into national and global markets. Knowledge can be found in the left half of CIM. Berkhout distinguishes hard knowledge and soft knowledge. Hard knowledge evolves from the beta sciences; soft knowledge from the gamma sciences. The hard sciences cycle describes the interaction between scientific exploration and technological research; the soft sciences cycle describes the interaction between scientific exploration and market transitions. In other words, some actors develop technologies while other actors describe markets. Actors involved with the development of technologies can be technical universities, research institutes or laboratories; actors involved with the description of markets can be social science universities or trend watchers. A dedicated entrepreneur should have interactions with both kinds of actors; the entrepreneur should keep a close interaction with both cycles.
On the right half of CIM we end up in the product creation node. Berkhout distinguishes two ways of product creation; through technologies (technology oriented) and through markets (user oriented). In other words; technological developments can lead to new product-service combinations and changing market conditions can also lead to new product-service combinations. The interaction between technological developments and product creation is named the ‘integrated engineering cycle’; the interaction between market transitions and product creation is named ‘differentiated valorization cycle’. Again, it is the dedicated entrepreneur who should interact with actors in both cycles. In a meeting with Professor Berkhout, he emphasized the fact that technology can be anything created by human beings. Laws or governmental rules can also be the product of the integrated engineering cycle. This is of importance for the development of the ZURBAN because a certain level of cooperation of the government will probably be necessary in order to make the concept economical attractive.

An overview of the Cyclic Innovation Model is given in Figure 7.

Figure 7: Layer 2 of Berkhout’s innovation theory, the Cyclic Innovation Model

Berkhout has also described the possibility of zooming into Cyclic Innovation Model. This operational format allows the entrepreneur to fill in actors, their relationships and their technologies, products or services. It creates an overview of the current or desired situation and it allows the entrepreneur to observe weaknesses in his network.
The operational format shows the many-to-one and one-to-many relationships that exist in the current economy. Several scientific disciplines can create one technology; several technologies can lead to one product; several product-service combinations can cause a market to change and changing markets can lead to the development of new scientific insights. These relationships can also be the other way around. The operational zoom combines partners with different knowledge and skills.

In Figure 8 one observes these many-to-one and one-to-many relationships. It creates a good view of the existing networks and needed networks. If a network does not work properly, the relationships will be blurred and the socio-economic goals will be out of focus. Normally, this operational level of the model can be filled in observing the actual situation; its nature is descriptive. In this thesis it will be used prescriptively.

**Figure 8: Layer 3 of Berkhout’s innovation theory, the operational zoom of CIM**
2.2.4 The complete innovation management model of Berkhout

Figure 9: The complete innovation management theory of Berkhout
2.2.5 Classification of innovations

Innovations can differ in several ways; in literature, Veryzer (1998) describes innovations as falling on a range from evolutionary to revolutionary. Terms which he uses for revolutionary innovations are radical, breakthrough, really new, and game-changing. Herrmann et al. (2007) have identified that most researchers, including Veryzer, use two elements in defining the term innovation: dimension and perspective. They observed that researchers subdivide the element dimension into technology and market, and the element perspective into micro-level, company, and macro-level, industry. Berkhout (2000) states that innovations build on innovations; it is a continuous process of incremental or radical improvements to product-service combinations. All four cycles of the Cyclic Innovation Model can change in order to create new scientific insights, markets, products or technologies. Berkhout proposes to distinguish different classes of innovations, in line with the number of cycles that change during the innovation process. Class 1 innovations are the result of a new development in one cycle; class 2 innovations are the result of new developments in two cycles; and etcetera. An overview of the classification system of Berkhout:

- **Class 1 innovations** involve improvements to existing product-service combinations where only the market concept is (radically) changed. Examples can be found in choosing a different market segment, like SuitSupply who explicitly focused on men who wanted the same value for less money and who could try-and-buy in a short period of time; just besides the A4.

- **Class 2 innovations** involve the development of new product-service combinations together with a unique market concept. An example is Radio Frequency Identification that brings added value to the logistic system since it creates a new easier way of information sharing. The technology already existed; the application of RFID for controlling logistics is a class 2 innovation because it changed the ‘product creation’ node and the ‘market transition’ node. The same holds for the introduction of the GPS route information system; the technology existed and was used by the US Army. When they decided to stop blurring the GPS system, it created the opportunity to introduce GPS route information systems like TomTom. The introduction of these new products will cause a market transition from the mass use of maps to the future mass use of car navigation systems.

- **Class 3 innovations** follow from new developments in three cycles of CIM. A class 3 innovation can start with the development of new technologies, which create a new product-service combination, which on its turn creates a new market to arise. A class 3 innovation however is not that radical that it needs new scientific insights to be created about consumer’s needs and concerns. An example is the development of the CD player by Philips or the introduction of the colour television.

- **Class 4 innovations** follow from new developments in all cycles of CIM. A class 4 innovation changes society so radically that new scientific insights and understanding of societal needs and concerns will have to be created. It requires efforts in the development of hard and soft sciences. The introduction of the mobile phone can be considered a class 4 innovation, just as successful products in the nano sciences.
Schumpeter (1934) stated that innovation is the introduction of a new method of production, or the opening of a new market, or the conquest of a new source of supply, or the carrying out of the new organization of any industry, and et cetera. If Berkhout’s classification of innovations is used for Schumpeter’s definition, one could state that the introduction of a new production method should be a class 1 innovation, while the introduction of a new production method (cycle 1) in combination with the opening of a new market (cycle 2) and the conquest of a new source of supply (cycle 3) should be a class 3 innovation. And so on.

According to Berkhout (2006) ‘the whole idea behind innovation is to successfully place new product-service combinations on the market.’ In the terminology of Berkhout, a product-service combination can be anything made by human kind; from physical products to non-physical services, which can also be laws, regulations or systems. The more cycles in his model are put into action, the higher the classification of the innovation.

**Classification of the ZURBAN innovation**

In the hard sciences cycle the technologies have already been developed several years ago; one can think of the fuel cells and climate change models. The prices of zero-emissions technologies are rather high at the moment because there is a lack of volume in the sales of these technologies. The hard sciences cycle has produced technologies while the other cycles did not move. At this moment, according to Berkhout’s classification of innovations, the creation of a Dutch zero-emissions vehicle therefore would be a class 3 innovation because we observe developments in three cycles of the Cyclic Innovation Model:

- **The soft sciences cycle:** societal needs and concerns change; we observe eco-friendly awareness and a cry for sustainable solutions which will be a feedstock for new scientific insights in the social studies environment. The soft sciences cycle creates an understanding of consumer behaviour and it has the capability of influencing this behaviour.

- **The differentiated valorisation cycle:** the traditional automotive market will transform to a more eco-friendly market the coming decades. In the differentiated valorization cycle the ZURBAN concept will be created; extra value to the actual vehicle.

- **The integrated engineering cycle:** a Dutch zero-emissions vehicle will be a new product-service combination with the use of zero-emissions technologies.

It needs to be mentioned that for the creation of a zero-emissions vehicle, Spring Newco does not need scientific research in technical institutes like TNO or Delft University of Technology; they prefer technologies that have already been invented because an initial development of a new technology would take to much time. It would slow down the process and the booster ambition of Spring Newco. That is why I believe the ZURBAN would be a class 3 innovation, because one observes dynamics in three cycles of change. These relevant cycles have been highlighted in Figure 10.
The division of innovations in categories like incremental, radical, or falling on a range from class 1 to class 4 can be interesting; for this research project however it is of minor importance. I just wanted to let the reader understand that innovations differ in characteristics and the more radical or the higher classed an innovation will be, the more wheels will have to rotate in order to move. Irrespective of the innovation classification of a zero-emissions vehicle, one will understand it will ask for a broader approach than just minor changes to a product.

Figure 10: For the creation of ZURBAN dynamics in 3 cycles are observed

### 2.3 Berkhout’s theory in a prescriptive role

In this Chapter, the three leading innovation management models of the modern time have been introduced; I have chosen to work with the innovation theory of Professor Berkhout. In this paragraph, two examples in which his theory is used prescriptively and thus upfront are given. At the end of this paragraph I will explain why Berkhout’s theory will be used for the creation of the ZURBAN innovation.

#### 2.3.1 CIM for the creation of the University of the Future

In the second part of his book ‘The Dynamic Role of Knowledge in Innovation’, Berkhout uses the CIM for exploring the future of the University. Berkhout observes that the modern discipline-oriented universities are incapable of meeting society’s high expectations. Therefore, Berkhout states that the CIM should be used in order to create more coherence between branches of knowledge in the processes of knowledge-teaching and knowledge-generation. Universities often
work like a large company having several independent business units; poor communication and collaboration between the business units causes poor overall performance. Berkhout shows the necessity for these university business units to create horizontal linkages. If connections in the university are filled in CIM, he states that CIM shows that the traditional university should be redesigned in order to meet the requirements of the 21st century. In other words; Professor Berkhout uses the Cyclic Innovation Model in order to advice about the structure of the University of the Future. He uses CIM prescriptively.

### 2.3.2 CIM for the creation of a successful Thixomolding cluster

In his thesis ‘Registered trademark, The Cyclic Innovation Model as normative model for the Thixomolding innovation cluster’, Matthijs Kok (2005) has used CIM in a prescriptive role. His research goal was to increase the success chances of the Thixomolding technology cluster by creating insight in the participants and the leadership of the cluster with the help of the CIM. Kok concluded that the CIM can be used effectively by executing the roadmap Kok proposes in order to translate the general CIM concept to specific characteristics of the Thixomolding cluster.

### 2.3.3 CIM for the creation of the ZURBAN

The difference between the latter two examples and my research project is that I have the assignment of creating a physical concept of just a vision. The mentioned examples all have a basic starting point with some predefined partners which have a common history. Spring gave a carte-blanche which means that I will have to deal with a great lot of uncertainty. CIM is the most detailed fourth generation innovation management model available. Using CIM as the guide in combination with common sense would allow me to successfully create the ZURBAN innovation. CIM comprises a very structured and handy treatment; first ‘the leader’ investigates the future and creates a view of the future. Second the leader formulates several transition paths that may lead to the agreed future. Innovations should fit the future and the transition path should be realistic. If it is clear what the innovation should be like, the leader becomes entrepreneur. The dragging and pulling starts; the CIM can be used more in the operational field. Which partners do we need? What connections do they have? Which barriers are there to overcome? Don’t we overlook some partners? The entrepreneur becomes the craftsman in order to allocate the necessary knowledge and skills.

The assignment of creating five zero-emissions vehicles within one year can be regarded almost impossible if the process that should make it happen is not managed properly. CIM has the characteristic of allowing the innovator to adopt a helicopter view on the one hand, and a detailed view on needed knowledge and skills on the other hand. By applying CIM it should be possible to succeed; all available cycles can be started from the beginning which will speed up the innovation process.

In Chapter 3 Spring will have the role of the leader by creating a view of the future and drawing possible transition paths that fit that future. In Chapter 4 Spring will be the entrepreneur and the craftsman that uses CIM for the process management activities.
2.4 View of the future: external trends

In this paragraph, the first step in the application of Berkhout's innovation theory will be set. The external trends will be described that add up to Spring’s view of the future. Spring has among others a focus on energy and sustainable solutions; there is a belief that propositions can be interesting for the economics and the environment. The external trends that will be described in this Paragraph are important to mention because they form the way Spring looks to the future.

Figure 11: The external trends in the business development framework will be described

In our human life we oversee 5 generations; one can imagine the life of our parents, and the life of our grandparents. This makes it possible to imagine how one would have lived around 100 years ago. If we become older, we observe the life of our children and we can imagine the life of our children’s children. By doing so, we create a scope of around 150 years in which we notice the world changing.

‘You see that pale, blue dot? That is us. Everything that has ever happened in all of human history, has happened on that pixel. All the triumphs and all the tragedies, all the wars all the famines, all the major advances... it is our only home. And that is what is at stake, our ability to live on planet Earth, to have a future as a civilization. I believe this is a moral issue, it is your time to cease this issue, and it is our time to rise again to secure our future.’ Al Gore, 2006.

Twenty years ago, the Brundtland committee (1987) defined sustainable development as the development which satisfies the needs of current generations without suppressing the possible needs of the future generations. Though we still acknowledge the trueness of that definition, more specific definitions have arisen, like Suzuki (2000) who defines sustainability as ‘optimization of economic level of human activity within the limit of renewable resources supply and the acceptance capacity of natural ecosystems’. Sustainability is one of the main drivers of current societal trends; one notices the public cry for sustainability. The world population increases, the share of developing countries increases, the world's garbage belt increases, water
shortage increases, the dominance of technology increases, energy consumption increases, and etcetera. Sustainable development seems to be hot like never before. It is 2007; the world has successfully entered the new millennium; it is time to conserve the planet. We have stated to realize there is more than the maximization of our own needs; we ought to make sure that the world does not end up being misused by our extreme consumption. In a report published by the World Future Society, Cetron and Davies (2003) describe fifty global trends shaping the future which can be categorized in four groups; trends in world population, in the environment, in energy resources and in the development of technologies. The information in the coming paragraphs are taken from the report of the World Future Society, published in 2003.

2.4.1 Trends in world population

Trends in world population focus on the composition and the norms and values of the population. People will get older and older. The share in the world population of people living in developing countries will increase because of uncontrolled baby birth. In developed countries more people die than get born. In 2050, only 10% of the world population lives in developed countries. In developed countries people focus more and more on social responsibility. Environmental issues get highly important in our every-day lives. Companies publish corporate governance and corporate social responsibility reports.

2.4.2 Trends in the environment

Trends in the environment show a depressing scenario. Governments of developed countries try to safe environment by the creation of protected areas or national parks. Despite the efforts, water shortages increase, especially in developing countries. According to the United Nations (2003), one-third of the population of Africa and most of the major cities in the developing world will suffer from water shortages. Around half a billion people in China will have the same problems. Large cities in developed countries will face pollutants in their water system. In 2050 two-thirds of the world’s population will be living in regions with widespread shortages of water. Garbage forms one of the biggest threats for the environment. Nowadays, an average American citizen produces around 2.5 kilograms of garbage every day. Seventy percent of American landfills will be full by 2025. Europe will specialize itself in waste management and recycling. The United States will have to follow Europe otherwise garbage will accumulate in US city streets, where it will spread diseases. Because of the chancing environment, an estimated 50,000 species disappear each year according to the United Nations Environment Programme (2003); 11% of the birds, 25% of the mammals and 25% of all plants are near to extinction. Causes can be found in agriculture and urbanization. Urban areas become bigger and bigger and drive away natural life. In 2015 there will be around 60 mega cities with a population of over 5 million, almost all of them in developing countries. Up to 1 billion city residents lack adequate housing, clean water, toilets or electricity. Every year, around 10 million people die needless because of lacks in the environment they live in.
2.4.3 Trends in energy resources

Trends in energy resources can be found in the ongoing dependency on oil and the rise of alternative energy resources, which will become more competitive in near future. The world used 57 million barrels of oil per day in 1973; consumption is forecasted at 110 million barrels per day in 2020. Oil's relative share of world energy consumption is expected to decline some percentages from 40% in 1999 to 37% in 2020. OPEC will remain the biggest supplier of the world's oil, followed by Russia. Prices are expected to increase further. Contrary to popular belief, the world is not about to run out of oil. As a result of intensive exploration of oil reserves, OPEC officials claim that the 11 member countries can provide for the world's energy needs for roughly the next 80 years.

Solar, geothermal, wind and wave energy will supply a rather small fraction of the future world's energy. Natural gas will become the main energy source. It can be burned cleanly and there is enough of it available to supply the world's total energy demand for the next 200 years. Consumption of natural gas is growing by 3.3% per year, compared with 1.8% for oil. US Government has the ambition to have 20% of their energy supplied by renewable resources by 2020. At this moment this share is less than 5%. The declining reliance on oil will help to reduce air and water pollution, at least in the developed world. By 2060, a costly but pollution-free hydrogen economy may be leading.

2.4.4 Trends in technology

Trends in technology focus on the continuous replacement of technologies by newer technologies. The rate of replacement will grow further in future. Computers become part of our environment. Wireless solutions will arise all around us and change the way we communicate. Citizens will be connected, everywhere and always. We get access to networked data whenever we want it. Simple service jobs and risky jobs will be replaced by robots. Personal robots will appear in our homes by 2010. Artificial intelligence, data mining and virtual reality will help companies to solve problems beyond the current computer capabilities. Spending on research and development (R&D) will grow quickly in the areas of information technology, electronics, biotechnology, aerospace and pharmaceuticals. R&D expenses in developed countries will grow to around 3% of total gross domestic product. Jobs created by technology are more than the number of jobs lost by increasing competition of low-wage countries. The demand for scientists, engineers and technicians will continue to grow.

New York, Tokyo and Frankfurt will become the main transfer points for passengers of high-speed, large-capacity supersonic planes. There will be fewer airline crashes thanks to technological advances such as safer seat design and explode-resistant fuels. The existing hub-and-spokes airline system will be enriched with high-speed train connections for travelling distances from 100 to 200 kilometers.
These global trends as described by Cetron and Davies (2003) have been visualized in Figure 12.

![Figure 12: Trends shaping the future, World Future Society (2003)]

2.4.5 New state-of-minds of the society

In the annual report ‘State of the World’ from the Worldwatch Institute (2004), two state-of-minds are described which have to get adopted if our society aims for a more sustainable balance; the economy should be less consumptive and we should make better energy choices.

2.4.5.1 The economy should be less consumptive

The economy should be less consumptive is written by Renner (2004) which reveals the gigantic consumption culture of the western world. Consumers, producers and Governments should be stimulated to consume less. Raw materials are often cheap in terms of money, but expensive in terms of environmental damage. There is a lack of balance in the production of raw materials; cheap wood coming from trees which already grew for ages are cut down by low-wage workers in developing countries. Developed countries like The Netherlands only pay the price which settles from traditional economic laws instead of paying a fee for the enormous environmental damage we create together.

Every developed household has the ability of using refrigerators, hifi equipment, computers, and central heating systems. If all households in developing countries would have the same facilities and every-day products like we have, the burden for the planet would be unbearable. Our western mass production and mass consumption have created a potential very big misbalance in our ecosystems. This misbalance will become more and more visible. In production processes most of the material flows do not even serve any purpose. Industry has many hidden flows like waste materials, dredging materials and greenhouse gas emissions. To shrink these hidden flows, industry should improve energy and materials efficiency, boost recycling, reuse materials and lengthen the lifetime of products. Zero-waste closed-loop systems should be created as described in the book ‘Cradle to Cradle: Remaking the way we make things’ by McDonough and Braungart (2002). They describe the possibility for by-products and waste from one factory to be the feedstock of another factory. Products should be designed and manufactured to be durable, repairable, upgradeable and re-usable as the base for other products.
In the South of the Netherlands, the local Chamber of Commerce, the Province of Limburg, the region of Venlo and the Floriade BV have agreed to implement the Cradle to Cradle principles in their daily activities. They will organize a professorship for the founder of Cradle to Cradle, Braungart, and they will start building offices and public building according to the CO2 neutral principle (Duurzaamheidnieuws, 2007).

An important actor in turning developed economies less consumptive is the Government. Renner (2004) advises the Government to stop subsidizing the production of raw materials. Subsidies lead to more consumption than can be justified by economical laws. In stead of subsidizing these consumption-enlarging productions, start subsidizing the development and production of renewable energies, new efficiency technologies, clean-production methods and public transport. At the same time, start taxing carbon emissions, non-renewable energies, virgin materials, landfills and other forms of waste and pollution. Governments being one of the biggest consumers should buy eco-friendly products themselves; Governments can influence the design of products, the use of the product, the time the product should last, and etcetera. Governments are even able to set product standards that can force complete industries to change their product line. Why would Governments not implement laws which obligate companies to adopt take-it-back strategies for structured recycling of packing, electric components, vehicles, tires, batteries and office supplies?

2.4.5.2 Citizens should make better energy choices

‘We should make better energy choices’ is written by Sawin (2004) and shows in terms of energy usage that we can ‘do far better without sacrificing quality of life’. She states that in the United States more than 50% of the new-bought cars are big energy consuming SUVs. If you regard a car as the means to get from a-to-b, why would you then by a SUV? People make more trips than previous times and they travel greater distances. The physical size of an average US house has grown for almost 40% in the past 25 years while at the same time the average number of people per household has decreased. She describes that the largest share of our global energy use goes to the manufacturing of vehicles, buildings, electrical devices and food. The energy used in the manufacturing process of a house is comparable to 10 years of living in that same house. Worldwide, over 20% of all fossil energy is used for the production and transport of food. Even more awkward; rich people use 25 times more energy than poor people and the United States consumes twice as much energy per capita as the number two, Germany. If China would consume as much oil as the US, then China alone would need more oil than the entire world produced in 2001. Sawin indicates that for developed countries there is no correlation between a marginal increase in energy usage and the perceived quality of life, which can be measured with the Human Development Index of the United Nations. So, why use more energy? In fact, if we do not change the way we use energy, the quality of our lives will decrease because of environmental, social and economic impacts. Sawin advices to do three things; waste less, conserve energy and shift to other energy sources. Again, she states the important role of the Government.
2.4.6 Eco-efficiency

To underline the importance of innovations in the sustainability era, Van den Hoed (2004) has introduced the term eco-efficiency in a model in which he uses the world population, the common wealth and the eco-efficiency as variables for the environmental burden. He states that if our common goal is to have an unchanged environmental burden in 2040, we need to make all our products and services with an energy use of 1/6 to 1/15 of the energy we are using today; he calls this eco-efficiency. If we want the environmental burden in 2040 to be less than 1, then we need an even better eco-efficiency rate. One can see this straightforward calculation in Table 1.

<table>
<thead>
<tr>
<th>Environmental burden</th>
<th>Population</th>
<th>Wealth</th>
<th>Eco-efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>1</td>
<td>x 1</td>
<td>x 1</td>
</tr>
<tr>
<td>2040</td>
<td>1</td>
<td>x 2.3</td>
<td>x 3.5</td>
</tr>
</tbody>
</table>

Table 1: Future eco-efficiency, Van den Hoed (2004)

Innovations can be seen as the most important driver of sustainable development. Sustainable development has several broad definitions; it is a transition process in which we move step-by-step; it is not only about creating awareness, setting new standards, and preserving the planet, it is also about connecting every citizen of the World; it is about creating a common goal. We all share the same interests; sustainable development starts with our own lives. It asks for a change of mindset; we have to adopt new systems. Transition paths should be connected to innovations and innovations should be aimed at sustainability. Brezet et al. (2004) have visualized the flow of innovations we need in order to arrive at a higher level of eco-efficiency. He emphasizes the needed efforts to arrive at a high eco-efficiency level; every aspect in the life-cycle of a product-service combination will have to be innovated in order to arrive at an acceptable level of environmental burden. His theory is visualized in Figure 13.

Figure 13: The needed effort to arrive at a high level of eco-efficiency, Brezet (2004)
The desired ‘system innovation’ as mentioned by Brezet implicates that the whole Cyclic Innovation Model of Berkhout will have to be dynamic in order to make every element change into a renewed system. A system builds up from several elements. Brezet wants to emphasize the need for all these elements to be innovated in order to arrive at a high level of eco-efficiency. For the ZURBAN innovation project, these elements are not only the vehicle, but also the way the vehicle is presented and communicated. The system that is under research is the ZURBAN concept which is broader and contains more elements than the ZURBAN vehicle.

By having almost read this Chapter, one will believe that innovations needs to bring us at a more sustainable balance; the more elements of the products and services surrounding us get innovated, the better this will probably be for the environment. In the daily news we observe political leaders signing environmental agreements; we observe companies publishing environmental reports; the European Union wants the emissions of CO2 to be reduced with 20%, and the New Oxford American Dictionary priced the word ‘carbon-neutral’ as ‘word of the year 2006’. We face one of the greatest challenges in human history.

2.4.7 Possible system errors

Berkhout describes two possible system errors of the Cyclic Innovation Model; the potential error between science and business which can be presented as a vertical barrier in CIM and the potential error between technology development and market transition which can be presented as a horizontal barrier (Berkhout 2000). This latter barrier is characteristic for the challenge the world faces today in terms of sustainable development. The awareness of the public is enormous; the topic is hot and sexy. There is a clear sense of urgency for every actor to cooperate. The public demand for sustainable, eco-friendly products is becoming enormous; unfortunately it is often not yet available; the development of technologies is lacking.

One notices the dominant position of the public awareness and sense of urgency that is typical for the sustainability era. It is the technology upside of CIM which is underperforming; technologies are unavailable or too expensive; niche players have insufficient resources; large industrial players do have the money, but they make sound profits from traditional ways of producing. Why does Shell still stimulate to build coal-fired power plants? Why is a Shell director the chair of the energy transition committee of The Netherlands? Doing research on the broad field of energy transition will reveal this kind of irregularities in the policy-making arena. Niche players will have to stand up, innovate, and be efficient and successful in order to force the large industrial actors to cooperate. According to Berkhout, the ‘development of products’ cycle incorporates everything made by human beings. In his theory, laws and regulations also fell under this definition. This approach completes the barrier as it becomes clear that we do not only have lacking technology developments, but we also have a lack of supporting laws and regulations which in general would be able to force the industry to cooperate. The barrier of innovating in the sustainability era is visualized in Figure 14.
The ZURBAN project can be regarded a project that will help in overcoming the barrier between automotive technology developments and market transitions. Spring Newco has the ambition of becoming the bridge between the socially desirable and the technically possible; they want to be the spider in Berkhout’s innovation arena.
2.4.8 Examples of market driven sustainable innovations

In April 2007, I had contact with Joop Verloop, alumnus of Delft University of Technology and trend watcher. I explained him the Cyclic Innovation Model, and he helped me selecting examples of sustainable innovations that were driven by the market side of the CIM (user oriented):

Figure 15: Sustainable projects will change our everyday life
Sources: sustainablestyle.org, citycargo.nl, hondaracingf1.com, thelaundry.biz

From left to right, starting at the top of Figure 15 we see:

- The **Laundry Recycle Service in London** which is a truck that drives through the City and collects office waste. Due to the ‘clean your soul’ approach, it has already 1,175 subscribers in a rather short period of time. The campaign focuses at creating awareness.

- The **Honda Formula 1 race car** is one of the most pollutant cars in the world, but Honda managed to create a green reputation by erasing advertisements and drawing the globe on the car. They offer fans to print their name on this car if these fans promise to better their lives. For instance, you can promise to actively stop the water tap in the time you are brushing your teeth.
The **sustainable living expo EPIC** is organized in Vancouver and focuses on ‘leading companies who care about the consumer, the community, the planet. Companies that make great products and offer exceptional services that don’t compromise style or function.’

The **City Cargo tram in Amsterdam** is a new approach to urban distribution of goods. The city counsel of Amsterdam has granted extra privileges to the City Cargo project because they distribute goods in the inner city without emitting pollutants. City Cargo uses trams and electric vehicles.

A **low-energy computer processor** has been produced which is similar to Intel en AMD, but which uses just one sixth of the energy of these leading processors.

A **poster from EPIC Fashion** ‘Buy a better future’ should stimulate consumers not only to buy eco-friendly cloths, but also organic beer, fair-trade coffee, sustainable tabletops and rooftop gardens. It is again aimed at creating public awareness.

**Fry-o-Diesel** has developed a new technology for the conversion of extremely distressed waste oils, like used for French fries, into high quality diesel fuels.

**Wind Power Cards** can be bought at large supermarkets in the United States. It allows citizens to simply invest in green electricity.

**RE: VOLT** is a think tank which focuses on the global switch to sustainable urban development.

**Eco-friendly Levi’s jeans** has been introduced and is made from 100% organic cotton.

The **Green Zebra in San Francisco** is a city guide that teaches the reader how to live a more sustainable life in San Francisco. They claim to make you safe thousands of dollars a year by offering coupons which give you a discount in green restaurants, buses, gyms, and eco-friendly retailers.

**Nike Ecos** are new eco-friendly shoes which are made of materials that dissolve in the environment by walking. All the materials are degradable by nature.

*(Sources: sustainablestyle.org, citycargo.nl, hondaracingf1.com, thelaundry.biz – May 2007)*
2.5 Conclusion

At the end of Chapter 2, the first sub question can be answered:

- **What are the characteristics of Berkhout’s innovation theory?**

The objective of this Chapter was to make an inventory of the characteristics of Berkhout’s innovation theory. In his theory, Berkhout proposed a stepwise approach with the help of a new business development framework (Figure 6) in which:

1. A view of the future will be sketched
2. One or more transition paths will be defined
3. The Cyclic Innovation Model will be used to gain insight in the innovation process

Berkhout distinguishes three types of actors in his theory; ‘the leader’ creates a vision in accordance with the view of the future (1) and a strategy in accordance with the transition path (2). The organizing and energizing in the innovation arena is done by ‘the entrepreneur’ as shown by the Cyclic Innovation Model (3). If one zooms into the Cyclic Innovation Model, one observes ‘the craftsman’ that connects the needed knowledge and skills at the lowest layer of the theory. The Cyclic Innovation Model (3) regards the innovation process as a dynamic arena in which never-ending cycles create new insights, technologies, products and services. The entrepreneur is the spider in Berkhout’s innovation arena. His theory is useful for situations in which multiple actors are needed to innovate and in which there is a lack of insight in the roles and interactions of these actors. In this research, the theory has been used prescriptively in order to provide Spring with best practices for guiding the innovative ZURBAN proposition to the market place.
Theory's contribution to the ZURBAN innovation process

In Chapter 2, Berkhout’s theory has been used in order to put the external trends into perspective:

![Diagram](Figure 16: View of the future: external trends)

- **Trends in world population**
  - population will double the next 40 years
  - people live longer
  - sensitivity to environmental issues
  - demand for social responsibility

- **Trends in energy resources**
  - oil consumption is still increasing
  - rise of alternative energy resources
  - alternative energy will be competitive

- **Trends in technology**
  - industry beats environmental concerns
  - technology dominates economy & society
  - transportation technologies improve

- **Trends in environment**
  - water shortages will increase
  - world’s garbage belt will be huge
  - species extinction causes less biodiversity
  - continuing urbanization

The economy should be less consumptive (Renner, 2004)
We should make better energy choices (Sawin, 2004)
Systems need to be innovated to arrive at a high eco-efficiency (Brezet, 2004)
3 The ZURBAN proposition

This Chapter is divided into four paragraphs; the view of the future will be presented that builds up from experts' opinions (3.1), the ZURBAN innovation project will be defined (3.2), several transition paths will be assessed in order to arrive at the ZURBAN vehicle (3.3) and the conclusion of the Chapter will be drawn (3.4) in which the second and third sub questions will be answered: *What are the characteristics of the ZURBAN proposition? & Which transition path will fit the ZURBAN best?*

![Diagram of business development framework]

**Figure 17:** The business development framework is the guide for Chapter 3

### 3.1 The view of the future

The view of the future is relevant for the development of the ZURBAN; the ZURBAN innovation should fit a certain belief about what the future in the Netherlands will be. The future in the Netherlands will be described at two perspectives; the technology perspective in which a vision on the development of future automotive standards has been given and the urban area perspective in which the expected future of the Dutch urban areas has been described as it will probably be the ‘playground’ of the ZURBAN concept.
3.1.1 The future from a technology perspective

In 1896 the first two cars were introduced in The Netherlands; in 1939 the number of cars had grown to 100,000 (Wiki 2007). These cars formed a melting pot of several technologies; older cars drove with the help of a steam engine, others with a combustion engine or an electric engine. Fast and radical technological improvements in the combustion engine made it the standard in the automotive industry; electricity and steam were no longer used as alternatives. Nowadays, over 7 million cars drive in The Netherlands (Wiki 2007). According to the Automotive Encyclopaedia (2001) there were 200 million cars driving in the world in 1970, a number that grew to 500 million around 1990. At the present time, there are over 600 million cars in the world and one expects this number to be doubled in 2030. Joseph Romm, connected to the Center for Energy and Climate Solutions and assistant Professor at the Massachusetts Institute of Technology, has reviewed ‘the car and fuel of the future’ (2005). In his article, he concludes that there is ‘an urgent need to reverse the business-as-usual growth path in global warming pollution in the next two decades to avoid catastrophic climate change necessitates action to make our vehicles far less polluting’.

3.1.1.1 McKinsey believes in the internal combustion engine

The internal combustion engine has been the standard in the automotive industry in the 20th century; some think the nearby future of the combustion engine is in danger, others think it will take at least 50 years for the combustion engine to be fully exchanged for an alternative technology. One observes hybrid power trains and the rise of alternative energy carriers like the fuel cell technology. The first fully electric powered cars which drive fast and far have already been developed. However, if one would ask whether the conventional combustion engine would disappear or not, it would probably be impossible to answer. The combustion engine producers have increased the quality of their engines considerably the past 20 years. The level of emissions of pollutant particles has decreased significantly, sometimes more than 99%, and the fuel efficiency has improved; the number of effective horse powers per litre of fuel has increased enormously. One is able to buy cars which drive 25 kilometres on 1 litre of diesel or even better. McKinsey (2002) therefore expects that in 2015 still 90% of the cars will have the traditional combustion engine. It will take supply-side measures like R&D assistance and demand-side measures like tax credits to speed up the shift to alternative engines. McKinsey states that the success of the internal combustion engine can be found in a clear and sound balance between technology, infrastructure, safety, durability, costs and ease of use. If this balance is brought out of equilibrium by the shift to a new technology or by an improvement in an existing technology, a new balance will have to be created in all those elements; infrastructure, safety, durability, and etcetera. According to McKinsey, this will be harder than one might think.

3.1.1.2 Romm believes in the hybrid gasoline-electric vehicle

Romm (2005) describes the fact that due to the risk of job losses in the automotive industry and compromises in terms of safety and performance, it will be most likely that a non-radical technology will become the new automotive standard. Romm thinks the hybrid gasoline-electric vehicle will be the dominant vehicle platform by the year 2020. He introduces the power of the
established industry by describing the barriers that will need to be overcome for the introduction of eco-friendly vehicles. When Intel had developed a series 2 of their Pentium processor, they waited until the series 1 was totally milked dry before making the series 2 reachable for the large public. That is a game which can be played in markets with a rather small number of large and powerful players; just like the automotive industry.

### 3.1.1.3 The automotive industry is in favour of the use of bio fuels

Jan Heetebrij is director of consulting firm HeeCon and he has been involved in the repositioning of Nedcar. According to Heetebrij, the lobby of the automotive industry is strong. If one looks into the potential new automotive technologies one observes several technologies which make the presence of car parts like link plates, acceleration barges, and even brakes unnecessary; if some technologies would become the new standard only 10% of the current supply of car parts would be used in the new production processes. One can imagine the enormous change this would create in the automotive industry. Most of the subcontractors of the large car producers would have to change their product portfolio radically; there is big chance that they would even go bankrupt. Moreover, a new standard which causes cars to be simplified and thus produced easier will create an opportunity for new companies to enter the market and start building cars themselves. What would happen with the established car producers if a substantial number of new entrants would show up because the complexity of producing cars decreases? One understands that a risky future can cause resistance. Heetebrij therefore argues that the automotive industry is in favour of the use of bio fuels which make it possible to still use the internal combustion engine. The mass use of bio fuels will keep a car rather unchanged and it will keep the public locked-in.

### 3.1.1.4 The oil industry is in favour of the use of bio fuels

If the world would switch to the use of electric engines, one can imagine that the traditional oil producing companies will loose their biggest client. The lobby of the oil companies supports the quest of the car producers and is in favour of the use of bio fuels. According to Ewald Breunesse of Shell, their focus is on the use of second generation bio fuels which will probably be available around 2020. Until then, the demand for their conventional oil will stay at the current high level and by 2020 they will start selling bio fuels at large volumes. Shell stays away from the first generation bio fuels because of ethical grounds; first generation bio fuels often interact with the food chain. This might be a cover-up of actually doing nothing ground-breaking in the field of alternative energy supply. Oil producers have visible political power and are thus in the possibility of guiding the migration process to new, innovative ways of dealing with energy. In The Netherlands the local director of Shell, Rein Willems, used to be the chairman of the national energy transition platform. This has given the Dutch oil industry a visible policy-influencing position which does not necessarily mean that the oil industry really wants to turn into the alternative energy supply.

### 3.1.1.5 Heetebrij believes in the use of in-wheel electric engines

Heetebrij, director of HeeCon Business Development and automotive expert, believes that the mentioned forces of the automotive and oil industries need a counterforce in order to start the
eco-friendly developments. Heetebrij has advised Nedcar to focus on the production of electric vehicles and he involved the electric power industry in the discussion. He advised the industry to combine forces in order to stimulate the use of alternative transportation. Most of the alternatives find their basics in the use of an electric engine. These engines get their energy from batteries, fuel cells, generators or something similar. Most of these alternative vehicles will have plug-in capabilities which mean that they can be plugged into the electricity net. The potential mass use of electric engines will create an enormous increase in the demand for electricity, especially at nights when cars are parked. It provides the industry the possibility of selling large amounts of nightly overcapacity. Jan Heetebrij interacts with Eurelectric, the European lobby group of the electricity power providers in order to influence the migration process. According to Heetebrij, the counterforce of the electric power industry should be enlarged by environmental organizations. The use of electric engines can have regenerative powers which mean that millions of micro warmth strength links can be created; if the car is not being used, it can operate like a generator and thus give back energy to the electricity net. Heetebrij thinks the electric vehicle will have the future in combination with high-capacity, quick-rechargeable lithium-ion batteries; he does explicitly not believe in the use of hydrogen fuel cells. According to Heetebrij, the reactions from electricity to hydrogen back to electricity cost too much energy to be cost-effective and eco-friendly.

3.1.1.6 Van Drunen believes in the hydrogen fuel cell car
In the process of creating the view of the future, I have interviewed Frits van Drunen, who works for the Municipality Transportation Company of Amsterdam and who is a member of the Dutch Platform on Sustainable Mobility. He has been the project leader of the hydrogen buses that drove in Amsterdam the past three years. Van Drunen confirms the uncertainty of the automotive future; he acknowledges the forces that have been described coming from the automotive and oil industry. He thinks the big breakthrough will be in the decade between 2020 and 2030 when he expects hydrogen fuel cells to be the future. Van Drunen does not believe that batteries will be a sound alternative; he states that at the end of their life-cycle batteries can be rather pollutant for the environment. Van Drunen argues that for both alternatives, batteries and fuel cells, a new infrastructure is needed so that will not be a real matter of influence. It is the combination of the ease-of-use and the needed price-fall that will have influence on the large adoption of an alternative automotive standard. He thinks it will be the hydrogen economy that will be leading. It should be noted that the first step, before 2020, will be the large-scale use of gasoline-electric hybrids according to Van Drunen.

3.1.1.7 Honda believes in hybrid gasoline-electric vehicles and in the fuel cell car
Joost Rust of Honda shared the vision of Van Drunen. Honda first focuses on the adoption of their gasoline-electric hybrid vehicles and at the same they invest in the development of the hydrogen fuel cell car. Though, it needs to be mentioned that according to Rust Honda is not able to pinpoint the future standards; their strategy is to assess as many technologies as possible. They want to get know several future solutions in order to be able to adjust to what will happen. Other cap producers like Toyota and Renault have stated the same strategy at their websites.
3.1.1.8  TNO does not pinpoint the future automotive standard

Olaf op den Camp, project manager at TNO Automotive underlines the uncertainty in the automotive future. He states that the only certainty we have is that the automotive future is uncertain; it is unclear which technology will be the standard. For the short term, Op den Camp believes the hybrid vehicle can form a sound solution in combination with the use of bio fuels. On the long run TNO Automotive does not dare to do any valuable predictions. They are willing to assess any available technology.

3.1.1.9  Spring Newco believes in regional diversity of standards

It is clear that the future of automotive technologies is rather uncertain at the moment. Ebel Kemeling and Femke Markus, both director at Spring, believe in the regional diversity in automotive standards. They think there will exist a platform that can be easily adjust to different standards. If an area for instance has a great surplus of hydrogen because of the existence of certain industries, this platform might be used in combination with a hydrogen fuel cell stack. If another area has a great surplus of green electricity, the platform might have an electric engine in combination with a large-capacity battery pack. In areas where gas is widely spread, vehicles might be driving on internal combustion engines fuelled with gas. This view creates the opportunity of assessing several possible options; it does not exclude any option upfront.

3.1.1.10  Examples of the future

In order to give the reader a feeling of the future in the automotive industry, I have selected some interesting initiatives that can have a forecasting value. In Figure 18 these examples have been visualized.

3.1.1.10.1  The Modec distribution vehicle (UK)

In the United Kingdom the former designer of the London cab has introduced the Modec Van which drives on a conventional electric engine that is placed between the front wheels. The electricity is taken from a very large and heavy battery pack. The Modec Van costs around 40,000 euro and the battery pack can be leased for 700 euro per month. In future, the price of batteries in general will lower substantially and the price of the Modec Van in particular will lower when volumes of production go up. In 2007, Modec expects to sell around 250 vehicles, in 2008 this number will have to be doubled to 500 pieces and in 2009 they expect to sell around 1,000 vehicles. The first 250 vehicles have been sold in just a couple of months. (Modec 2007).

3.1.1.10.2  The Tesla electric race car (USA)

In the United States a company named Tesla Motors had developed a fancy looking sports car which drives on a conventional electric engine that is placed between the rear wheels. The Tesla Roadster has a range of 300 kilometres on one charge; the battery is from the latest lithium-ion technology and the engine has an enormous power of 185kW. The top speed of the Roadster is 200 km/hour. The car costs 100,000 dollar and the first 100 cars were sold before production started. The Roadster has been developed in collaboration with Lotus and it is an idea of the founder of PayPal, billionaire Elon Musk. (Tesla 2007).
3.1.1.10.3 The Venturi Fetish electric race car (USA)
If one believes that the Tesla Roadster is not exclusive enough, one could buy the Venturi Fetish which costs 400,000 dollar and of which only 25 are produced. The Monaca-based company customizes the vehicle exactly the way the customer wants. The sports car has just one gear which enables the driver to speed up till around 240 km/hour. (Venturi 2007).

3.1.1.10.4 The ZAP Xebra (USA)
In the United States ZAP is a company that produces electric vehicles since 1994. It has already sold over 90,000 vehicles which makes ZAP market leader in the United States. They sell all kinds of electric mobility solutions; from bikes to trucks. The performance of their vehicles is starting to be sufficient for every-day use on the highways in the United States. ZAP has signed a 10 million dollar deal with PML, a producer of direct-drive electric engines which allows them to stop using conventional electric engines. An engine placed directly on the wheels (direct-drive) is more efficient than an engine placed between the wheels. This deal will help ZAP keeping their prices low and their performance high. In Figure 18 I have placed the ZAP Xebra which provides place for 4 passengers and which costs around 15,000 dollar. (ZAP 2007).

3.1.1.10.5 The Hybrid Beetle (NL)
In The Netherlands, TNO Automotive has rebuilt a Volkswagen Beetle into a hybrid Beetle based on a powerful electric engine. TNO took out the traditional drive train and the internal combustion engine. They replaced it with an electric engine and super condensers (instead of batteries). The super condensers can be charged by a small combustion engine that is placed in the trunk of the Beetle. The combustion engine thus acts like an electricity generator and does not transmit labour to the wheels. This Beetle has an electric engine of 200 horse powers which makes it a powerful alternative. (TNO 2007).

3.1.1.10.6 The Plug-in Prius (NL)
Again in The Netherlands, Sjef Peeraer, an alumnus of Delft University of Technology, has developed the Plug-in Prius which is an improved version of the standard Toyota Prius. Peeraer has replaced the battery of the standard Prius with a large-capacity battery, he has redesigned the on-board software and he has added a stopper contact at the bumper. These improvements enable the Prius to drive solely on the electric engine for over 50 kilometres. Test riding has shown that the average fuel consumption of the Plug-in Prius is around 1 litre of gasoline per 40 kilometres of driving. Additional costs for rebuilding a standard Prius are around 10,000 euro which can be lower if volumes go up. (Prius 2007).

3.1.1.10.7 Other examples
It would not be fair if I would not mention the initiatives that come from the established automotive companies. Every car producer has already developed one or more eco-friendly vehicles. There are hybrid vehicles available from Toyota, Lexus, Honda, Citroen, Fiat and Mercedes (sources: corporate websites). There are concept cars available with integrated fuel cell technology from Nissan, Honda, Opel, Jeep and General Motors (sources: corporate websites). Toyota even equipped their all terrain vehicle RAV4 with hydrogen and methanol fuel cell
capabilities. According to Marcel Vos, business development manager at Pon Automotive it will take until 2020 before the traditional car producers like Volkswagen and Audi will start producing eco-friendly vehicles for the large public. Until then, the automotive future will mainly be guided by niche players that focus on the production of several thousands of cars.

![Image: Modec Van, Tesla Roadster, Venturi Fetish, ZAP Xebra, TNO Beetle Hybrid, Plug-in Prius]

**Figure 18: Six vigorous examples of the automotive future**

### 3.1.2 The future from an urban area perspective

Spring Newco has the ambition of creating a vehicle concept that will be used for distribution purposes in urban areas. The focus is on an application in urban areas because of the direct benefit it can cause for the local air quality, which is a matter of interest for local politicians. Moreover, the visibility for the public if the ZURBAN drives in and around the cities will be higher. One should think of a fancy looking light van that will attract the attention of every traffic user. Even stronger; this vehicle should perform activities that contribute to the eco-friendly character of the vehicle. TNT could for instance use the vehicle to collect waste paper while delivering mail or Van Gansewinkel could use the vehicle to collect dry waste in the centre of Amsterdam.

In the innovation theory of Berkhout, an innovation should fit a certain future. Besides the fact that the ZURBAN will fit the dynamics around new automotive technologies, it does also fit the future of the Dutch urban areas which will be the playground of the vehicle. Several city counsels of large Dutch cities have an active policy on discouraging the use of cars in and around their cities. The past 5 years almost every large city in the Netherlands has introduced the so-called ‘eco zones’. An eco zone is a predefined part of the city that suffers from bad air conditions and congestion. In the eco zone it is forbidden to drive by car, except for inhabitants and for selected distributors of goods. These distributors suffer from all kinds of extra obligations. In Amsterdam for instance, a distributor driving a diesel vehicle should have an engine with at least a Euro3 or Euro4 norm. Furthermore, the vehicle should be filled for 80% with goods which have a destination in the eco zone and the distributor is only allowed to be in the eco zone between 7am and 11am. In Amsterdam, The Hague and Utrecht these measurements have been taken some years ago. Some instances have been selected in this paragraph that provide an idea of the future of transportation in urban areas (see Appendix).
3.1.2.1 Enschede has successfully introduced the eco zone
In Enschede, an eco zone was introduced in January 2007 by project leader Huib Rietveld. He managed to reduce the total number of distribution kilometres in the eco zone by more than 50%. According to Rietveld, Enschede will extend the eco zone the coming years because of this success (see Appendix).

3.1.2.2 Wim Kok sees congestion as one of the biggest treats for the economy
By the committee Kok that advised Minister Remkes on the foundation of one Randstad metropolitan area, congestion and the life climate are named as two of the biggest treats for our economy (see Appendix). By discouraging the use of cars, municipalities try to reduce congestion in and around their city. A large city that cannot be reached in the future will not have a flourishing local economy, according to Kok.

To adopt a realistic view of the future in urban areas and to make sure that the ZURBAN concept would fit this future perfectly, I have taken part in multiple group sessions with policy makers of the municipalities of Amsterdam and Rotterdam.

3.1.2.3 Amsterdam avoids vehicles in the city
In Amsterdam, I have attended a meeting with experts on the field of air quality strategy. Several discouraging measures have been talked about.

3.1.2.3.1 High parking tariff
According to alderman Herrema from Amsterdam, the quest against the polluting vehicles has just started. He will try to introduce an even higher parking tariff and an extension of the eco zone; a high parking tariff will reduce congestion around Amsterdam. London has the congestion charge, and Amsterdam has the parking tariff (see Appendix).

3.1.2.3.2 Good park and ride places
In Amsterdam, Harry van Bergen is in charge of the air quality strategy of the city. According to Van Bergen, Amsterdam should stay reachable by car the next decade. Therefore, the use of the car in the city itself will be discouraged by higher parking tariffs and less parking places. Good ‘park and ride’ places will be created and stimulated more on the outside of the city. People will use bicycles or public transport for travelling the last mile. The Noord/Zuid metro project is one of the big initiatives that fits this ambition.

3.1.2.3.3 The Citycargo project
The support that the city counsel has given to the Citycargo project is another example. By stimulating the widespread transportation of goods via the tram infrastructure, an amount of hundreds of trucks do not have to enter the city. Trucks drive to a cross dock location in Osdorp where the goods are placed on the tram. Although I do not believe in the potential success of the Citycargo concept because of the many overload points, it is still a good example of what might be the future. The fact that the municipality allows a commercial party to exclusively use their infrastructure in order to distribute goods more eco-friendly and in order to reduce congestion, is
a trend which will continue. Citycargo will use electric distribution vans that are allowed to drive on bus and tram lanes in Amsterdam. These clean vehicles will not suffer from congestion problems and thus will be able to deliver more goods in less time (see Appendix).

3.1.2 Subsidized bicycles
To show the seriousness of Amsterdam, it is nice to mention that two students from Amsterdam received over 200,000 euros of subsidy to implement a corporate bicycle lease plan for the large companies in Amsterdam. It is the change of a new mindset in which transportation should be eco-friendly for the air quality and fast by avoiding the traffic jams.

3.1.2.4 Rotterdam has its Climate Initiative
In Rotterdam, my contact person has been Peter Verschoor who is the project leader of the Rotterdam Climate Initiative (see Appendix). On behalf of Spring Newco, I was placed in a committee which was called ‘de Koploperstgroep’. Ivo Opstelten, the Mayor of Rotterdam, has announced the cooperation with the global Clinton Climate Initiative plan. Therefore, the committee has been founded of which Peter Verschoor is in charge. The committee came together several times and discussed a pilot which Rotterdam should start in order to decrease the total number of distribution kilometres in the city.

Rotterdam and TNT will start a pilot in sustainable urban distribution
Spring Newco proposed several options for a pilot in Rotterdam, from exchanging the current car park of the municipality workers by the Toyota Plug-in Prius (see ‘examples of the future’) to the start of a ‘TNT train’ in which TNT would drive with zero-emissions vehicles and distribute goods from outside the city to the shops. To show the momentum that can be developed around this kind of initiatives, it is interesting to mention that I was called by Gijs van Breda Vriesman, director at Shell Hydrogen, who has offered to cooperate in a pilot with Rotterdam. If the municipality would choose to drive with hydrogen vehicles, Shell Hydrogen is willing to invest in a new hydrogen filling station in the region. This would kill the chicken-egg problem of alternative transportation and can be seen as a sign that these developments might be closer than one thinks. The Rotterdam/TNT pilot has the potential of becoming the launching customer for the ZURBAN vehicle concept, because it incorporates the broad view on urban distribution. Moreover, these two actors are trustworthy and therefore interesting to have aboard such an initiative. In Chapter 4 of this report, the option of having Rotterdam and TNT in the ZURBAN concept will become serious.

3.1.2.5 Nijmegen has the ‘Binnenstadservice’
In Nijmegen, I had contact with Birgit Hendriks from the Binnenstadservice initiative which is a non-profit project that, again, collects goods just outside of the city and brings it with eco-friendly vehicles or –even better- bicycles to the entrepreneurs in the city. It is a big hit and mainly used by small entrepreneurs like shoe shops and specialized super markets like the Natuurwinkel.
3.1.2.6  Spring's view of the future urban areas

The conclusion which can be drawn from these examples is that the urban areas will become cleaner the coming years. Large polluting vehicles will disappear and be replaced by sustainable distribution concepts like Citycargo or the TNT train. Distributors like TNT Express, DHL, and GLS, which per vehicle drive a daily average of just 50km in the city, will start using electric vehicles or other eco-friendly solutions in order to be able to have extra privileges like the use of bus and tram lanes. Inhabitants of the big cities will be encouraged to use the ‘park and ride’ places. Projects like the Noord/Zuid metro line accomplish the public transport system. At the end of the day, this belief in the future creates an opportunity for the introduction of our ZURBAN vehicle concept.

3.2  The ZURBAN proposition

Spring Newco has the ambition of being the booster for sustainable mobility in The Netherlands by creating a zero-emissions vehicle; the ZURBAN should in fact be a communication means in itself. It should be visible and attractive; it should be clearly distinctive from traditional vehicles. The PR value of the vehicle should be high; people will have to recognize the vehicle as the ZURBAN if they see it driving through the Dutch cities. In order to create serious momentum, a learning curve and a potential scalable business, Spring Newco wants to produce at least 5 ZURBANS. Spring Newco will be the entrepreneurial management partner in a consortium of partners that together create the ZURBAN. The final selection of partners will be done with the help of the Cyclic Innovation Model in Chapter 4. For the selection of the needed transition path, Spring Newco defined three criteria.

3.2.1  The ZURBAN should be used for urban distribution purposes with a green twist

Spring Newco believes that potential launching customers can be found best in the urban distribution sector. These companies have a high visibility to the public and suffer most from congestion in the cities. If Governments would stimulate to drive eco-friendly by allowing zero-emissions vehicles to use bus- or tram lanes, a very huge advantage especially for this kind of companies would be created then. They can do their deliveries faster and thus deliver more in one day. This is confirmed by the fact that one notices urban distribution companies to be already involved in uncommon projects like the hydrogen distribution boat in the canals of Amsterdam which is used by DHL and the Citycargo project which is partly subsidized by DHL (see Appendix). Spring aims at distribution purposes ‘with a green twist’ in order to increase the value of the ZURBAN concept; it would be good if an urban distributor would drive with the ZURBAN, it would be better if the activities performed by this distributor would have an eco-friendly footprint.
3.2.2 The ZURBAN should be zero-emissions

Experts differ from opinion on the future standards in automotive technologies. However, in order to innovate and change the way we live, it is sometimes necessary to aim for the more extreme. At this moment in automotive history the application of zero-emissions technologies can be regarded as rather extreme because the development and production is still very cost-intensive, while the very cheap combustion engine seems to get cleaner every year. In order to create awareness, momentum and PR value, the aim should be at zero-emissions for the ZURBAN.

Note: If it would turn out to be too expensive to create a fully zero-emissions vehicle, it would also be possible to make a partly zero-emissions vehicle: if one drives at a maximum speed of 60 km/h the vehicle is zero-emissions and at higher velocities, the vehicle is low-emissions. The border is set at 60 km/h because that is the maximum velocity needed in and just around Dutch cities.

3.2.3 The ZURBAN should stimulate the Dutch automotive industry

The Netherlands are one of the biggest producers of trucks in Europe; in 2005 DAF in Eindhoven produced 41.000 vehicles and Scania in Zwolle produced 22.000 vehicles (HeeCon, 2007). In the field of vehicles under 3,5 tonnes, light trucks and passenger cars, the Netherlands does not play a large role in Europe. We only have Nedcar in Born which is fully owned by Mitsubishi and produces 70.000 cars per year while the maximum production capacity is around 300.000 cars per year. The future of Nedcar is unclear because of this underperformance (HeeCon, 2007). In Helmond we have what one could call an automotive industry: it is a melting pot of research institutes and subcontractors of the established car producers. Small, innovative companies can be found in Helmond. In order to create new employment in The Netherlands, Spring Newco wants to focus on the potential stimulation of the Dutch automotive industry. Zero-emissions technologies are new and innovative; the development and application of these technologies offers the Netherlands the chance of becoming the specialized expert in Europe. The ZURBAN can be a good start; therefore it should be a role-model for the future.

In terms of performance the ZURBAN should have a maximum speed of 120km/h and a driving range of at least 150km. These figures have been defined on basis of interviews with potential users of the ZURBAN; Stef Bouwhuis from the Platform Express Vehicles, Jean-Paul Duurland from DHL and Michiel Cusell from TNT Express.
### 3.3 Possible transition paths

A transition path should lead to the physical realization of the ZURBAN; the ZURBAN has to be developed and operational by mid 2008, which implicated that the transition path is dependant on the technologies that are available in the market.

![Diagram

**Figure 19:** Possible transition paths will be described in Paragraph 3.3

#### 3.3.1 Start from scratch or rebuild a vehicle

The first choice Spring Newco had to make was whether they would build a vehicle from scratch or rebuild an existing vehicle. According to Robert Loman from Frog Automated Guided Vehicles in Utrecht it is not a sinecure, building a vehicle. He had built a transportation vehicle from scratch and he had run into many problems. It had taken Loman more than 3 years of pulling and dragging to create a vehicle that was technically sound and safe. In The Netherlands the RDW is responsible for controlling the safety of new vehicles. They do not have any other objective than safety, which means that the process of getting a new developed vehicle approved is very time-consuming. It took almost a year of getting the Frog vehicle approved by the RDW. If one would choose to rebuild an existing vehicle, and one would keep most of the vehicle unchanged, the process of getting a vehicle approved by the RDW can be substantially quicker.

Spring Newco should therefore choose to rebuild an existing vehicle because that would be the only solution that would fit the time requirement of the project. A vehicle which has already been developed, produced and approved is able to be changed into a zero-emissions vehicle within one year. Having this decided, a partner was needed that would have access to such vehicles; preferably a Dutch partner. In The Netherlands, there is not a large producer of transportation vehicles with a maximum weight of 3.5 tonnes. Luckily, Pon Holdings which is one of the biggest vehicle dealers in Europe with a turnover in the billions of dollars range and over 9,000 employees (Pon, 2007). Femke and I spoke with Bert van Haarlem, chief information officer of Pon and Marcel Vos, manager business development.
It turned out that the ZURBAN project came at the right time; they had several demands from customers who wanted to buy eco-friendly vehicles. Moreover, Pon had contacted Volkswagen to ask for the status in the development of eco-friendly vehicles from Volkswagen. According to an unofficial reaction of Volkswagen, Volkswagen aims for the large scale application of the clean blue motion internal combustion engine vehicles the coming years instead of more radical solutions like the use of electric engines. This created the opportunity for Pon to fill the gap that their preferred car producer had created: Pon will create the first zero-emissions transportation van in the Netherlands.

Four possible transition paths have been proposed to Pon; all based on their current Volkswagen Transporter. All these paths are based on the use of electric engines:

1. E-Traction, Apeldoorn
2. Spijkstaal, Spijkenisse
3. PML Automotive, Alton (United Kingdom)
4. TNO Automotive, Delft

There is one other engine that could have been chosen: the pressured air engine from MDI in France. I had contact with Christian Brunsil who is the assistant of the founder of MDI, Guy Negre. He sent the business plan of MDI; the time requirement of one year turned out to be unreacha

Although option 3 (PML Automotive) is in principal not Dutch, there is a Dutch company that represents PML in The Netherlands; HeeCon Business Development. HeeCon is partner in PML which makes it possible to regard PML as falling in the ZURBAN set of requirements.

In accordance with the wishes of Spring Newco and Pon, the four serious options will be assessed in which they score in six variables.

1. Reliability of the technology
2. Price of 5 ZURBANS
3. Price of 100 ZURBANS, in other words: the scalability
4. Subsidy chances
5. Possible footprint for the launching customer
6. Chances of becoming a future standard
Note 1: time is not a variable because every potential partner is able to create 5 ZURBANS within one year and 100 ZURBANS in two years.

Note 2: the cooperation with Pon has already increased the chances for subsidy enormously. According to Hans Kelderman, the subsidy advisor involved in the project, Pon enables to create a network effect because Pon has many supporting units, like 20 Dutch petrol stations and a big financial lease unit. Though there still are some options that will increase the chances for subsidy compared to other options.

Note 3: a hydrogen fuel cell can be used in every option. One should regard a fuel cell stack as nothing more than a battery that can be charged with some specific fuel, like hydrogen or methanol. Therefore, the application of a hydrogen fuel cell stack of Nedstack will be optional in every transition path. The four paths will be assessed without the use of a hydrogen fuel cell stack. These stacks can be placed for the same price in every option.

3.3.2 E-Traction

E-Traction is a supplier of electric engines for some decades. Several years ago, director Arjan Heinen invented a direct drive in-wheel electric engine for large wheels. He built a prototype city bus that has been frequently in the news (see Appendix). The technology of E-Traction has enabled buses to drive eco-friendly; the bus has become a hybrid vehicle with an electric engine in combination with a battery and a small diesel generator. If Pon would choose for E-Traction, their technology would have been redeveloped for the use in smaller wheels, namely the wheels from a Volkswagen Transporter. This makes the E-Traction option rather expensive. In order to be totally zero-emissions, it would be necessary to exchange the small diesel generator by a hydrogen generator from Nedstack or to use no generator at all, only a large-capacity battery.

3.3.2.1 Reliability of the technology

This seems like the most uncertain variable of E-Traction. Their technology has only been approved in a non-similar concept car, which was a city bus driving on wheels with a rather large radius. Critics doubt the applicability of E-Traction's technology on smaller wheels. We all know the physical law ‘force times distance’; what if the radius of the wheel becomes so small, that the applied torque is too low to set the wheels in motion?
3.3.2.2  Price of 5 ZURBANS

The price of 5 ZURBANS will be € 1,300,000 as offered by E-Traction. This price is based on calculations of E-Traction. E-Traction has given a rough division of this price in several elements, however, they have stated that this division would probably be dynamic and that the total price would be around € 1,300,000, one way or another. They knew that their offering would be compared with 3 alternatives. Therefore, their price can be expected to be rather sharp, otherwise they won’t win the internal tender. The mentioned price is included parts supply, system integration and homologation. This price is excluded the costs made by Pon for the delivery of 5 Volkswagen Transporter (€100,000), and the potential costs for 5 hydrogen fuel cell stacks if needed (€525,000). These excluded costs are constant for every transition path and thus out of scope for the selection process.

3.3.2.3  Price of 100 ZURBANS

The price of 100 ZURBANS will be € 4,000,000. This price is based on calculations made by E-Traction and it is not based on previous assignments. It is the price that E-Traction would ask if Spring would deliver 100 Volkswagen Transporter at the gate of E-Traction. A price of € 4,000,000 means that the scalability is rather good. The price per ZURBAN declines from €260k to €40k, which is minus 84%. These costs are still excluded the costs of purchasing the Volkswagen Transporter and the costs for the optional hydrogen fuel cell stacks.

3.3.2.4  Subsidy chances

The chance of subsidy is based on the opinion of our subsidy advisor Hans Kelderman. He has found out that E-Traction is already involved in a series of subsidy trajectories. According to Kelderman this might have created a negative sentiment around E-Traction. He has therefore suggested that there might be other companies that have a higher chance of obtaining subsidy with. Jan Piet van der Meer has confirmed the negative sentiment around E-Traction, as they are working together in a project for Mitsubishi dealer Boudesteijn. In this project, which is focused on creating a proof-of-concept for the E-Traction and Nedstack technology, subsidy has already been granted to E-Traction which makes chances for the ZURBAN project shrink.

3.3.2.5  Possible footprint for the launching customer

The possible footprint for the launching customer will be rather good with the E-Traction option. The city bus which has been rebuilt by E-Traction has acquired a lot of publicity; the Dutch Minister Balkenende even drove in the bus. The fuel efficiency of the in-wheel technology of E-Traction will be better than a conventional electric engine. This will attract the attention. The creation of a Volkswagen Transporter that drives 1:40 in diesel-equivalents will be interesting input for the media.

3.3.2.6  Chances of becoming a future standard

Spring’s vision of the future standard in the automotive industry is that it will be possible to have multiple standards in multiple regions. However, if the focus is on electric engines, the in-wheel direct drive technology will probably become the standard because of the ease of use. It can be placed in the wheels and nothing more than electricity is needed in the car to make it operate.
Gear boxes, transmission plates, links, it is all unnecessary. Though it might take some time before a large-scale switch will be put into motion.

3.3.3 Spijkstaal

Spijkstaal is a producer of electric vehicles from Spijkenisse. It has become famous because of the production of the SRV vehicle in the Netherlands. In the Netherlands Spijkstaal is the market leader with a production of around 500 electric vehicles per year. They focus on niche markets like European airports and municipalities (Spijk 2007). Spijkstaal creates their vehicles from scratch. However, Spijkstaal has also some experience in rebuilding a conventional internal combustion engine vehicle. In 1995 they have turned 12 Volkswagen Caravelle into electric vehicles with a top speed of 100km/hour and a driving range of 200km. In fact, they have already created a ZURBAN back then (see Appendix).

Spijkstaal produces battery electric vehicles with a conventional electric engine that is placed between the front wheels. The main advantage of choosing a battery electric vehicle with a conventional electric engine is the ease of operation. It has already been done thousands of times; the drill is known and the costs are rather low. At the same time this can also be regarded the main disadvantage of choosing for this option. It is not new and innovative and therefore will not be able to set an example for sustainable mobility in the Netherlands.

3.3.3.1 Reliability of the technology

Spijkstaal can be regarded a very reliable company if it comes down to technology. They use conventional electric engines which have been tested over and over again. They have made electric vehicles that drive in the most extreme weather conditions in several European airports, for instance in Scandinavian countries. Spijkstaal will use the most conventional electric engine they can get.

3.3.3.2 Price of 5 ZURBANS

Based on an offering of Spijkstaal, the total price of 5 ZURBANS will be € 450.000. This is, again, excluded the costs made by and the potential costs for the hydrogen fuel cell.
3.3.3.3 Price of 100 ZURBANS
The price of 100 ZURBANS will be € 5,000,000. This means that the scalability is less than the E-Traction path. The price per ZURBAN declines from €90k to €50k, which is minus 44%. It should be mentioned that this decline is rather certain, because Spijkstaal has done this kind of projects before. The decline predicted by the other companies is less certain than the prediction of Spijkstaal.

3.3.3.4 Subsidy chances
The Volkswagen Caravelle project of 1995 was granted a subsidy by the Minister of Transport back then. If Pon would choose once again for Spijkstaal, the project might be too much alike. Therefore, according to subsidy advisor Kelderman, the expectation is that the chances for subsidy are not very favourable if Spijkstaal would be the hardware supplier.

3.3.3.5 Possible footprint for the launching customer
The cooperation with Spijkstaal will per definition not be regarded ‘sexy’ or ‘hot’. It is a rather traditional producer of rather traditional electric vehicles. Moreover, they have done the trick before. The risks of cooperating with Spijkstaal are low, but the upside or footprint is rather low as well.

3.3.3.6 Chances of becoming a future standard
Spijkstaal will use a Volkswagen Transporter with an automatic acceleration barge, which makes it almost possible to just replace the internal combustion engine with a conventional electric engine. The chances for this solution to become a future standard can be regarded close to zero. A replacement option will always cost extra time, and the fuel efficiency of such a solution will be worse than the possible fuel efficiency for in-wheel systems.

3.3.4 PML Automotive
PML Automotive seems like an interesting alternative. During my research I came into contact with Jan Heetebrij because I discovered his name in several documents that dealt with the repositioning of Nedcar. Heetebrij wanted to create a zero-emissions automotive industry in The Netherlands by reinvesting in Nedcar. Heetebrij introduced me to PML Automotive, which just had rebuilt a Mini with an internal combustion engine into a Mini with an electric direct drive engine. The PML Mini accelerated in less than 4 seconds to 100 km/h (see Appendix). The technology of PML has the same base as the technology of E-Traction; it is an in-wheel motor. However, according to Heetebrij, the technology of PML is better than E-Traction because PML has invented a way of keeping the weight of their motor lower, while the applied torque can be higher. Furthermore, if PML is used, it is possible to exchange wheels if one drives with a flat tire; the in-wheel motor of PML is attached to the wheel framework of the car, while the in-wheel motor of E-Traction is attached to the wheel itself. In the E-Traction case it would become very expensive to have a spare wheel in the car. According to Martin Boughtwood, director of PML, they have signed initial contracts with Volvo and Lotus. The configuration of the ZURBAN if created by PML just look likes the solution of E-Traction. It should be mentioned that if the choice...
would be PML, the ZURBAN will still be made in the Netherlands. Via HeeCon it would be possible to find a Dutch system integrator.

Figure 22: ZURBAN if created by PML

3.3.4.1 Reliability of the technology
PML produces electric engines for more than 25 years; the last 5 years they have redesigned their application for the use in a vehicle. E-Traction focused on city buses in the prototype phase while PML focused on passenger cars. The wheels of the Volkswagen Transporter, which will be the base for the ZURBAN, are similar to those of passenger cars. It seems like the reliability of the technology of PML is rather good. According to Heetebrij, who paid a visit to the factory of PML, their technology is quiet simple, and thus low-weight. It seems like a trustworthy technology for the ZURBAN, with all the advantages of an in-wheel motor. Spring will visit the PML factory in September.

3.3.4.2 Price of 5 ZURBANS
Based on calculation from PML, the price of 5 ZURBANS will be € 1.200.000. This is, again, excluded the costs made by and the potential costs for the hydrogen fuel cell.

3.3.4.3 Price of 100 ZURBANS
The price of 100 ZURBANS will be € 3.500.000. This means that the scalability is slightly better than E-Traction. The price per ZURBAN declines from €240k to €35k, which is minus 85%.

3.3.4.4 Subsidy chances
The Dutch subsidy system is mainly focused at stimulating Dutch initiatives; the presence of an English company is per definition not in favour of a subsidy tender. However, HeeCon can be the Dutch agent for the English technology. Furthermore, the system integration of the vehicle can be done in the Netherlands. In accordance with the subsidy advisor, it turned out that the PML path has better subsidy chances than E-Traction and Spijkstaal.

3.3.4.5 Possible footprint for the launching customer
The possible footprint that will be created by the application of the PML path, is rather good and quite similar to the footprint of E-Traction. E-Traction and PML both have the in-wheel technology, and both have already created an operating vehicle. If a suitable generator is chosen, the PML
product can drive for more than 1,600 km without charging the battery (PML 2007). This will leave a clear footprint for the launching customer and this kind of performance will attract media.

### 3.3.4.6 Chances of becoming a future standard

The chances of becoming a future standard are quite similar to the E-Traction case. If the electric engine becomes a new standard, then it will probably be the in-wheel direct drive technology. PML seems to have invented a technology that might be superior to E-Traction’s technology because of the combination low-weight/high-torque. PML chances of becoming a successful future standard are rather good.

### 3.3.5 TNO Automotive

TNO Automotive is the last transition path that has been investigated. I had contact with Salem Mourad, the manager business development of TNO Automotive in Delft. He has changed a Volkswagen Beetle into an electric Beetle, powered by a gasoline generator (see Appendix). TNO Automotive is in these cases not the owner of the technology; they can be regarded a trustable system integrator of vehicles. They assess the wishes of their customers, and in line with these wishes they select the needed hardware. In fact, it can be the case that TNO Automotive does the system integration with the help of the technologies of E-Traction or PML. However, according to Salem Mourad, in the ZURBAN case TNO would choose technologies that have already been proven several times in order to make sure that the launching customer will have a reliable product. He would advice us to work with a conventional electric engine that is placed between the front wheels.

Probably the most interesting thing about the TNO Automotive transition path is the RDW approval process; TNO Automotive is responsible of executing 75% of all tests needed to get a new vehicle approved by the RDW. A cooperation with TNO would therefore make this approval process substantial easier. The proposed design of TNO looks the same as Spijkstaal:

![Figure 23: ZURBAN if created by TNO Automotive](image)

**Figure 23: ZURBAN if created by TNO Automotive**

### 3.3.5.1 Reliability of the technology

According to Salem Mourad, TNO will use the same technologies as has been used in the Beetle. These technologies have already been proven and the risk of developing a new technology is excluded, the reliability is therefore rather good.
3.3.5.2 Price of 5 ZURBANS
The price of 5 ZURBANS will be €1,275,000. This is, again, excluded the costs made by and the potential costs for the hydrogen fuel cell.

3.3.5.3 Price of 100 ZURBANS
The price of 100 ZURBANS will be €11,000,000. The price per ZURBAN declines from €255k to €110k, which is minus 57%. According to TNO, the real scalability will take place if the ZURBAN would be produced in the thousands range. According to Salem Mourad, the other companies have offered a very sharp price for the 100 series which they will not be able to meet. He claims that these companies have set this price to get the assignment. He states that his offering has the maximum scalability if 5 ZURBANS become 100. For real sharp prices Mourad advises us to start producing in the 1000s.

3.3.5.4 Subsidy chances
The subsidy chances will be good if TNO is aboard. According to Salem Mourad, TNO has good contacts with Senter Novem which might come in handy for the tender process. This has been acknowledged by subsidy advisor Hans Kelderman.

3.3.5.5 Possible footprint for the launching customer
If one would choose the TNO Automotive path, the initial footprint for the launching customer will probably be better than Spijkstaal, but worse than E-Traction and PML. Although TNO has a great reputation and therefore will attract media, they will not work with ground-breaking technologies. The media value in terms of technology usage is not very high; the rebuilding of the Transporter will be similar to the rebuilding of the Beetle.

3.3.5.6 Chances of becoming a future standard
There is chance that the technologies that TNO will use, become the future standard, although TNO works with a conventional electric engine, generator and battery. The way these technologies are placed together might be a future standard. In comparison to Spijkstaal, TNO does change the conventional setup of the car. In comparison to E-Traction, TNO is less radical in changing this setup.
3.3.6 Assessment of the transition paths

It needs to be mentioned that a thorough analysis of the possible transition paths is hard to execute; it’s not a bucket of pure apples. Pon has final decision power in the selection of the transition path; they are the largest participating company and they will be the main contractor of the project. The variables that have been defined in accordance with Pon, are assessed in this paragraph.

A financial overview of the four paths including the costs for Nedstack and Pon can be found in Figure 24. An overall assessment has been given in Figure 25. One notices a rather good score for PML. According to Marcel Vos, Pon will most likely choose for the PML option. At the moment of writing in August 2007, Pon is busy asking permission to the Volkswagen factory to start rebuilding the Transporter. If this permission is given, the factory of PML will be visited by Pon and Spring in October in order to verify their choice and to make initial agreements.

![Financial assessment of the transition paths](image)

**Figure 24: Financial assessment of the transition paths**

An overview of the assessment:

<table>
<thead>
<tr>
<th>Transition Path</th>
<th>Reliability technology</th>
<th>Price 5 ZURBANS</th>
<th>Price 100 ZURBANS</th>
<th>Subsidy chance</th>
<th>Footprint</th>
<th>Future standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Traction</td>
<td>☼</td>
<td>☼</td>
<td>☼</td>
<td>☼</td>
<td>☼</td>
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</tr>
<tr>
<td>Spijkstaal</td>
<td>☼</td>
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<tr>
<td>PML Automotive</td>
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<td>☼</td>
</tr>
<tr>
<td>TNO Automotive</td>
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<td>☼</td>
</tr>
</tbody>
</table>

**Figure 25: Overall assessment of the transition paths**
In which the variables are measured the following:

- **Reliability of the technology:** the more there needs to be developed for the production and integration of the electric engine, the less level of reliability. Thus; if the technology has already been developed and it has already proven itself, the reliability is 100%, which is the case for Spijkstaal. For the product of E-Traction, the most elements need to be developed, which is the reason that there reliability is set at 50%. TNO and PML are expected to score in between because they have already developed something similar (the electric Beetle respectively the electric Mini).

- **Price of 5 ZURBANS:** the higher the price for the creation of the first series of 5 ZURBANS, the lower the score for this variable. These prices are all-inclusive prices which means that if Spring would drive the 5 Volkswagen Transporter to the workplace of E-Traction, Spijkstaal, PML or TNO, they would get the Transporter returned as electric vehicles including software development, systems integration and homologation. All companies knew that they were competing with one another. That’s why I have assumed that they have given their sharpest possible price. All prices are however rather high; Spijkstaal is the cheapest (score of 75%) and E-Traction and TNO Automotive are the most expensive (score of 25%). PML scores in between (50%).

- **Price of 100 ZURBANS:** the higher the price for the creation of the second series of 100 ZURBANS, the lower the score for this variable. Again, it’s the turn-key price. PML Automotive and E-Traction offer the same and best price and get a score of 75% (it is still quite expensive). TNO Automotive has offered the worst price for 100 vehicles and therefore scores just 25%. Spijkstaal is in between (50%).

- **Subsidy chances:** the higher the subsidy chances, the higher the score. A score of 100% would mean that it is already certain that subsidy will be granted. This is not the case. The subsidy chances are based on the expert opinion of Hans Kelderman, the subsidy advisor of Spring Newco. From the beginning of the project, he has had meetings with advisors connected to SenterNovem. Kelderman has communicated with them about the possible transition paths that would be proposed to Pon. He has formed his opinion on the base of these meetings; tenders in which the non-profit organization TNO is participating have a rather high chance of success, so the TNO path scores 75%. Because E-Traction is already involved in a subsidized project with competitor Boudesteijn, they score 25%, just as Spijkstaal which has already had subsidy in 1995 when they rebuild the Volkswagen Caravelle. If PML manages to have an impact for Dutch industry, which is one of the objectives of the ZURBAN project, Kelderman thinks their chances lie somewhere between TNO and E-Traction/Spijkstaal. PML therefore scores 50%. The subsidy chances are the most critical in the project as the project will only continue if subsidy will be given. Therefore, I have suggested to use TNO anyhow, because it will increase subsidy chances. According to Pon however, they prefer PML because of the future perspective of this technology; its potential horizon is broader than that of TNO.
Footprint; the sexier the product that will result from a transition path, the higher the possible footprint it will leave for the launching customer. It is hard to uniformly define a sexy product. PML and E-Traction have scored 75% because their products have the potential of creating a vehicle that drives fast and has a long range. The city bus of E-Traction has realized a rather good performance just as the Mini of PML. The Spijkstaal option will create a vehicle that has a maximum speed of 80km/h which will be too slow to be sexy; therefore Spijkstaal scores the worst and gets 25%. TNO Automotive scores 50% because their performance will be somewhere in between E-Traction/PML and Spijkstaal. Moreover, E-Traction and PML will produce a brand new in-wheel technology which on itself will make their product sexier than the conventional electric engines of the Spijkstaal and TNO paths. From a technical point of view, the new developed in-wheel technology will be attractive.

Chances of becoming a future standard; Spring believes in regional diversity in automotive standards; it is unclear which technology will become the standard. Spring wanted to leave the option open that the used technology in the ZURBAN could become a future standard. The higher the chances that a chosen transition paths leads to a product that might become leading, the higher the score in this variable. Spijkstaal scores the worst because they will just replace the combustion engine of the Transporter for a conventional electric engine. E-Traction and PML score the best (75%) because if electric engines become the standard, it will probably be the in-wheel electric engines that are used. These engines are the most efficient because they can be placed where the power is needed, in the wheels of the vehicle. TNO Automotive scores in the middle (50%) because they do change the traction system though they still use a conventional electric engine.

In accordance with Marcel Vos from Pon, there has been made a choice for the PML path with the mentioned variables in mind. In order to test the application of the hydrogen fuel cell stack and to increase the footprint for the launching customer, it is agreed that one of the five vehicles will be equipped with a hydrogen fuel cell stack from Nedstack.

Thus, the following vehicles will be produced:

- 4 Battery Electric Vehicles, PML technology
- 1 Hydrogen Fuel Cell Vehicle, PML technology in combination with Nedstack
3.3.7 Kaleidoscopic programming

Spring’s view of the future and the possible transition paths can be placed in the kaleidoscopic programming theory of the European Centre for Innovation (2006). This can be used to give the reader a feeling for the track Spring Newco is in. The view of the future as defined by Spring is one in which companies will use zero-emissions transportation means for the distribution of goods to shops and offices in the centres of Dutch cities. By doing so, urban areas will suffer less from pollutant particles in the air or CO2 emissions. By creating extra privileges for the zero-emissions distributors, these developments can be stimulated. However, the full scale adoption of Spring’s view of the future will probably be a matter of decades. This creates uncertainty and in this kind of uncertain situations, a tree can be visualized which lead to the view of the future. The branches of the tree can be regarded to be transition paths. One path leads to another, and some lead to nothing. It is the ongoing dynamics of innovations that build up on other innovations.

The theory of kaleidoscopic programming teaches us to acknowledge that the ZURBAN is just one of the branches in the tree that will lead the world to zero-emissions urban distribution. The ZURBAN branch might be a continuous one that gets a follow-up, for instance the production of the next series of 100 ZURBANS instead of 5, or the ZURBAN branch might be a dead end.

Besides succeeding in the creation of the first 5 ZURBANS, it should also be a challenge to make sure that the ZURBAN branch will not be a dead end in the ‘zero-emissions urban distribution tree’.

Figure 26: The ZURBAN is just one branch in the tree that might lead to Spring’s view of the future
3.4 Conclusion

What are the characteristics of the ZURBAN proposition?

The characteristics of the ZURBAN proposition has been described in this Chapter. The proposition fits Spring’s view of the future in which there is plenty room for zero-emissions transportation, especially for heavy usage in urban distribution. In collaboration with business partner Pon, the ZURBAN concept is defined as a Volkswagen Transporter that:

1. Should be used for urban distribution purposes with a green twist
2. Should be zero-emissions
3. Should stimulate the Dutch automotive industry

It is the ambition of Spring to create the ZURBAN proposition in close cooperation with a launching customer. Advisory work that has been done for the business development department of the Dutch TNT Group created an opportunity to fit the ZURBAN in a future sustainable urban distribution pilot that will be organized by a consortium of TNT and the Municipality of Rotterdam.

Which transition path will fit the ZURBAN best?

The third sub question has been asked in order to advice Spring on the best possible transition path for the realization of the ZURBAN vehicle; this choice has been technology oriented. Four paths have been described; the path in which PML Automotive provides their in-wheel direct-drive electric engine for construction in the Volkswagen Transporter is expected to score overall as the best fit on six variables:

1. Reliability of the technology (score of PML: 75%)
2. Price of 5 ZURBANS (50%)
3. Price of 100 ZURBANS, in other words: the scalability (75%)
4. Subsidy chances (50%)
5. Possible footprint for the launching customer (75%)
6. Chances of becoming a future standard (75%)

The board of Pon has final decision power in the selection process of a suitable transition path. If the Volkswagen factory in Germany will give authorisation for the project (they will most likely do so in September), then Pon will choose for PML because their technology has a unique weight/torque ratio and they have scored best in the overall transition path assessment of Chapter 3.

Note that more actors than just the technology provider PML are needed in order to complete the transition path. In the operationalization of the ZURBAN proposition with the Cyclic Innovation Model in Chapter 4, an advice will be given on which actors should be doing what.
The analysis of Chapter 3 has been guided by the new business development framework of Berkhout, the following overview can be used to put the conclusions into theory’s perspective:

Spring Newco believes in the regional diversity of automotive standards; there will exist a platform that can be easily adjusted to different standards.

Spring Newco believes in ‘clean’ urban areas in which goods are brought to stores and offices with zero-emissions transportation as part of sustainable distribution projects.

In accordance with Pon, there has been made a choice for the PML transition path; PML will be the supplier of their direct-drive in-wheel engine for the retrofit of the Volkswagen Transporter. 1 of 5 vehicles will also be equipped with the Nedstack hydrogen fuel cell stack.

The ZURBAN should be used for urban distribution purposes with a green twist
- The ZURBAN should be zero-emissions
- The ZURBAN should stimulate the Dutch automotive industry

Figure 27: Berkhout's new business development framework applied for the ZURBAN innovation
4 Cyclic Innovation Model & the ZURBAN proposition

Van der Duin et al. (2006) emphasize that the Cyclic Innovation Model is meant to visualize the complexity of an innovation system and to show which actors are important for enhancing the performance of an innovation system. They state that CIM is a process model that can be used by actors within the system to establish an innovation system and to keep it running. Modern control can exist if the cyclic interactions are performed well; thanks to feedback, actors are constantly reminded of the consequences of their actions. In this project, CIM will be used (1) to determine the set of needed actors in order to increase the success chances of the ZURBAN innovation and (2) to supply Spring Newco with some basic insight in the role they ought to play.

In this Chapter the current set of actors is given (4.1), starting from the basic choice that was made in the previous Chapter to go for the PML trajectory, the desired set of actors is given (4.2) and the desired role of Spring Newco is analysed (4.3).

The following sub questions will be answered in paragraph 4.4.: How can the Cyclic Innovation Model be operationalized to arrive at the desired ZURBAN concept? & How can Spring Newco support the creation of the ZURBAN proposition?

If one looks back at the first step of Berkhout's innovation theory (Figure 28), one will notice that in this Chapter the process model will be described.

Figure 28: In this Chapter the cyclic process model will be described

Note: At the moment of writing the project is still in a phase in which the partners are being selected; therefore Chapter 4 can be regarded a possible setup, it is an advice for the current partners in the ZURBAN project.
4.1 Analysis of the current situation

In this paragraph the current set of partner will be described and visualized in the Cyclic Innovation Model.

4.1.1 Spring Newco

Spring Newco is the entrepreneurial project manager and is placed in the centre of the Cyclic Innovation Model; Spring is the spider in the web, the entrepreneur.

4.1.2 Pon Holdings

Pon Holdings is one of the largest vehicle dealers in Europe. Pon wants to be more than just a company shifting boxes; they want to add value to the vehicle by transforming it the way their customer wants; they want to deliver a turn-key solution to the wishes of their customer. Besides adding features like cooling systems, or tailboards, Pon has the aim of creating a zero-emissions feature for high-demanding customers. Pon has not the ambition of transforming these vehicles themselves; they do not have the right knowledge and facilities. They expect the ZURBAN project to organize things the way it becomes easy of outsourcing these activities. Pon will be responsible for the delivery of the Volkswagen Transporter to the systems integrator that will change it into a zero-emissions vehicle.

In order to determine the value of the current situation and to determine the needed actors for the actual realization of the ZURBAN concept, the knowledge and skills of the current partners should be defined. The knowledge and skills of Pon can be found in logistics and sales.

Pon will be visualized the following in CIM:

In principal, Pon is a sales organisation that has a certain influence on product development, therefore they are placed on the edge of Product Creation and the Differentiated Services Cycle. However, I have also placed them on the edge of Product Creation and the Integrated Engineering Cycle because they have some influence on the ZURBAN engineering activities.

4.1.3 PML Automotive

PML has invented and developed an direct drive in-wheel electric engine. According to Martin Boughtwood, director of PML, this product is ground-breaking in terms of weight and applied torque. He emphasizes that PML were able to develop such a product because of their years of experience in the field of brushless electric engines and because of five years of extended research trajectories. Their product has been build up from several technologies. The product of PML is able to be produced in series, which will make its price very competitive in future. PML will be a product supplier for the ZURBAN. Their product will have to be delivered to a Dutch system integrator that has the engineering capabilities of integrating their product into the Volkswagen Transporter. PML will only be responsible for the right delivery and quality of their product. De facto, they will be a subcontractor of the system integrator. PML’s skills and knowledge can be found in the development and production of the electric engine.
PML will be visualized the following in CIM:
In the Cyclic Innovation Model, PML can be placed on the edge of Technological Research and the Integrated Engineering Cycle as they will be responsible for the development of their engine and the right incorporation of needed technologies.

4.1.4 Nedstack
Just like PML, Nedstack will be subcontractor for the system integrator; they will deliver their hydrogen fuel cell stack and the needed accessories like the hydrogen tank and a cooling system. For Nedstack the ZURBAN will be the first automotive project in which they are involved. Therefore they will also do some technological research on the vehicle. From the five ZURBANS, one will be equipped with the Nedstack generator instead of a large battery pack.

Nedstack will be visualized the following in CIM:
In the Cyclic Innovation Model, Nedstack can be placed on the edge of Technological Research and the Integrated Engineering Cycle as they will be responsible for the development of their fuel cell stack. They touch the technological research node because they will continue research on the application of fuel cell stacks in a vehicle.

4.1.5 HeeCon Business Development
HeeCon Business Development is a company that acts on the edge between consulting and engineering, its director is Jan Heetebrij. HeeCon is shareholder in PML Automotive and in return acts like their agent for the Netherlands. HeeCon therefore is quite important for the success of the ZURBAN project; they will be responsible for defining the Volkswagen Transporter constraints for the PML product. The central role of Spring Newco will be supported by a engineering based central role which will be created for HeeCon; this allows the ZURBAN project to have guidance in terms of technology and system integration.

PML will be visualized the following in CIM:
HeeCon’s knowledge and skills can be found in the communication with subcontractors and the overall technological project management. HeeCon will therefore be placed in the middle of the Cyclic Innovation Model.

4.1.6 KC Group
KC Group is the company of the ZURBAN subsidy advisor Hans Kelderman. He has been added to the project team right from the start of the project, because in the initial stage it became clear that the project could only exist if it would be subsidised. The KC Group is responsible for advising the strategic project management team of Spring in the process of selecting partners; hereby Kelderman focuses on the network effect that should be created by the ZURBAN.
KC Group will be visualized the following in CIM:
KC Group is placed in the middle of the model, because they have some influence in the selection of all the actors. Furthermore, they have some influence in describing the activities the several actors should perform in order to increase subsidy chances.

4.1.7 Overview in CIM

In CIM, the current partners can be plotted the following:
4.2 Analysis of the desired situation

This paragraph will show the setup of the desired situation. The current overview of Figure 29 reveals a lack of actors in the Differentiated Services Cycle and the two Sciences Cycles. Furthermore, it might be necessary to have more actors in the Integrated Engineering Cycle.

4.2.1 Boundaries of the desired situation

This thesis focuses on the creation of five zero-emissions vehicles within one year. The Sciences Cycles will be of greater interest if the scope of the project becomes larger, for instance because the ambition changes into the production of 1,000 vehicles. Then it might be interesting to have scientific research included to create new improvements to technologies. Due to the scale and time span of the ZURBAN project, the Hard Sciences Cycle will be out of scope because Spring will choose for technologies that already exist. The Soft Sciences Cycle will be used in order to make sure that the developed concept fits changing market’s and consumers’ demands.

- The desired situation focuses on the actors needed to create 5 ZURBANS in 1 year.

  *The creation of 5 vehicles in one year is a reasonable objective if compared to the rebuilding project of the Volkswagen Caravelle in 1995 by Spijkstaal which took 10 months (Spijk 2007). HeeCon and TNO have acknowledged this.*

- The Hard Sciences Cycle will be out of scope.

In the process of creating an innovation, the presence of a launching customer is of utmost importance to have market success. One of the characteristics of the ZURBAN proposition as described in Chapter 3 is the ‘urban distribution purpose with a green twist’. Spring Newco is involved in a project with TNT and the municipality of Rotterdam. In this project, a pilot will be arranged which fits the Rotterdam Climate Initiative. At the moment of writing, it seems like the pilot will be focused on the collection of dry office waste materials by TNT in combination with the setup of a sustainable distribution programme. This pilot will start in the first half of 2008 and TNT has the ambition of driving with eco-friendly vehicles in order to go all the way and leave their footprint. This is where the ZURBAN project matches; it has already been presented to the board of TNT Post and to Peter Bakker, director of the TNT Group. It seems like they are willing to cooperate. The ZURBAN will fit in the transition path of TNT to a green fleet of vehicles. As this report can be regarded an advise for Spring how to guide the ZURBAN project the coming months, the collaboration of TNT and the municipality of Rotterdam will be assumed. This is in line with the expectations of Spring.

- TNT and the Rotterdam municipality will be launching customer for the ZURBAN project.
4.2.2 Analysis of the desired Engineering Cycles

The desired situation will be described as a result of interviews with the partners that potentially have already been committed to the project. For the technological upside of the Cyclic Innovation Model several experts have been interviewed, among others: Marcel Vos (Pon), Jan Heetebrij (HeeCon), Sjef Peeraer (SP Innovation), Jan Piet van der Meer (Nedstack) and Wim Heijboer (Spijkstaaal). They have provided a clear insight in the needed engineering cycles for the technical realization of a battery electric vehicle and a fuel cell stack vehicle.

In Figure 30 the technology upside of the Cyclic Innovation Model has been visualized. The Sciences Cycle is out of scope. In the Technological Research node in the middle, the several technologies have been plotted that are needed for the Engineering Cycle. In the process of creating the ZURBAN; the production, the systems integration and the testing are the main functions.

![Figure 30: The technology upside of the Cyclic Innovation Model](image-url)
In Figure 30, one observes “one-to-many” cyclical linkages between the science disciplines (D1 to D4) and the technologies (T1 to T6). In real life, these linkages mostly are available. PML for instance, has contacts with the Sheffield University for the Mechanical Engineering and the ICT part; they have contact with Henk Polinder from the faculty of Electrical Engineering of Delft University of Technology. Sjef Peeraer, mechanical engineer and a potential supplier of energy supply systems, uses scientific institutes in India for battery research. The interviewees have indicated that connections with the science side is aimed for the long term developments of their technologies. This is in support of the decision to leave the Hard Science Cycle out of scope.

The Technological Research node in the middle of Figure 30 will be the guideline for the organization of the Integrated Engineering cycles. One notices “many-to-one” cyclical linkages from the Technological Research node to the Product Creation node. The technologies have been numbered T1 to T6.

1. The in-wheel technology (T1) will have to be produced and integrated in the vehicle.
2. The energy supply technology (T2) will have to be bought and integrated in the vehicle.
3. The software needs to be developed (T3) and integrated in the vehicle.
4. The power electrics (T4) will have to be bought and integrated in the vehicle.
5. The fuel cell technology stack (T5) will have to be produced and integrated in the vehicle.
6. The overall vehicle technology (T6) will have to be integrated in the vehicle and tested.

In Figure 31 a more detailed view is given of the technology upside of the Cyclic Innovation Model. The numbers in the pink area represent the Integrated Engineering Cycles:
In Figure 31 ten Integrated Engineering Cycles can be identified in order to create the ZURBAN. An overview:

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 in-wheel</td>
<td>1 engine production cycle</td>
</tr>
<tr>
<td>T2 energy supply</td>
<td>2 engine integration cycle</td>
</tr>
<tr>
<td>T3 software development</td>
<td>3 battery pack integration cycle</td>
</tr>
<tr>
<td>T4 power electronics</td>
<td>4 software development cycle</td>
</tr>
<tr>
<td>T5 fuel cell technology</td>
<td>5 software implementation cycle</td>
</tr>
<tr>
<td>T6 vehicle technology</td>
<td>6 power electrics integration cycle</td>
</tr>
<tr>
<td>T7 technical design</td>
<td>7 fuel cell production cycle</td>
</tr>
<tr>
<td>P1 production</td>
<td>8 fuel cell stack integration cycle</td>
</tr>
<tr>
<td>P2 integration</td>
<td>9 overall systems integration cycle</td>
</tr>
<tr>
<td>P3 testing</td>
<td>10 vehicle testing and homologation cycle</td>
</tr>
</tbody>
</table>

An advice will be given per cycle with whom to work with and what to do. This will create transparency for the future strategic and technical project management.

4.2.2.1 Engine production cycle (1)

The in-wheel electric engine will be produced by PML Automotive in England. They will produce five sets of engines by hand, because their engines aren’t produced in series yet. PML has already produced a similar engine for the use in a Volkswagen Beetle. However, in the ZURBAN project, the Volkswagen Transporter will be used. The Transporter has wheels which are larger than the wheels of the Beetle; therefore PML will slightly adjust the design of their engine. According to PML, no scientific input is necessary to do so. HeeCon will be responsible of providing PML with the right specifications. In October, a delegation of Pon, Spring and HeeCon will visit the PML plant in order to meet face-to-face with Martin Boughtwood, director of PML.
4.2.2.2 Engine integration cycle (2)
The engine which has been produced by PML, will need to be integrated in the Volkswagen Transporter. This will not be a sinecure. Most of the existing car parts will have to be removed from the Transporter, and the in-wheel engines will have to be fixed to the car's platform. PML is capable of doing this themselves, but a Dutch partner is preferred. This is because when the ZURBAN becomes popular, the next 100 will have to be produced in the Netherlands. To make sure the engine integrator has already had his learning curve then, it is preferred to let the Dutch integrator also do the first 5 vehicles. In accordance with HeeCon, a choice is made for NEMS in Rotterdam. NEMS is a foundation sponsored by the Municipality of Rotterdam that focuses on the industrial development in the Rotterdam area. Frank Rienk is one the initiators of NEMS and has created a retrofit company that has the needed knowledge and skills to build a ZURBAN vehicle. Hans Kelderman, the subsidy advisor, has also encouraged the use of NEMS because of the network effect the ZURBAN needs to be created in order to increase the subsidy chances. NEMS is involved in a project of stimulating the industry in and around Rotterdam; the ZURBAN and the Municipality of Rotterdam fit this ambition.

![Figure 33: Engine integration cycle](image)

4.2.2.3 Battery pack integration cycle (3)
The battery pack for the ZURBAN will be ordered at the Dutch company SP Innovation. SP Innovation is the company of Sjef Peeraer and they have recently changed the battery of the conventional Toyota Prius by a large-capacity alternative. By doing so, Peeraer has created the Prius Plug-in that is able to drive solely on the battery. According to Peeraer, he has performed extended research on the several batteries that are available worldwide. He is also expert on the combination with super capacitors. Therefore, SP Innovation will be the company delivering the battery pack. Specifications will be given as input to Peeraer by PML. At the end of the trajectory, NEMS will place the battery pack in the vehicle.

![Figure 34: Battery pack integration cycle](image)
4.2.2.4  **Software development cycle (4)**

In electric vehicles, software is a very important component. Making use of PML’s technology allows us to remove a substantial number of existing car parts. The in-wheel electric engine has so much applied torque, that it is able of slowing down the vehicle autonomously. This means that the brakes can be removed. One can understand that their needs to be developed new software that recognizes the movement of the brake pedal and that translates this movement into a high, negative torque in order to slow the vehicle down. PML will be responsible for the software development needed for the systems and control of their electric engines.

Besides the software for the electric engines of PML, there is also software needed to guide the balance of the energy supply systems. PDE Automotive from Helmond has already developed such software for other projects in which they have been involved. PDE Automotive is a supplier of automotive engineering services, like engineering, prototyping, simulations, testing and quality services. PDE Automotive and PML will have to be the actors in the software development cycle to make sure that both software packages will understand each other.

![Figure 35: Software development cycle](image)

4.2.2.5  **Software implementation cycle (5)**

After the development of the two software packages as described in the Software development cycle, there is need to implement the software in the vehicle. This will again be done by PDE Automotive because they are the most experienced and have done similar jobs under assignment of Benteler, which is one of the largest automotive subcontractors in Germany. Again, some information exchange will be needed with PML, because they own the other half of the software. Information from PML will be used by PDE as input for the Software implementation cycle.

![Figure 36: Software implementation cycle](image)
**4.2.2.6 Power electrics integration cycle (6)**

The power electrics integration will be done by NEMS, PDE Automotive and the supplier of the energy supply system, SP Innovation. It will be done at the workshop of NEMS in Rotterdam, and NEMS will be responsible for the physical screw down of the circuit. PDE Automotive and SP Innovation for the proper functioning of the power electrics as a whole. PDE Automotive has a quality guarding function.

![Power electrics integration cycle](image)

**Figure 37: Power electrics integration cycle**

**4.2.2.7 Fuel cell production cycle (7)**

Nedstack is the only producer of fuel cell stacks in the Netherlands. They have never created a fuel cell stack for a distribution vehicle. The heavy use and the short driving distances will be new to Nedstack. Therefore, they will have to produce an extraordinary high-quality fuel cell stack. The capacity of the stack will be defined on the inputs from the energy supply system of SP Innovation. Nedstack will also deliver the hydrogen storage tank.

![Fuel cell production cycle](image)

**Figure 38: Fuel cell production cycle**

**4.2.2.8 Fuel cell stack integration cycle (8)**

The fuel cell stack will be integrated in the vehicle by NEMS. NEMS will receive input from Nedstack and SP Innovation in order to make sure that the integration will be executed in a sound balance with the existing energy supply systems.

![Fuel cell stack integration cycle](image)

**Figure 39: Fuel cell stack integration cycle**
4.2.2.9 Overall systems integration cycle (9)

The overall systems integration will be done by NEMS. At their workshop in Rotterdam, Pon will deliver 5 Volkswagen Transporter. NEMS will change these vehicles into ZURBANS. They will receive physical and non-physical inputs from PML, SP Innovation, TNO, Nedstack and PDE Automotive. All the integration cycles combined creates the overall systems integration cycle. HeeCon is the head responsible for this trajectory; they are the technological project manager.

![Diagram of Overall systems integration cycle]

Figure 40: Overall systems integration cycle

4.2.2.10 Vehicle testing and homologation cycle (10)

The testing of the ZURBAN will be done by PDE Automotive. The RDW, who is responsible for the security approval of vehicles in the Netherlands, has granted the homologation process to PDE Automotive. This means that if PDE tests the ZURBAN, the homologation process will speed up and become easier. Instead of one year, the testing and homologation process can be done in two or three months (based on expectations of PDE).

![Diagram of Vehicle testing and homologation cycle]

Figure 41: Vehicle testing and homologation cycle
4.2.3 Analysis of the desired Market Cycles

The analysis of the desired market transitions has been the result of interviews with several experts, among others: trend watcher Joop Verloop; Coen Faber (Ministry of Transport), Richard Smokers (senior researcher CE), marketing expert Ivo Roelfs (DDB), Harry van Bergen (Municipality of Amsterdam), Frits van Drunen (Platform on Sustainable Mobility), Simone Veldema (Chamber of Commerce) and employees from TNT and the municipality of Rotterdam that have been involved in the Rotterdam Climate Initiative and/or the pilot.

In Figure 42 the market transitions downside of the Cyclic Innovation Model has been visualized. The Sciences Cycle has been taken into account because it formed the basics for the initial ZURBAN idea, which originated in the observation that the automotive and the distribution markets would change the coming decades to a more eco-friendly situation. The market transitions side of CIM is in support of the ambition to create the ZURBAN as a communications means that has a positive influence on sustainable mobility in the Netherlands.

Figure 42: The market downside of the Cyclic Innovation Model
Scientific insights in law, societal, political and economics studies have created the belief that future automotive- and distribution markets would change. It has been used by Spring to understand new social needs and concerns. In this thesis scientific insights and experts’ opinions have been used to describe external trends and create the view of the future (paragraph 2.4 and 3.1). Trends, laws, regulations, PR and marketing and the launching customer of the ZURBAN concept will cause the market to transfer.

In the market transition node, the launching customer is the main actor because they are able to follow the market transition or – even stronger – stimulate the market transition. In the case of a pilot between TNT and the municipality of Rotterdam, which will be the launching customers, the market transitions can be stimulated by (local) laws and regulations, but also by a suitable marketing plan that will create extra value to the ZURBAN concept.

For the completion of the ZURBAN concept, laws and regulations, trends, PR and marketing are important and – if used correctly – can create added value for the ZURBAN concept. In order to have a successful concept, that has a communication function and that has a positive footprint for all involved actors, it is necessary to influence future laws and regulations, to adjust the concept to the latest trends and to execute a thorough marketing plan. The market side of CIM will turn the vehicle into the sustainable concept. It will make sure that the launching customers TNT and the Municipality of Rotterdam will make the most of the concept.

In Figure 43 a more detailed view has been given of the market transitions.

![Figure 43: Detailed view of the market downside of the Cylic Innovation Model](image-url)
In the market side of CIM, five cycles (cycles 11 to 15) can be identified in order to create extra added value to the ZURBAN concept. An overview of the symbols:

<table>
<thead>
<tr>
<th>Disciplines</th>
<th>Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>D5 law studies</td>
<td>11 customer's demands cycle</td>
</tr>
<tr>
<td>D6 societal studies</td>
<td>12 laws and regulations cycle</td>
</tr>
<tr>
<td>D7 political studies</td>
<td>13 external trends cycle</td>
</tr>
<tr>
<td>D8 economics</td>
<td>14 communication cycle</td>
</tr>
<tr>
<td>Market transitions</td>
<td></td>
</tr>
<tr>
<td>M1 launching customer</td>
<td>15 customization cycle</td>
</tr>
<tr>
<td>M2 laws and regulations</td>
<td></td>
</tr>
<tr>
<td>M3 trends</td>
<td></td>
</tr>
<tr>
<td>M4 PR and marketing</td>
<td></td>
</tr>
<tr>
<td>P4</td>
<td>added value to the ZURBAN concept</td>
</tr>
</tbody>
</table>

If one compares the technology upside and the market downside, one notices a different approach in defining the cycles. During the thesis, there has been contact with experts from law, societal, political and economy studies. The experts that have been interviewed (see Appendix) were often specialized in more than one discipline. Therefore, the cycles have been placed at the edge of the pink quadrant in the soft sciences corner. This is also done because most of the experts should be positioned more to the market transition node than to the scientific research node. 'Pure scientists' have not been interviewed; all experts combined scientific research with business purposes. For instance; Joop Verloop is a professional trend watcher and alumnus of the TU Delft. He keeps up his scientific knowledge by visiting conferences and reading scientific books and articles. However, he is not just specialized in societal studies, but he keeps also track of law, politics and economy. He is an all-rounder that has had influence in describing the trends that take place in the market transition node. Another example; Richard Smokers is a senior researcher for the CE institute. He is an automotive industry expert that publishes about market transitions in terms of laws and regulations, but also in terms of politics and economics. One extra example; Emil Möller, a PhD student from the University of Maastricht is doing research on energy transition in the Netherlands. He shared information on all disciplines.

If one observes cycle 15 that is in the right quadrant of the market side of CIM, one notices that this cycle is also placed on the edge. This has been done because the mentioned market transitions – the launching customer, laws and regulations, trends, PR and marketing – are combined and used for the customization of the ZURBAN concept in order to fit broad developments in society and specific needs of the launching customer. In other words; insights created in the soft sciences cycle in terms of customer's demands, laws and regulations, trends and PR and marketing (cycles 11 to 14) are used in the services cycle for the customization of the ZURBAN (cycle 15). In line with the technology side, there will be in the next paragraphs an advice per cycle in the market side of the Cyclic Innovation Model.
4.2.3.1 Customer's demands cycle (11)

The customer’s demands cycle is guided by Spring Newco in order to make sure that the ZURBAN concept will fit the demands of the TNT/Rotterdam consortium. There have been several meetings with the workgroup of the Rotterdam Climate Initiative in order to observe their wishes. This has been an iterative process in which Spring has presented their view on the pilot and received feedback. At the moment of writing, some decisions have been made about the pilot grounded on these presentations; it will be a pilot in the centre of Rotterdam focused on zero-emissions distribution of goods to shops and offices. Collaborating shops and offices will get a ‘frontrunners’ label that provides them with all kinds of privileges, like the delivery of goods outside the conventional ‘window times’ (in Dutch: ‘venstertijden’). The pilot will be worked out in more detail in September, October and November by a multifunctional team of Spring, TNT and the municipality of Rotterdam.

The customer’s demands cycle is also aimed at the vehicle specifications; what should be the range of the vehicle and what should be the top speed? How should the vehicle look? What should be the load that can be carried by the vehicle? Answers to these questions have been given by the TNT fleet manager; in order to have a competitive vehicle, it should have a maximum speed of 120 km/h, a driving range of at least 200km and it should be able to carry a load of around 800kg.

In a broader sense, the customer’s demands cycle is also aimed at the transition of the vehicle fleet of TNT and Rotterdam to a zero-emissions fleet. In this sense, other advises has been given as well, like the potential purchase of Smith Electric vehicles, which is an alternative to the ZURBAN vehicle that is based on the Ford Transit, and the Prius Plug-in, which can be used as lease cars for the employees of TNT and the municipality of Rotterdam.

In future, the customer’s demands cycle will be used to refit the ZURBAN to needs that will change. In order to keep the presence of Spring as the necessary craftsman in Berkhou’ts innovation arena, it will be Spring that keeps a close contact with TNT and Rotterdam and it will be Spring that observes their demands.

Figure 44: Customer’s demands cycle
4.2.3.2 Laws and regulations cycles (12)

There can be distinguished two law and regulations cycles; one concerning local Governments and one concerning central Governments.

4.2.3.2.1 Local Government cycle (12a)

In the local law and regulations cycle, it is about creating extra added value to the ZURBAN concept by enabling positive privileges to arise from a local Government. Local Governments have the power of allowing eco-friendly distribution concepts to behave different from non eco-friendly concepts. In Dutch cities, the board of Mayer and Aldermen can decide on which vehicles are allowed to enter their city. This power is not bounded by higher-ranked regulations; Dutch Government and the European Union do not have defined uniform regulations on the city-level (source: Richard Smokers, CE institute). In Amsterdam for instance, a distribution vehicle that delivers goods in the centre is obliged to have packed his vehicle for 80% of the total vehicle volume. This stimulates distributors to sharply schedule their deliveries. In Rotterdam, which will be the playground of the ZURBAN, it might be the case that the user of the ZURBAN is allowed to drive on bus- or tramlanes. Even stronger, local Governments can oblige pollutant actors to stay away from the centres of the cities. The eco-zones have been an example of such an obligation. These eco-zones might be irrelevant for an actor driving with the ZURBAN. That would create extra added value to the ZURBAN concept. Spring Newco will be responsible for influencing local Governments in order to make them implement laws and regulations that create extra value to the ZURBAN concept. In this case, it will be the municipality of Rotterdam that needs to be influenced. Spring Newco will be supported by TNT in this process. In meetings that has been organised with Peter Verschoor, project manager of the Rotterdam Climate Initiative, and the assistant of the board of Mayer and Aldermen of Rotterdam it turned out that they are willing to implement regulations that are in favour of sustainable distribution concepts as soon as possible. The scope of one year should be met.

4.2.3.2.2 Central Government cycle (12b)

The central law and regulations cycle will create extra value to the ZURBAN concept because of the several subsidy programs the central Government has initiated. These programs are focused on sustainable developments within the Dutch industry. They are often initiated by SenterNovem, which is the Dutch Agency of Sustainability and Innovations. Every year, several programs are opened and can be applied for. In October 2007, the tender for the subsidy program ‘Unieke Kansen Regeling’ will start, granting a maximum subsidy of 4 million euros per project. Spring Newco will, supported by their subsidy advisor Hans Kelderman from KC Group, probably join the
tender. In order to gain insight in the requirements that the central Governments has defined for subsidised projects, there has been contact with Coen Faber from the Ministry of Transport and with Hugo Brouwer, director of energy transition of the Ministry of Economic Affairs. The ZURBAN fits SenterNovem’s ambition to stimulate industries to become more eco-friendly. Other subsidy tenders that can be accessed are ‘EOS Demo’ which grants a maximum of 1 million euros and ‘Pieken in de Delta’ which is organized by the Industrial Group Amsterdam.

4.2.3.3 External trends cycle (13)

In paragraph 2.4 external trends have been described that have lead to the general wish of Spring Newco to be active in sustainable propositions. In paragraph 3.1 Spring’s view of the future has been presented that fits the ZURBAN proposition. For the development of the ZURBAN, external trends can also be defined as the general tendency or direction in the sustainable distribution market or industry. The external trends cycle is about monitoring of and acting on major events affecting the market. On its turn, these trends should be communicated to the launching customer. The coming years, it should be the unique asset of Spring to be well informed about trends that might ask for a different approach to the ZURBAN concept. In order to be well informed, Spring will have to keep contact with trend watchers and researchers. In the time that this thesis has been written, good contact has been established with trend watcher Joop Verloop, Emil Möller (University of Maastricht) and Richard Smokers (CE). For the future, other actors in the soft sciences cycle should be added to this group.

4.2.3.4 Communication cycle (14)

The communication cycle will be used to gain extra attention for the ZURBAN concept. TNT wants to show that it takes their responsibility as a semi public company; Rotterdam wants to be first in the Netherlands with the pilot and impress the other Clinton Climate Cities in the world. The ZURBAN will also help create a positive sentiment around the Volkswagen Transporter, which is
interesting for Pon. DDB Amsterdam will be the marketing agency for the project. Ivo Roelf, deputy director of DDB, has assured that DDB will cooperate with the ZURBAN project. They will think of a national campaign, most likely driven by TNT, in which the ZURBAN concept will be presented to the Dutch public. Furthermore, they will think of the way the vehicle should be painted in order to be a communication means itself. Spring Newco is in charge of supporting DDB Amsterdam.

**Figure 48: Communication Cycle**

### 4.2.3.5 Customization cycle (15)

The customization cycle is meant to adjust the ZURBAN concept to the market transitions. This cycle is placed in the right quadrant of the market side and it combines transitions in customer’s demands, laws and regulations, trends and PR and marketing. The insights and developments in cycles 11 to 14 will combined in cycle 15 in order to change the ZURBAN vehicle into the ZURBAN concept. Cycle 15 can be regarded the cyclical funnel in which the developed knowledge, insights and demands from the soft sciences cycles come together.

An example of the outcomes of the customization cycle can for instance be; the ZURBAN will be a zero-emissions vehicle that has extraordinary looks and performance, focused on TNT and Rotterdam (customer’s demands cycle), the ZURBAN will be a vehicle that is allowed to drive on bus- and tram lanes (local government cycle), the ZURBAN will be developed with the help of subsidy (central government cycle), the ZURBAN will be easy adjustable to changing market trends (external trends cycle), the ZURBAN will be a communication means and it will fit the style of TNT and Rotterdam (communication cycle).

These possible characteristics of the ZURBAN will be created in the Customization cycle. As owner of the intellectual idea of the ZURBAN, Spring Newco has the ambition to be in charge of the Customization cycle; it can be seen as the overall integrating cycle that turns the physical vehicle in the broad concept. Spring will use the launching customer in this cycle as the feedback and feed forward partner.

**Figure 49: Customization cycle**
4.2.4 The Technology and Market Cycles combined

After the analysis of the desired Technology Cycles and the Market Cycles, these two can be combined in order to create an overview, see Figure 50. The role of the craftsman in the middle of the model, will be fulfilled by Spring Newco. Paragraph 4.2 can be used by Spring as the guide in allocating the right knowledge and skills to the right actors. Assistance will be given by HeeCon, responsible for the technological project management and thus active in guiding the Technology Cycles. KC Group will also help Spring in the middle of the innovation arena by providing information on the way things can be organised best in order to make the subsidy chances increase. Pon will act in the middle of the model because they will be the chief contractor of the ZURBAN project.

Figure 50: Layer 3 of Berkhout's innovation theory applied to the ZURBAN innovation
At one level higher than Figure 50, one can plot all the actors in the Cyclic Innovation in Figure 51:

Note:
1) ZURBAN is a class 3 innovation as three cycles interact for the creation of the concept
2) Several actors have multiple positions in the model

Figure 51: Cyclic Innovation Model applied to the ZURBAN innovation
Every company has been positioned in CIM because of the activities they will perform for the project:

**In the Technological Research Node are positioned:**
- PDE Automotive for the software development and their knowledge on systems design.
- PML Automotive for their direct drive in-wheel technology.
- SP Innovation for the energy supply and storage technology.
- Nedstack for the hydrogen fuel cell technology

**In the Product Creation Node are placed in the technology upside:**
- NEMS for the retrofit of the vehicle and the systems integration.
- PDE and RDW for the testing and the homologation.
- Pon for the delivery of the Transporter and influence on the ZURBAN creation.

**In the Product Creation Node are placed in the market downside:**
- TNT and Rotterdam for their influence on the ZURBAN as they are the launching customer.
- DDB for their influence on the looks of the ZURBAN and the publicity around it.
- KC Group for streamlining the concept in order to increase the subsidy chances.
- Spring as the ZURBAN should fit their idea.

**In the Market Transition Node are placed:**
- TNT and Rotterdam because they will change the distribution market in Rotterdam.
- The Central Government because they will grant subsidy in order to stimulate zero-emissions solutions.
- Pon because they want to be able to deliver eco-friendly Transporters to their customers.
- Spring Newco as the booster of sustainable solutions in Dutch society.
- DDB as they will have to translate changing insights in marketing concepts.
- KC Group because they will have to monitor the market transition in order to make sure that the subsidy tender is up-to-date.

**In the Gamma Sciences Node are placed:**
- Trend watcher Joop Verloop for identifying the changing interests of the public.
- PhD student Emil Möller for his research on energy transition in the Netherlands.
- CE Research for their research on the transitions in the automotive industry.
- Spring because they will have to do research themselves in order to keep their unique asset being one of the frontrunners in the Netherlands in sustainable solutions.

**In the Entrepreneurial role are placed:**
- Spring Newco for the entrepreneurial project management.
- HeeCon for the technological project management.
- Pon because they will be chief contractor of the whole project.
- KC Group in order to assist Spring Newco in order to guide the project in line with subsidy requirements.
All described cycles together will create the ZURBAN concept. In order to give Spring an indication on the expected planning over time, Figure 52 have been created:

<table>
<thead>
<tr>
<th>Cycle</th>
<th>2007 Q4</th>
<th>2008 Q1</th>
<th>2008 Q2</th>
<th>2008 Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Engine production cycle</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2 Engine integration cycle</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Battery pack integration cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Software development cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Software implementation cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Power electrics integration cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Fuel cell production cycle</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>8 Fuel cell stack integration cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Overall systems integration cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Vehicle testing and homologation cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Customer’s demands cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Laws and regulations cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>13 External trends cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Communication cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Customization cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 52: All cycles placed in the time planning

4.3 The role of Spring Newco

Having analysed the current situation and the desired situation with the Cyclic Innovation Model in the previous two paragraphs, it becomes interesting to analyse the role of Spring Newco as they want to be the spider in the innovation web. In this paragraph, an advice will be presented on (1) what Spring’s focus should be in terms of future challenges, (2) how they should organize the collaboration with the desired set of partners and (3) which possible threats they need to monitor closely.

4.3.1 Facing the challenges

The focus of Spring should be on the identification and solving of problems that will arise; these problems are regarded to be challenges. For the ZURBAN project, challenges in terms of Engineering and Marketing can be identified and added to the Cyclic Innovation Model in order to create a helicopter view about which group of actors should be doing what. These challenges can be used by Spring in their daily project management activities. Though the sciences cycles are not directly relevant for the short term development of the ZURBAN, some challenges in sciences have been described in order to make the overview complete.
4.3.1.1  Challenges in Sciences

Challenges in Sciences have been distinguished in challenges in the hard sciences cycle and the soft sciences cycle. Though sciences often aim for the longer term, it can be interesting to mention that cost-focused technology research, market's demands anticipation and the influence on Governmental regulations are relevant challenges for Spring. From these challenges, the cost-focused technology research is probably the toughest because this should be carried out by independent scientific institutes that Spring cannot have a direct influence on. In fact, cost-focused research can be regarded a business approach to scientific inventions; this business approach is sometimes lacking in universities and research institutes. At Delft University of Technology, this so-called ‘knowledge valorisation strategy’ is a hot issue that they try to tackle by several business-like course ('Turning Technology into Business' and ‘Writing a Business Plan’) and by the foundation of YES!Delft, the Young Entrepreneurial Society, which in fact is an incubator for young engineers that want to bring technologies to the market.

4.3.1.1.1  Cost-focused technology research

In the hard sciences cycle, Spring should stimulate research on zero-emissions technologies which is focused on lowering the costs of these technologies. One could say that the actors in the hard sciences cycles like technical universities and research institutes are too late with their developments; though the technologies exist, prices of these technologies are too high. As technology developer they should have felt the responsibility of making technologies ready for the large scale adoption. The main reason that there is a lack of eco-friendly transportation, is the high price that is asked for the needed technologies. Cost-focused technology research should be carried out by institutes like Delft University of Technology or TNO; applied sciences should focus on the creation of break-through inventions while they keep a close track of the future price when inventions become innovations.

4.3.1.1.2  Anticipate on market’s demands

In the soft sciences cycle, Spring should stimulate research on the ongoing changes in market’s demands. The ZURBAN will be a concept that should be flexible to changes in customer's needs, concerns and demands. For the ZURBAN case, these changes will be influenced by the launching customers, TNT and Rotterdam, but also by actors in the soft sciences cycle like trend watcher Joop Verloop, senior CE researcher Richard Smokers, PhD student Emil Möller, and others. For the longer term, Spring has the ambition of financing future PhD students in order to be able to have access to latest developments on market’s demands.

4.3.1.1.3  Influence Governmental regulations

To increase the success chances of the Rotterdam pilot, the local regulations for vehicles entering the centre need to be reviewed. It might be necessary to install or increase the available eco-zone; or it might be necessary to enlarge the entry times for sustainable distributors; or TNT might be allowed to drive on bus- and tram lanes. Local Governments have the power to install these kind of regulations and therefore they need to be influenced to actually do so.
The Municipality of Rotterdam has already indicated that they are really willing to change regulations in order to arrive at a CO2 neutral distribution system in their city centre in order to make the pilot in 2008 successful; therefore it’s a manageable challenge for Spring.

### 4.3.1.2 Challenges in Engineering

In the Engineering Cycle of CIM, four main challenges have been identified that need to be tackled by the available actors; interaction of technologies, systems integration, the vehicle guarantee, and the RDW approval. The systems integration of the Transporter vehicle will be the toughest challenge in Engineering. If this is executed right, the technologies will interact, the RDW approval will not be a problem (PDE is able to execute the homologation themselves) and it will help in finding an a company that is willing to supply the vehicle guarantee (PDE, NEMS, Pon or a combination of the three).

#### 4.3.1.2.1 Interaction of technologies

All technologies that will be used by the partners will have to interact in order to make the vehicle operate. It will be the first time that developed technologies like the hydrogen fuel cell and the energy supply system will be operating together. There is little knowledge available on the interaction of the needed technologies. The challenge will be to make the technologies communicate. SP Innovation and Nedstack will have to make sure that the electricity storage and supply system will be right. PML will have to make sure that their in-wheel motor fits the Volkswagen Transporter and that it can be geared by the electricity system. HeeCon will be responsible for the overall, technical project management.

#### 4.3.1.2.2 Systems integration of the Transporter vehicle

The system that needs to be integrated is the Volkswagen Transporter with the technologies that will make it an electric vehicle with or without the hydrogen fuel cell stack. The actual systems integration of a distribution vehicle is an activity for NEMS. They will have the challenge of removing all the unnecessary parts from the Transporter and of installing the new technologies. The systems integration will be the red line of the engineering challenges. It will have its impact on the interaction of technologies, on the vehicle guarantee and on the RDW approval. Moreover, the systems integrator needs to have its learning curve in the first project of 5 vehicles, in order to be able to produce more vehicles fast en cheap if that turns out to be necessary. NEMS will be supported by Pon, HeeCon and PDE for the systems integration.

#### 4.3.1.2.3 Vehicle guarantee

If the power train of a vehicle has been changed, the guarantee given by the factory is often not valid any more. It will be a challenge of changing the vehicle in a way that either Volkswagen, or another party will dare to give guarantee to the vehicle. According to the potential technological project manager HeeCon, the systems integrator or the systems designer should be able to give guarantee on the new vehicle.
4.3.1.2.4 RDW approval

The RDW is an institution that guards the security of the vehicles driving on the Dutch roads. They do not have any other objective than safety; therefore they do not have any other incentive than be as severe as possible if it comes down to approving new vehicles. One of the reasons that PDE Automotive is present in the model is that they are capable of doing the testing and homologation of new vehicles in very close cooperation with RDW. They have a license for this kind of activities. If Spring will bring PDE aboard, the chances of obtaining RDW approval for the ZURBAN are substantial high.

4.3.1.3 Challenges in Marketing

In the Marketing Cycle of CIM, four main challenges have been identified that need to be tackled by the available actors; create a clear footprint for the launching customer, involve the launching customers TNT and the Municipality of Rotterdam, acquire subsidy and get publicity. The acquirement of subsidy will be the toughest challenge in Marketing; without subsidy there will be no project at all because of the high costs that are not bearable for the partners without subsidy. If the subsidy is granted, the other challenges will be faced subsequently.

4.3.1.3.1 Create a clear footprint

The ZURBAN vehicle will only become a concept if the footprint is clear; it should have the green twist in its purpose and it should be a communication means by just driving through Rotterdam. The clear footprint will be created by giving the ZURBAN a look that is fancy and attractive. It might even be possible that the shape of the vehicle will be changed in order to be different from a conventional Volkswagen Transporter. The insights given by trend watcher Verloop and the experience of marketing agency DDB should together be able to provide the ZURBAN vehicle with a clear footprint in order to complement the concept. A sound execution of the customization cycle (15) should create the total ZURBAN concept.

4.3.1.3.2 Involving TNT and Rotterdam

TNT and Rotterdam are the preferred launching customers for the ZURBAN. In terms of technology they do not have a big influence on the vehicle; in terms of marketing they need to be given a clear influence on the concept. They should be able to choose between different designs in order to create a satisfying look. Furthermore, they need to have influence in the way the public will be reached; marketing campaigns will need to be organised in close cooperation with the TNT and Rotterdam consortium. Last but not least, the launching customers will be asked to help acquiring subsidy. Peter Bakker and Ivo Opstelten are well connected to relevant organs of the Dutch Government and could therefore give a positive boost for the subsidy tender.
4.3.1.3.3 Get subsidy

Acquiring funds is hard; acquiring subsidy can be a time consuming process. The firm Boudesteijn, importer of Mitsubishi, has been granted a € 1 million subsidy in the EOS Demo program of SenterNovem. EOS Demo is a program that aims at testing new, sustainable technologies in practice. Boudesteijn will rebuild a 7.5 tonnes Mitsubishi truck into a hydrogen fuel cell truck. They use the E-Traction and Nedstack technologies. This project is kind of similar to the ZURBAN project; although the ZURBAN is more focused on being a concept than a vehicle. SenterNovem will probably not be pleased to grant subsidy to a project that looks like the Boudesteijn project, because SenterNovem has the ambition of spreading their money over several different projects. According to the subsidy advisor, Spring's tender should therefore be different from the Boudesteijn project to avoid a rejection. Kelderman thinks chances for subsidy can be high if Spring aims for the network effect the ZURBAN should create, which can be found in its green purpose (for instance the collection of office waste or the sustainable distribution of foods) and the participation of Pon, PDE and NEMS. Pon might be able to develop a zero-emissions dealer business, PDE can be boosted to expand its activities in the Helmond area and NEMS will attract labour in Rotterdam. This is a broader approach than the Boudesteijn project and thus more attractive to SenterNovem. Though, getting subsidy will be a weak link for the existence of the ZURBAN project and is thus a challenge of managing right. Besides the EOS Demo, Spring could also join tenders in the ‘Pieken in de Delta’ program or the ‘Unieke Kansen Regeling’. The world of subsidies can be rather vague; Kelderman often shifts his focus from one program to another. At the moment of writing this part of the thesis, in September 2007, it will probably be the ‘Unieke Kansen Regeling’ that is aimed for. The Unieke Kansen Regeling can provide subsidies of maximum 50% of the total project costs if the project has the ambition to change society to a more sustainable, less energy consuming balance. The network effect needs to be clear in this program. The deadline for this tender is at the end of October.

4.3.1.3.4 Get publicity

It should be evident that in order to have the wanted effect in Dutch society, the ZURBAN will have to get as much as publicity as it can get in the Dutch media.
4.3.1.4 Challenges visualized

In Figure 53 the described challenges that need to be tackled by Spring and the other actors, have been visualized:

**Challenges in Sciences:**
- Cost-focused technology research
- Anticipate on market’s demands
- Influence governmental regulations

**Challenges in Engineering:**
- Interaction of technologies
- Systems integration
- Vehicle guarantee
- RDW vehicle approval

**Challenges in Engineering:**
- Interaction of technologies
- Systems integration
- Vehicle guarantee
- RDW vehicle approval

**Challenges in Marketing:**
- Create a clear footprint
- Involving TNT / Rotterdam
- Get subsidy
- Get publicity

Figure 53: Cyclic Innovation Model with all needed actors and their challenges
In order to make an estimation of the actual manageability of the faced challenges by Spring Newco, Figure 54 has been created in accordance with HeeCon, Pon, KC Group, DDB and Spring. This overview can be used by Spring to focus at what they can manage or to strengthen relations with actors that have a low manageability:

<table>
<thead>
<tr>
<th>Faced challenge</th>
<th>Main actors</th>
<th>Manageability by Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-focused technology research</td>
<td>TU Delft, TNO</td>
<td>Low</td>
</tr>
<tr>
<td>Anticipate on market’s demands</td>
<td>Gamma sciences</td>
<td>Low</td>
</tr>
<tr>
<td>Influence governmental regulations</td>
<td>Spring</td>
<td>Low</td>
</tr>
<tr>
<td>Interaction of technologies</td>
<td>NEMS, PDE</td>
<td>Low</td>
</tr>
<tr>
<td>Systems integration</td>
<td>NEMS, PDE</td>
<td>Low</td>
</tr>
<tr>
<td>Vehicle guarantee</td>
<td>NEMS, PDE, Pon</td>
<td>Low</td>
</tr>
<tr>
<td>RDW vehicle approval</td>
<td>PDE</td>
<td>Low</td>
</tr>
<tr>
<td>Create a clear footprint</td>
<td>Spring, DDB</td>
<td>Low</td>
</tr>
<tr>
<td>Involving TNT / Rotterdam</td>
<td>Spring</td>
<td>Low</td>
</tr>
<tr>
<td>Get subsidy</td>
<td>KC Group</td>
<td>Low</td>
</tr>
<tr>
<td>Get publicity</td>
<td>Spring, DDB</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Figure 54: Manageability of the challenges**

### 4.3.2 Management of the ZURBAN organization

If the managerial role of Spring Newco needs to be valued with help of the Cyclic Innovation Model, one observes that Spring wants to position itself in the middle of the innovation arena. This means that Spring wants to manage the scientific cycles, the engineering cycle and the marketing cycle, which can be regarded to be rather ambitious for a small firm like Spring. Moreover, the unique asset of Spring is rather vague; they do not own any technology or patent, they just had the vision that there would be an opportunity for the development of a zero-emissions vehicle in the Netherlands. The only unique asset that can be defined for Spring are the good contacts with Governments and several involved companies (like TNT and Pon). However, for the actual production of the vehicle, they had a lack of knowledge and contacts in engineering and sciences. It might be questionable why Spring would be the preferred company to act in the middle of the innovation arena. Though the goal of the research was to create insight in the ZURBAN innovation process, this paragraph presents some basic tips that should help Spring in managing the ZURBAN organization.

This paragraph is divided in two parts; (1) what Spring already has done and (2) what Spring should do in the future concerning the organization structure of the ZURBAN project.
### 4.3.2.1 What Spring has already organized

Spring has already done the following; (1) they have acknowledged the fact that innovating is collaborating, (2) they have searched for a large partner with good financial resources and (3) they have initiated the foundation of the ZURBAN B.V.

#### 4.3.2.1.1 Innovating is collaborating

In history, companies were often afraid to cooperate in their innovation processes because of the worry that others would steal their ideas. Nowadays, innovation is often presented as collaboration because most companies haven’t got all the needed resources to create a successful innovation (see Chapter 2). The knowledge which is for instance acquired accidentally by one company can be very useful for another company; knowledge spill-over can create innovations to occur. Moreover, ‘people and firms need outside sources of cognition and competence to complement their own’ (Nooeboom, 1999). Three leading scientists that have described fourth generation innovation management models; Chesbrough (2003), Von Hippel (2005) and Berkhout (2000) have stated the necessity to collaborate for the innovation process. Spring has acknowledged the trueness of these theories and searched for partners from the start of the innovation process. They kicked off with a potential collaboration with E-Traction and Nedstack; after the adoption of Berkhout’s cyclical innovation theory, they have taken a step back and scanned the market for suitable transition paths and partners. They have found several different partners with whom they will create the ZURBAN. Spring has been constantly collaborating in order to succeed; ‘Spring shares in order to multiply’.

#### 4.3.2.1.2 Pon is aboard and has good financial resources

Spring is a rather small consulting firm with access to a large network of other companies which is the result of previous work of the managing partners (Booz Allen Hamilton, Lost Boys, Elsevier). One of the requirements for the projects that are performed by Spring, is that it needs to be possible to cooperate with a large company. In the article ‘Entrepreneurship and strategic alliances’ of Alvarez (2006) one of the largest attractions for a small entrepreneurial venture is described as the formation of an alliance with a larger, more established partner in order to gain access to that firm’s financial capital. Alvarez describes financial capital to be a resource that is in insufficient supply. By choosing for the collaboration with Pon, Spring has created access to good financial resources.

#### 4.3.2.1.3 The ZURBAN B.V. is under construction

In an interview with Professor De Ridder from the Dutch Foundation for Society and Entrepreneurship, he advised Spring to create an independent entity in order to be able to innovate without the direct control of the business partners. According to De Ridder, large companies are worse innovators than small companies. Large companies might have a lack of creativity; they might be unwieldy and not flexible. Nooteboom (1999) confirms the view of De Ridder; he states that there is evidence that small firms produce more innovation output per unit of input. By the foundation of the ZURBAN B.V. Spring Newco will create a rather independent entity that will be responsible for the project management of the ZURBAN.
4.3.2.2 What Spring should organize for the future

After the description of what Spring has already achieved in terms of organization, it might be useful to pinpoint some activities that should be performed by Spring in the final months of 2007. I have identified some steps that needs to be taken.

4.3.2.2.1 Decide which actors will become shareholder to the ZURBAN B.V.

According to Spring, partners can be involved in the ZURBAN project in two ways; inside the entity partners can become shareholder and outside the entity partners can become subcontractor. The decision who will be shareholder and who will be subcontractor is rather dependent on the future’s perspective of the project. If the believe grows that the ZURBAN will be produced in series of hundreds or thousands, it might be interesting of not having too much shareholders in the entity in order to increase future profitability for the shareholders. If the project will end after the creation of the five vehicles, it might be interesting of having all partners in the entity in order to cut on the subcontracting costs.

4.3.2.2.2 Clearly define managers’ roles

In the book ‘Smart Alliances’ written by Harbison and Pekar (1998) several best practices are provided in order to make an alliance between partners succeed. They advise the organization of an alliance to clearly define managers’ roles; who is responsible for what. Spring Newco will perform the entrepreneurial project management; HeeCon will perform the technological project management of the project. And what will Pon do? Being the largest partner, they might want influence on both the strategic and technological project management. Moreover, TNT and Rotterdam probably want to have some influence as well. Therefore, these roles need to be defined clearly in order to avoid frustration.

4.3.2.2.3 Organize repetitive meetings

In the period that the ZURBAN case has been analysed, several meetings with (potential) partners have been organized (see Appendix). These meetings were useful in a sense that partners had the possibility of getting to know each other. Cooperation is a process which needs trust to be created; trust will appear if the partners have common goals and balanced inter-firm relations (Nooteboom, 1999 and Harbison, Pekar, 1998). Repetitive meetings with consortium partners should create a general understanding of each other’s activities and goals. This will clear the road for trust to arise and thus a good potential strategic alliance.

4.3.2.2.4 Implement formal agreements and contracts

In September 2007, there have not been signed any formal agreement or contract yet. Most of the preferred partners have stated that they will cooperate; the ZURBAN B.V. is under construction. The next step for Spring should be to make the partners’ promises explicit by defining agreements and signing contracts. One of the most important contracts that needs to be signed will be the project price contract with PML Automotive. They will probably ask a total price of around € 1.3 million which – at the end of the day – is too high to make the project profitable. Luckily, the bargaining power of Spring has increased the previous months because the
seriousness of the project has increased. This bargaining power will have to be used in order to make sure that PML asks for a lower price per for their technology.

4.3.2.2.5 Decide what will be the next stage
In accordance with the partners that will be added to the ZURBAN B.V., Spring will have to decide what will be done after the introduction of the first five vehicles; continue or stop. After all, the boosting ambition of Spring can also be satisfied in the first series of five vehicles. Pon has the ambition of creating more ZURBANS in order to satisfy their customers’ demands. The other partners have the ambition of creating more ZURBANS as well. However, the business case is not sound at the moment. Therefore, Spring will only be in favour of increasing the number of produced vehicles if the business case improves. This will mainly be dependent on the costs for PML’s technology. According to Martin Boughtwood, it will take until the production in series before PML’s technology will become substantial cheaper. At this moment, PML is in the process of acquiring a contract for the construction of 20,000 hybrids Volvo C30. If this becomes reality, then the price will go down to € 4,000 per vehicle. At that moment, the business case is very attractive and Spring will probably be in favour of continuation. In the next paragraph, the bad business case will be described as one of the threats for the project.

4.3.3 Threats for the ZURBAN project
The ZURBAN project has brought Spring in contact with several interesting partners, which caused other projects to arise like the advice the mother company Spring Associates is given to the TNT/Rotterdam consortium on sustainable distribution concepts. For Spring, these generated assignments have made the ZURBAN project worthwhile. However, the actual creation of the Dutch zero-emissions vehicle within one year faces four serious threats; (1) the cooperation of Pon that is influenced by the Volkswagen factory in Germany, (2) a rejection of the subsidy tender, (3) a bad business case and (4) malfunction of the technology partners.

4.3.3.1 The cooperation of Pon
At the moment of writing the board of Pon has given their blessings to the project under the condition that the Volkswagen factory does not have any objections. Pon is needed to connect a serious automotive player to the project and to be able to have access to rather large financial resources. If the Volkswagen factory forbids Pon to cooperate, for instance because the factory wants to do this kind of rebuilding projects themselves, then Spring can start over again. According to Marcel Vos from Pon, the chances that the Volkswagen factory will do so are rather small.

4.3.3.2 A rejection of the subsidy tender
The total calculated project costs for the ZURBAN are around € 2 million; the three subsidy programmes that potentially will be tendered – EOS Demo, Pieken in de Delta, Unieke Kansen Regeling – grant a maximum subsidy of 50%, which means that around € 1 million can be subsidized. These three programmes have their deadlines in October and November 2007. Without subsidy the project will not continue. In the process of acquiring a subsidy, it can be useful to have a subsidy advisor. SenterNovem, the Governmental institution that is responsible
for subsidies, has advisors that can help companies to streamline their tender. Spring has chosen to make use of an external subsidy advisor, Hans Kelderman, that already has good contacts with the advisors of SenterNovem. Therefore, Spring has assured that they will be well informed about the way they should present their tender. According to Kelderman, the chance that Spring will get the asked subsidy is rather high. It is however necessary to have the described set of partners aboard. Spring alone will not get subsidy.

### 4.3.3.3 A poor business case

If 50% subsidy will be granted, which will be around € 1 million, there will be an initial financial gap of € 1 million. The ZURBAN has been presented to the board of TNT for a purchase price of € 75.000 each. This is a competitive price if compared to market leader Smith Electric from the United Kingdom, that rebuilds a less performing Ford Transit for a price of € 65.000. If TNT decides to buy the first series of 5 vehicles, they will pay € 375.000 for the ZURBANS, which reduces the initial financial gap. Thus, if subsidy is granted and TNT buys the ZURBANS, then the gap will be:

\[
€ 2\text{ million (total project estimate)} - € 1\text{ million (subsidy)} - € 375.000 (sales) = € 625.000 (gap)
\]

This gap will need to be filled in order to create a business case. My suggestion would be to wait for the subsidy to be granted. If granted, the partners know that money is available. However, this money will only be available if the project will really be executed and this will only happen if the business case can be created. Especially for PML, that asks for € 1.3 million and therefore will take the largest part of the pie, the continuation of the project is important. I would create a take-it or leave-it situation for PML. Do it for half of the asked price or the project will not continue. If PML delivers their product for half the price, the business case can be created.

### 4.3.3.4 Malfunction of the technology partners

The Volkswagen Transporter will be delivered to NEMS, the vehicle systems integrator. At NEMS, the technologies from PML, SP Innovation, PDE and others will have to be fitted in the vehicle. The level of complexity is hard to estimate for Spring, but it is possible to identify the malfunction of technologies or the technology partners as a big threat to the project. HeeCon, who will be responsible for the technological project management, has assumed that the time period of one year will be more than enough to rebuild 5 vehicles. This is also confirmed by competitor Smith Electric that has rebuild the first Ford Transits within one year. However, what if one of the partners is misjudging the situation? One weak link in technology development will be a threat to the whole project.
4.4 Conclusion

How can Berkhout's innovation theory be operationalized to arrive at the ZURBAN concept?

Berkhout's theory has been operationalized in order to support the introduction of the ZURBAN proposition by following the stepwise approach that has been described in the characteristics of the theory. This approach turned out to be clear and easy to follow; it provides a logic way of dealing with the innovation process. The switch between being 'the leader' for the creation of a vision and strategy, being 'the entrepreneur' for the actual 'pulling and dragging' in the cyclical innovation arena and being 'the craftsman' for the choice of the right combination of knowledge and skills on the shop floor, fits the ambition of Spring as they want to be the booster for sustainable mobility in the Netherlands. The operationalization of Berkhout's theory asks for an open mind and broad view; the cyclical thinking has to be adopted. Only by doing so, the theory can be operationalized in order to arrive at the ZURBAN concept. A good example of this open mind is the assessment of the partners that had been initially selected by Spring before this research project started. One of these partners turned out to be not the best possible fit for the creation of the ZURBAN vehicle. Theory advised Spring to choose for another transition path than foreseen. Another good example of this open mind is that around 45 meetings have been organized during the thesis project in order to be well informed about all four relevant cycles of the model (see Appendix).

It needs to be mentioned that the actual operationalization of the Cyclic Innovation Model with all desired actors will have a start after the subsidy will be granted by SenterNovem. Then these actors need to be guided in order to really create the innovation. The seven months period of this research project can be regarded the preparation phase in the actual creation of an innovative proposition.
How can Spring Newco support the creation of the ZURBAN concept?

Spring wants to have the central role in both the business development framework and the Cyclic Innovation Model. By a sound execution of these roles – leadership as well as entrepreneurship and bringing in the right craftsmanship – Spring will support the creation of the ZURBAN concept. Spring’s capabilities can be found in strategic management. They need to have the overall picture in the project; they need to know which actor should be doing what and when. In Chapter 4, the supportive role of Spring Newco is divided in identifying and guiding challenges, in the organization of the collaboration between the actors and in monitoring threats. In terms of challenges, Spring will have to manage challenges in Sciences, Engineering and in Marketing. In terms of organization, several recommendations have been done about what they could organize in nearby future. Furthermore, four serious threats to the project have been described.

In Sciences, the following challenges have been identified:
1. Cost-focused technology research in order to cut the price of zero-emissions technologies
2. Anticipate on market's demands to make sure that the ZURBAN will stay up-to-date
3. Influence Governmental regulations in order to create extra privileges for the ZURBAN

In Engineering the following challenges have been identified:
1. The interaction of the technologies that make the vehicle zero-emissions
2. The overall systems integration of the vehicle
3. The guarantee of the vehicle
4. The RDW vehicle approval

In Marketing the following challenges have been identified:
1. Create a clear footprint to make sure that the ZURBAN communicates a strong message
2. Involve the launching customers TNT and Rotterdam
3. Get subsidy from the central Government
4. Get publicity in order to be the booster for sustainable mobility

Recommendations have been given in the organizational field. These recommendations are to make sure that (1) there is cyclical collaboration between actors, (2) there are sufficient financial resources, (3) there is an entity that is responsible for the ZURBAN as a company, (4) there is a clear description of roles and (5) there is a realistic roadmap.

At the end of the Chapter, the four main threats to the project have been identified as (1) the cooperation of Pon which is dependent on the approval of the Volkswagen factory, (2) the possible rejection of the subsidy tender which will create an unbearable financial gap, (3) a poor business case if the used technologies aren’t lowered in price and (4) the possible malfunction of the selected technology partners.
Theory's contribution to the ZURBAN innovation process

Challenges in Sciences:
- Cost-focused technology research
- Anticipate on market's demands
- Influence governmental regulations

Challenges in Engineering:
- Interaction of technologies
- Systems integration
- Vehicle guarantee
- RDW vehicle approval

Challenges in Marketing:
- Create a clear footprint
- Involving TNT / Rotterdam
- Get subsidy
- Get publicity

Figure 55: The process model applied to the ZURBAN innovation process
5 Conclusions

The conclusions of the research will be given by the answering of the research questions.

- What are the characteristics of Berkhout’s innovation theory?

The objective of Chapter 2 was to make an inventory of the characteristics of Berkhout’s innovation theory. In his theory, Berkhout proposed a stepwise approach with the help of a new business development framework (Figure 6) in which:

1. A view of the future will be sketched
2. One or more transition paths will be defined
3. The Cyclic Innovation Model (Figure 7) will be used to gain insight in the innovation process

Berkhout distinguishes three types of actors in his theory; ‘the leader’ creates a vision in accordance with the view of the future (1) and a strategy in accordance with the transition path (2). The organizing and energizing in the innovation arena is done by ‘the entrepreneur’ as shown by the Cyclic Innovation Model (3). If one zooms into the Cyclic Innovation Model, one observes ‘the craftsman’ that connects the needed knowledge and skills at the lowest layer of the theory (Figure 8).

The Cyclic Innovation Model (3) regards the innovation process as a dynamic arena in which never-ending cycles create new insights, technologies, products and services. The entrepreneur is the spider in Berkhout’s innovation arena. His theory is useful for situations in which multiple actors are needed to innovate and in which there is a lack of insight in the roles and interactions of these actors. In this research, the theory has been used prescriptively in order to provide Spring with best practices for guiding the innovative ZURBAN proposition to the market place.

- What are the characteristics of the ZURBAN proposition?

The characteristics of the ZURBAN proposition has been described in Chapter 3. The proposition fits Spring’s view of the future in which there is plenty room for zero-emissions transportation, especially for heavy usage in urban distribution. In collaboration with business partner Pon, the ZURBAN concept is defined as a Volkswagen Transporter that:

1. Should be used for urban distribution purposes with a green twist
2. Should be zero-emissions
3. Should stimulate the Dutch automotive industry
It is the ambition of Spring to create the ZURBAN proposition in close cooperation with a launching customer. Advisory work that has been done for the business development department of the Dutch TNT Group created an opportunity to fit the ZURBAN in a future sustainable urban distribution pilot that will be organized by a consortium of TNT and the Municipality of Rotterdam.

### Which transition path will fit the ZURBAN best?

The third sub question has been asked in order to advice Spring on the best possible transition path for the realization of the ZURBAN vehicle; this choice has been technology oriented. Four paths have been described; the path in which PML Automotive provides their in-wheel direct-drive electric engine for construction in the Volkswagen Transporter is expected to score overall as the best fit on six variables:

1. Reliability of the technology (score of PML: 75%)
2. Price of 5 ZURBANS (50%)
3. Price of 100 ZURBANS, in other words: the scalability (75%)
4. Subsidy chances (50%)
5. Possible footprint for the launching customer (75%)
6. Chances of becoming a future standard (75%)

The board of Pon has final decision power in the selection process of a suitable transition path. If the Volkswagen factory in Germany will give authorisation for the project – they will most likely do so in September, then Pon will choose for PML because their technology has a unique weight/torque ratio and they have scored best in the overall transition path assessment of Chapter 3.

Note that more actors than just the technology provider PML are needed in order to complete the transition path. In the operationalization of the ZURBAN proposition with the Cyclic Innovation Model in Chapter 4, an advice will be given on which actors should be doing what.

### How can Berkhout's innovation theory be operationalized to arrive at the ZURBAN concept?

Berkhout’s theory has been operationalized in order to support the introduction of the ZURBAN proposition by following the stepwise approach that has been described in the characteristics of the theory. This approach turned out to be clear and easy to follow; it provides a logic way of dealing with the innovation process. The switch between being ‘the leader’ for the creation of a vision and strategy, being ‘the entrepreneur’ for the actual ‘pulling and dragging’ in the cyclical innovation arena and being ‘the craftsman’ for the choice of the right combination of knowledge and skills on the shop floor, fits the ambition of Spring as they want to be the booster for sustainable mobility in the Netherlands.
The operationalization of Berkhout’s theory asks for an open mind and broad view; the cyclical thinking has to be adopted. Only by doing so, the theory can be operationalized in order to arrive at the ZURBAN concept. A good example of this open mind is the assessment of the partners that had been initially selected by Spring before this research project started. One of these partners turned out to be not the best possible fit for the creation of the ZURBAN vehicle. Theory advised Spring to choose for another transition path than foreseen. Another good example of this open mind is that around 45 meetings have been organized during the thesis project in order to be well informed about all four relevant cycles of the model (see Appendix).

It needs to be mentioned that the actual operationalization of the Cyclic Innovation Model with all desired actors will have a start after the subsidy will be granted by SenterNovem. Then these actors need to be guided in order to really create the innovation. The seven months period of this research project can be regarded the preparation phase in the actual creation of an innovative proposition.

How can Spring Newco support the creation of the ZURBAN concept?

Spring wants to have the central role in both the business development framework and the Cyclic Innovation Model. By a sound execution of these roles – leadership as well as entrepreneurship and bringing in the right craftsmanship – Spring will support the creation of the ZURBAN concept. Spring’s capabilities can be found in strategic management. They need to have the overall picture in the project; they need to know which actor should be doing what and when. In Chapter 4, the supportive role of Spring Newco is divided in identifying and guiding challenges, in the organization of the collaboration between the actors and in monitoring threats. In terms of challenges, Spring will have to manage challenges in Sciences, Engineering and in Marketing. In terms of organization, several recommendations have been done about what they could organize in nearby future. Furthermore, four serious threats to the project have been described.

In Sciences, the following challenges have been identified:
1. Cost-focused technology research in order to cut the price of zero-emissions technologies
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In Engineering the following challenges have been identified:
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Recommendations have been given in the organizational field. These recommendations are to make sure that (1) there is cyclical collaboration between actors, (2) there are sufficient financial resources, (3) there is an entity that is responsible for the ZURBAN as a company, (4) there is a clear description of roles and (5) there is a realistic roadmap.

At the end of the Chapter 4, the four main threats to the project have been identified as (1) the cooperation of Pon which is dependent on the approval of the Volkswagen factory, (2) the possible rejection of the subsidy tender which will create an unbearable financial gap, (3) a bad business case if the used technologies aren’t lowered in price and (4) the possible malfunction of the selected technology partners.

How does Berkhout’s innovation theory contribute to the introduction of the sustainable, innovative ZURBAN proposition?

At the end of the research project, the main research question can be answered the following:

Berkhout’s innovation theory provided a clear overview of all the important steps that need to be taken in the ZURBAN innovation process, creating the possibility for Spring Newco to act as leader, entrepreneur and facilitator in the cyclical innovation arena.

At the end of the conclusions, I would like to add a personal note:

The ambitions for the project under research are high; Spring Newco will create five ZURBAN vehicles that incorporate brand new technologies within one year. By following Berkhout’s approach of which an inventory has been given, this report provides a clear insight in why and how the ZURBAN should be created. In a relative short period of seven months, I have tried to acquire relevant knowledge on all cycles of the Cyclic Innovation Model. Therefore, over 45 actors have been interviewed, each placed in a different position of the model. Personally, Berkhout’s theory has helped me structuring my activities as the ZURBAN project manager; it provided a stepwise approach that has been documented in this thesis report. I strongly believe that a sound execution of the given advises will be the easiest way that leads to the satisfaction of Spring Newco’s ambitions.
Future sustainable projects of Spring Newco

In future, Spring Newco has the ambition of having the entrepreneurial project management role for the creation of other sustainable propositions as well. Spring might be interested in using Berkhout's theory for these future projects. They were surprised by the approach of the theory; after defining why the sustainable proposition should be created, it prescribes an open and cyclical view in which the desired set of actors that is needed to realize the proposition can be easily analysed and visualised. It creates a helicopter view that allows Spring to have influence in all cycles that need to be put into action; it allows them to be the ‘leader’, the ‘entrepreneur’ and the ‘craftsman’ at the same time. This thesis can be used by Spring as an example for the preparation and possible execution of other projects. Especially the overall figures that have been presented at the end of each chapter (under the heading ‘Theory’s contribution to the ZURBAN innovation process’) can be useful for the entrepreneurial project manager.

At the moment of writing, Spring Newco is searching for its identity; they are struggling what their focus should be. In principal, their focus will be ‘something with sustainability or new media’. They have not ventured anything successfully yet. Besides the approach that has been described above, I think that Spring Newco could use CIM for the creation of a constant feedstock of potential venture ideas. Until now, Spring has acquired their ideas via their experiences as strategy consultant and by keeping their eyes and ears open. CIM could help structure the idea acquisition. I therefore suggest that layer 2 of Berkhout’s theory, which is the highest level of the Cyclic Innovation Model, should be filled in by Spring with actors from their network that need to be monitored now and then for the durable construction of an idea acquisition process. At the end of this thesis, a general setup of the model which needs to be filled in with connected actors by Spring Newco is provided:

Figure 56: Potential setup of CIM for a continuous generation of venture ideas for Spring Newco
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7 Appendices

7.1 Interviewees

In order to create insight in the innovation process and in order to be able to assess the applicability of Berkhout’s innovation theory, around 45 meetings have been organized during the graduation period. In this appendix, these meetings have been described and the actors are placed in the Cyclic Innovation Model to show that all cycles have been covered during the research project. All interviewees can be categorized in several categories:

- Potential business partners
- Potential hardware suppliers or integrators
- Governmental institutes
- (Scientific) research institutes
- Potential customers
- Trendwatchers
- Supportive institutes in terms of entrepreneurial and technical management & marketing

The interviewees have been chosen in order to cover all cycles of CIM and they have been chosen because they are ‘not far away’ of Spring Newco or myself. It was easy to make contact with the mentioned actors, which made it possible to organize around 45 face-to-face meetings.

Before the meetings started, I did prepare some questions in a specific theme. However, a predefined set of questions or questionnaires have not been used. It were dynamical conversations.

1. Ministry of Transport, Public Works and Water Management
Coen Faber, advisor innovation policy
29 January, The Hague

*Application of CIM:* Governments make laws and regulations and can be a supportive partner in the cyclical innovation arena by granting subsidy. We have discussed the innovation policy of the Dutch Government and the way they could support the ZURBAN project. Coen Faber advised Spring to arrange a launching customer and then to return. The Ministry turned out not to be interested in being a launching customer themselves.

2. Delft University of Technology
Professor Schoonman, applied inorganic chemistry
12 February, Delft

*Application of CIM:* Professor Schoonman supplied me with knowledge on the developments in the world of fuel cell stacks in the hard sciences cycle. He explained the technological operations of a fuel cell stack and he provided lecture sheets on the technical background.
3. E-Traction
Arjan Heinen, director
14 February 2007, Apeldoorn

*Application of CIM:* E-Traction could form one of the transition paths that might lead to the creation of the ZURBAN. This has been a meeting to get more information on E-Traction’s technology ‘TheWheel’ and their former project which has been the creation of a low-emissions city bus.

4. Nedstack
Jan Piet van der Meer, director
15 February 2007, Arnhem

*Application of CIM:* Nedstack provides a technology that might be used in the integrated engineering cycle to increase the performance of the ZURBAN in terms of driving range. We have discussed the way the ZURBAN could help Nedstack getting foot on the ground in the automotive industry.

5. TNT Post
Ger Jacobs, commercial director TNT Post
Kees van den Heuvel, manager business development TNT Post
16 February 2007, Den Haag

*Application of CIM:* TNT Post could be the launching customer for the ZURBAN project. They were interested, and asked Spring to work out a proposal for a sustainable pilot that TNT Post could organize. The ZURBAN could be one of the elements in this pilot. According to Berkhout's theory, innovation can only be achieved if the potential customer(s) has been involved, preferably in an early stage.

6. GVB Amsterdam / Platform on Sustainable Mobility / Phileas
Frits van Drunen, senior project manager
21 February 2007, Amsterdam

*Application of CIM:* Frits van Drunen has been the entrepreneur in the cyclical innovation arena; he has already combined technologies and products in the process of creating a zero-emissions city bus (GVB). Van Drunen knows the industry and the possibilities. He also contributed to the creation of a zero-emissions passenger bus for the Municipality of Eindhoven. Van Drunen's focus is mainly on the engineering cycles, although he has some information on the lower part of CIM as he is a member of the Dutch Platform on Sustainable Mobility. Frits van Drunen emphasized the need to have a large automotive company aboard in order to achieve Spring's goals.
7. Value Enhancement Partners
Frits Thieme, partner
6 March 2007, Amsterdam

Application of CIM: Value Enhancement Partners is a private equity firm. Commercial investors can be needed to make sure the entrepreneur thinks in terms of business cases; in principal one could state that without a potential business case, a new product-service combination cannot find its way to the market place to become an innovation. The role of Value Enhancement Partners is to make Spring think of the ZURBAN as a business case. Frits Thieme de facto acts like a customer in order to make sure that Spring develops something that will attract him, and the public.

8. Springtime
Marcel Schreuder, director
19 March 2007, Amsterdam

Application of CIM: Springtime is a publicity agency that works for well known companies like Coca Cola and Unilever. CIM prescribes the needed involvement of the launching customer in an early stage of the product development process. Springtime has created some impressions that could give the launching customer a feeling about the way the ZURBAN would look like. Moreover, Springtime is well informed on the current needs and desires of potential customers; they have a trend watching function.

9. Verloop Innovatie
Joop Verloop, director
19 March 2007, Amsterdam

Application of CIM: Joop Verloop created insights in the market cycles of CIM. He provided me with information on trends and future needs. He has been active in the soft sciences cycles and he advises in the valorisation cycle to create the ZURBAN concept.

10. Pon Holdings
Bert van Haarlem, chief information officer
Marcel Vos, manager business development
20 March 2007, Nijkerk

Application of CIM: We have discussed the possibility of Pon to join the ZURBAN project in an entrepreneurial role (besides Spring Newco) and in a facilitating role in the engineering cycle. Moreover, Pon has knowledge on their clients’ needs which can be useful in the differentiated valorisation cycle.
11. Spijkstaal
Wim Heijboer, director
23 March 2007, Spijkenisse

*Application of CIM:* Spijkstaal is a potential hardware provider in the engineer cycles and Spijkstaal has the capabilities to do the hardware systems integration. We have discussed the potential transition path that could be formed by Spijkstaal.

12. Van Gansewinkel
Yoeri van Alteren, commercial manager
3 April 2007, Amsterdam

*Application of CIM:* It turned out that Van Gansewinkel needed a zero-emissions transportation vehicle for a new waste collection pilot they wanted to organise in the centre of Amsterdam. I have interviewed Yoeri van Alteren in order to gain insight in the possibility of having Van Gansewinkel aboard as launching customer and to gain insight in their wishes.

13. Agrologistiek
Douwe-Frits Broens
12 April 2007, Wageningen

*Application of CIM:* I have interviewed Douw-Frits Broens, who is connected to the Wageningen University and who is entrepreneur with his company Agrologistiek. Broens provided an insight in competing zero-emissions solutions like second generation bio fuels. It turned out to take at least 5-10 years before technologies would be ready to produce second generation bio fuels. Till then, other zero-emissions solutions would be better for the environment. CIM prescribes a broad view in which there is space for alternatives. That’s why I though it would be interesting to have an expert’s opinion on bio fuels.

14. Netras Mobile Systems
Michel van Dooren, director
17 April 2007, Helmond

*Application of CIM:* Netras has rebuild a Renault vehicle into an easy container transportation vehicle. They had a view of the future in which there would be city boxes in the centres of the cities that would perform the need for quick and clean urban distribution. They have stated that this new system would need a new kind of vehicle that is able to easy pick-up and deliver city boxes. That’s why they had rebuild a Renault vehicle. In fact, they have created a new product-service combination in the role of entrepreneur. They advised Spring to just-do-it. Do not wait, but start building. In terms of bringing people together, Spring afterwards organized a meeting with E-Traction, Nedstack and Netras in order to provide Netras the possibility of creating a zero-emitting vehicle. Here, the desired boosting function of Spring was put into practice.
15. Pon / E-Traction / Nedstack
Marcel Vos, business development manager Pon
Arjan Heinen, director E-Traction
Jan Piet van der Meer, director Nedstack
24 April 2007

*Application of CIM:* This meeting has been organized by Spring in order to bring the preferred partners together. Technical capabilities have been discussed as well as the roadmap for commercialisation. These meetings were meant for knowledge sharing and putting all noses in the same direction.

16. Spinnovation
Sjef Peeraer, director
24 April 2007

*Application of CIM:* Spinnovation can be a provider of batteries and other electronics that are needed in the engineering cycles. Moreover, Spinnovation is active in the hard sciences cycles as they have hired a scientific research institute in India to perform research on power storage technologies.

17. TNT Post
Ger Jacobs, commercial director TNT Post
Eric Dietz, strategy director TNT Post
25 April 2007

*Application of CIM:* The continuous involvement and feedback rounds with the potential launching customers fits the prescriptions of CIM. We have discussed the broader sustainable approach for TNT Post in which the ZURBAN would be one element. This has been the beginning of the pilot in Rotterdam.

18. Delft University of Technology
Professor Berkhout, innovation management
9 May 2007, Delft

*Application of CIM:* Professor Berkhout helped me creating more insight in his innovation management theory in order to continue the process of making the desired companies enthusiastic for the ZURBAN project.
19. TNT Post
Ger Jacobs, commercial director TNT Post
Eric Dietze, strategy director TNT Post

*Application of CIM:* The involvement of and feedback creation with the potential launching customer. This has been a follow-up meeting to discuss the broader sustainable strategy of TNT in which the ZURBAN can be used as the newest addition to their vehicle fleet.

20. Oranjewoud Engineering Agency
Ka Lung To, project manager
14 May 2007, Amsterdam

*Application of CIM:* I have had contact with Oranjewoud in order to discuss the technical challenges that would be hardest in the product development cycles. Oranjewoud explained that technologies exist, and that there are several systems integrators in the Netherlands that are able to build the ZURBAN. They named the possible high prices as the biggest challenge to overcome.

21. DDB Amsterdam
Ivo Roefs, deputy managing director
15 May 2007, Amsterdam

*Application of CIM:* DDB is a well known marketing agency that is specialized in creating concepts that fit current market developments. They have stated that they are willing to join the ZURBAN project in the differentiated valorization cycle. They are specialized in knowing what’s hot and what’s not.

22. KC Group
Hans Kelderman, director
21 May 2007, Amsterdam

*Application of CIM:* KC Group is the subsidy advisor of Spring. Kelderman explained which kind of actors should be aboard the project to increase subsidy chances. We agreed that he would start the lobby process with SenterNovem to warm them up for Spring’s subsidy tender. It needs to be remarked that the advice of Kelderman had a connection with CIM. The more cycles of CIM would be covered by the project, the higher the chances for subsidy, according to Kelderman.
Application of CIM: In order to gain insight in the automotive industry, I have visited the Sustainable Day organized by Pon. This day was all about the future of mobility and sustainable automotive products. It contributed to Spring’s view of the future and to their entrepreneurial role in the cyclical innovation arena by acquiring knowledge on the engineering and market cycles.

Application of CIM: This has been a feedback meeting in order to discuss the status of the subsidy tender.

Application of CIM: This has been a feedback meeting in order to discuss the status of the ZURBAN project. I have explained Nedstack that it would be possible that their hydrogen fuel cell stack would not be used in the engineering cycle because of the high price they asked. Nedstack understood this approach, but said that there was no room for lowering their prices at this moment.

Application of CIM: This has been a feedback meeting in order to discuss the status of the ZURBAN project. I have explained E-Traction that I am investigating several other transition paths that could create the ZURBAN to avoid a focused view and to adopt the cyclical thinking of Berkhout. Although Heinen was not amused, he understood my approach.

Application of CIM: Richard Smokers has worked for TNO and he currently works for CE. He performs research on the transition to sustainable mobility in Europe and he focuses on the edge between industry and Governments. Smokers filled in some question marks in the market cycles of CIM.
28. HeeCon Business Development
Jan Heetebrij, director
18 June 2007, Rotterdam

*Application of CIM:* I have contacted Jan Heetebrij because he has been active in the repositioning committee of Nedcar. He turned out to be representative of an English company that could form an alternative transition path for the creation of the ZURBAN. PML Automotive had developed a direct-drive in-wheel engine that could make a Volkswagen Transporter zero-emissions. PML would be an alternative for E-Traction or Spijkstaal. The meeting with Heetebrij fits the broad approach of CIM.

29. Nederland Distributieland
Madelon den Dulk, researcher
25 June 2007, Amsterdam

*Application of CIM:* Madelon den Dulk works for the organization that represents the Dutch distribution sector. She is the researcher that has been responsible for the publication ‘De Logistieke Kracht van Nederland’ and she can be regarded an expert in the market cycle. She provided interesting information on sustainable distribution concepts that came in handy for the TNT pilot and in which the ZURBAN is the used vehicle.

30. Commissie Stedelijke Distributie
Martin Salet, secretary
26 June 2007, Amsterdam

*Application of CIM:* Martin Salet provided new insights on the innovation in urban distribution concepts that could be used to persuade TNT to organize a pilot in which the ZURBAN would be used in order to gain privileges from local Governments. Martin Salet provided information in the market cycles of CIM.

31. Buck Consultants
Erik Koekebakker, consultant
26 June 2007, Amsterdam

*Application of CIM:* Peter Koekebakker provided information in the market cycles of CIM. He is specialized in innovative urban distribution concepts and he contributed to Spring’s view of the future.
32. Boudesteijn Groep  
Jan Boudesteijn, director  
29 June 2007, Amsterdam

*Application of CIM:* Boudesteijn is active transforming a conventional Mitsubishi truck into a hydrogen fuel cell truck. I have had contact with Jan Boudesteijn because he fulfils the entrepreneurial role in this project. He also deals with Governments (for subsidy) and with technical partners. He did not adopt a broad approach in the beginning of the project and he selected two technical partners with whom he wanted to complete the job. One of these partners, which was E-Traction, turned out to be the underperformer in the project. This could have been foreseen if Boudesteijn had adopted the broad cyclical approach of Berkhout in which multiple partners need to be researched in the transition path phase.

33. Maastricht University  
Emil Möller, PhD student  
2 July 2007, Amsterdam

*Application of CIM:* Emil Möller is connected to the International Centre for Integrated Assessment and Sustainable Development of the Maastricht University. His PhD research is about energy transition in the Netherlands. He has provided scientific information in the soft sciences cycles to Spring and he brought us – in an earlier stage – into contact with Jan Heetebrij.

34. Chamber of Commerce  
Simone Veldema, senior project manager Amsterdam  
4 July 2007, Amsterdam

*Application of CIM:* With Simone Veldema we discussed the possibility of getting subsidy from the Chamber of Commerce in Amsterdam if the ZURBAN would stimulate the industry in and around Amsterdam. Because TNT wanted to focus on Rotterdam, this meeting resulted in nothing but the acquiring of information on the market cycles.

35. Entrepreneurial Society Amsterdam  
Rein Aarts, industry manager  
4 July 2007, Amsterdam

*Application of CIM:* Rein Aarts explained us the sustainable developments that he has observed among member companies. It seemed like Aarts was able to provide Spring with a short list of potential launching customers. In the meeting, it turned out that Aarts was willing to share information about industrial development (on the edge of soft sciences and the valorisation cycle) but that he did not want to help Spring with the acquisition of a launching customer among his members.
36. Municipality of Amsterdam
Harry van Bergen, environmental policy advisor
4 July 2007, Amsterdam

*Application of CIM:* Harry van Bergen is responsible for the environmental policy of the Municipality of Amsterdam. I have advised him in his process of creating a vision on the future industrial, automotive developments in his region. He has examined the possibility of the Municipality of Amsterdam to become launching customer. They were interested but the scope of the project was too soon for Amsterdam. Their vision will be presented in January 2008 after which a selection of supported projects will be made. The ZURBAN could be one of these projects by then. Amsterdam is placed in the market cycle of CIM.

37. Pon Holdings
Marcel Vos, manager business development
5 July 2007, Vianen

*Application of CIM:* As prescribed by Berkhout's theory, this meeting has been organized to create a feedback loop with Pon. Spring has given Pon an update about the ZURBAN project and the potential technology partners.

38. TNO Automotive
Salem Mourad, business manager advanced powertrains
10 July 2007, Delft

*Application of CIM:* TNO Automotive is able to provide one of the transition paths that turns the Transporter into the ZURBAN. They can provide hardware, do the technical systems integration, the software development and the RDW approval. I have talked it over with Salem Mourad, who has provided Spring with an offering.

39. KC Group
Hans Kelderman, director
12 July 2007, Amsterdam

*Application of CIM:* This has been a meeting to give feedback about the current developments. Hans Kelderman uses these meetings to give feedback to SenterNovem in order to keep them warmed up.

40. HeeCon Business Development
Jan Heetebrij, director
17 July 2007, Amsterdam

*Application of CIM:* This has been a feedback meeting in which Heetebrij has given Spring an update on PML's willingness to cooperate. He also provided the price of the project to Spring.
41. Spinnovation
Sjef Peeraer, director
17 July 2007, Amsterdam

_Application of CIM:_ This has been a feedback meeting to make sure that Spinnovation is able to join the project. Peeraer has sorted some technical things out, and he showed the Prius Plug-in that has been created by his company.

42. TNT / Municipality of Rotterdam
Kees van den Heuvel, manager business development TNT
Peter Verschoor, project manager Rotterdam Climate Initiative
25 July 2007, Rotterdam

_Application in CIM:_ This has been a meeting in which Spring tried to identify the wishes of the launching customer. Spring facilitated a meeting in which it became clear that TNT and Rotterdam wanted to organise a pilot in sustainable urban distribution, with the help of zero-emissions distribution vehicles that would drive through the city from some sort of cross dock location to the shops and offices in the centre. Again, this is in accordance with Berkhout’s theory because customer’s wishes are need to be fulfilled for the creation of an innovation.

43. City Cargo
Charles Vaanhold, director
3 August 2007, Amsterdam

_Application in CIM:_ In this meeting I have tried to understand how City Cargo had succeeded in obtaining Governmental support and a successful pilot. Moreover, they have the ambition of buying hundreds of electric vehicles the coming decade. That’s why they are regarded a potential launching customer, or at least a potential customer for the nearby future. The first contact has been made.

44. Pon Holdings
Marcel Vos, manager business development
14 August 2007, Amsterdam

_Application in CIM:_ This has been the meeting in which Pon has chosen for the PML transition path (see Chapter 3) in accordance with the information provided by Spring Newco. From this point on, there can be seriously tendered for subsidy; the board of Pon officially supports the ZURBAN project.
45. Foundation Society and Entrepreneurship
Professor Wim de Ridder, director
16 August 2007, The Hague

Application in CIM: Professor Wim de Ridder has given advice on the desired entity structure of the ZURBAN project; he states that large companies are unable to radically innovate and therefore a new entity needs to be founded in order to guide the ZURBAN to the market place.

In Figure 57 all interviewed actors are visualized in their CIM position if they would have been involved in the ZURBAN project. One observes that all cycles are covered.

Figure 57: If CIM would be filled in with all the interviewed actors, it would probably look like this
7.2 Introduction of eco-zones in the Netherlands

Op grote schaal worden milieuzones en venstertijden ingevoerd, om distributie schoner en efficiënter te laten plaatsvinden

- In april 2006 hebben tien gemeenten, het bedrijfsleven en het rijk een convenant ondertekend waarin afspraken zijn gemaakt over de instelling van milieuzones en de milieueisen voor vrachtauto's in milieuzones
- Enschede is erin geslaagd om in twee jaar tijd het aantal vervoersbewegingen te halveren. In combinatie met venstertijden zijn de mogelijkheden bekeken om goederen te bundelen.

Source: Spring Associates presentation TNT (July 2007)
7.3 Eco-zone in Enschede

ENSCHEdE - Enschede vervult een voorbeeldfunctie op het gebied van stadsdistributie. De Twentse stad is erin geslaagd om in twee jaar tijd het aantal vervoersbewegingen te halveren.

De aanzet tot het huidige geavanceerde stadsdistributiesysteem van Enschede werd gegeven door aparte gesprekken met alle verladers en vervoerders. Er werd toen in kaart gebracht wanneer en waarom zij op bepaalde tijdstippen de stad inreden. Huib Rietveld, projectleider bij de dienst stedelijke ontwikkeling in Enschede, stelt dat er wel zo'n 600 gesprekken zijn gevoerd. Tijdens deze gesprekken zijn mogelijkheden bekeken om goederen te bundelen en zich aan de geldende venstertijden te houden.

De gesprekken hebben uiteindelijk geresulteerd in de invoering van een venstertijd van 7.00 tot 11.00 uur. De binnenstad wordt dagelijks tussen deze uren middels bollards (paaltjes) afgesloten. Buiten deze venstertijd is het stadserf alleen toegankelijk voor vervoerders met een stadserfontheffing. Veel versleveranciers mogen 24 uur per dag de stad in.

Het stadsdistributiesysteem voorziet verder in een toegangspas voor bewoners en kentekenregistratie voor vrachtwagens en taxi’s. Vervoerders dienen volgens vaste, milieu vriendelijke korte routes de stad in te rijden.

*Source: Nieuwsblad Transport (September 2005)*
7.4 Amsterdam discourages pollutant car usage

Source: Telegraaf (June 27, 2007)
7.5 Committee Kok worries about the accessibility of the Randstad

DEN HAAG - De Randstad moet in de toekomst onder één bestuur vallen. Door de aansturing van de huidige vier provincies te vervangen door één autoriteit, kan de Randstad blijvend een plaats verwerven in de topvijf van stedelijke regio's in Europa.

Dat staat in het advies dat een commissie onder leiding van oud-premier Wim Kok woensdag heeft uitgebracht. De commissie heeft op verzoek van minister Johan Remkes (Binnenlandse Zaken) een analyse gemaakt van de zwakke internationale concurrentiepositie van de Randstad en de bestuurlijke problemen in het gebied.

Het nieuwe kabinet moet volgens Kok de regie in handen nemen van de ingrijpende veranderingen die nodig zijn om een Randstad-bestuur op te tuigen. De meest nijpende knelpunten in de regio kunnen echter niet wachten op deze complexe reorganisatie en moeten nu al worden aangepakt. Het gaat onder meer om de bereikbaarheid van de regio en het leefklimaat.

Source: ANP (January 17, 2007)
7.6 The Citycargo concession

Op 9 juli heeft de gemeente Amsterdam de 10-jarige exclusieve concessie verleend aan Citycargo Amsterdam, voor het vervoer van goederen per vrachttram. Dit werd op feestelijke wijze gevierd op het terras van Prins H. Op het stuk spoor voor het terras diende een historische tram, beschikbaar gesteld door de Museumlijn, als locatie voor de ondertekening.

Voorafgaand aan het zetten van de handtekeningen wensten onder andere Marijke Vos (wethouder Milieu Amsterdam) en Gert-Jan Kroon (directeur GVB) CityCargo veel succes toe. Daarbij benadrukten zij het belang van de vrachttram voor Amsterdam, met betrekking tot de verbetering van de luchtkwaliteit en de doorstroming van het verkeer in de binnenstad.

Na verschillende toespraken werd, onder toezicht van de pers en degenen, in de tram door CityCargo de concessieovereenkomst getekend met de gemeente Amsterdam. Tevens werd er ten behoeve van deze concessie een convenant gesloten tussen CityCargo, de gemeente Amsterdam en het GVB.

Met de ondertekening van de concessie is een eerste stap gezet voor een wereldprimeur op het gebied van goederentransport. Vanaf 2008 zullen de eerste vrachttrams en E-cars het stadsbeeld van Amsterdam voorgoed veranderen.

Source: Citycargo website (July 2007)
7.7 Rotterdam aims for eco-friendly vehicles and distribution

ROTTERDAM - Schoon wagenpark

Rotterdam sets its sights on a cleaner municipal car park with hybrid vehicles and the use of bio ethanol. For the mayor and aldermen, new service vehicles have been ordered: a flexifuel car (delivery time several months), which will run on bio-ethanol. In Rotterdam, the first bio-ethanol pumps are available. The goal is to have 12 of these pump stations by 2010.

*Source: Rotterdam Climate Initiative website (July 2007)*

In Rotterdam worden de milieuzones in 5 jaar tijd stapsgewijs uitgebreid tot aan de ring

- Een milieuzone maakt het mogelijk de meest vervuilende voertuigen te weren uit delen van de stad waar de normen voor luchtverontreiniging worden overschreden. Het doel van de milieuzone is het verbeteren van de leefbaarheid, en met name de luchtkwaliteit, in de stad.

- Ook is afgesproken dat gemeente en bedrijven zullen bezien of bevoorrading van winkels op een efficiëntere en duurzame wijze geregeld kan worden.

- De restricties gelden voor vrachtwagens met EURO 2 of 3 zonder roetfilter of ontheffing en maakt de weg vrij voor vrachtwagens met EURO 4/5 normering.

- Dat betekent dat vanaf september 85% van de huidige vrachtwagens buiten de zone moet blijven.

*Source: Spring Associates presentation TNT (July 2007)*


### 7.8 The Fuel Cell Boat

De doelstelling van Fuel Cell Boat is:
Het in Amsterdam realiseren van een passagiersboot die door een brandstofcel op waterstof aangedreven wordt plus de noodzakelijke infrastructuur om waterstof te tanken. De boot kan 100 personen vervoeren en wordt na oplevering commercieel geëxploiteerd.

Deze doelstelling hangt samen met een complex geheel aan nauw verweven deelproblemen:
- De technische realisatie van een passagiersboot voor 100 personen met een 60-70 kW brandstofcel die op waterstof vaart.
- Het realiseren van een waterstoftankstation aan de waterkant waar de boot groene waterstof kan tanken. Dit betekent door middel van elektrolyse met groene stroom gegenereerde waterstof.
- Het zorg dragen voor de benodigde vergunningen om de boot als passagiersboot te laten fungeren.
- Het zorg dragen voor een goede samenwerking en kennisoverdracht binnen de deelnemende partijen.
- Het zorg dragen voor een goede communicatie en kennisoverdracht naar externe partijen, zowel professioneel geïnteresseerden als het grote publiek.
- Het verkrijgen van voldoende financiering via kapitaal en leningen van deelnemers, subsidies en leningen van derden, inkomsten van klanten.

Source: [http://www.fuelcellboat.nl](http://www.fuelcellboat.nl) (July 2007)
7.9 E-Traction city bus

The E-Traction low-emissions city bus:

![E-Traction city bus](http://www.e-traction.nl) (June 2007)
7.10 Electric Volkswagen Caravelle

The demonstration project with electric Volkswagen Caravelles started at the end of 1995 with 3 vehicles. During the project the number of vehicles grew to 12. The Volkswagen Caravelle is a small passenger bus with 7 seats. The objective of the project is to gain experience with electric vehicles in daily use. The aim of the various measurements which were carried out is to get an insight into the behaviour of the electric vehicles used. The prime area of the investigation is related to the energy use.

The first measurements on the road showed a much higher energy consumption compared to what was expected on the basis of rolling road measurements. During the demonstration project it quickly became obvious that the initially high energy consumption showed a gradual reduction in time. To drive efficiently with the electric VW Caravelle is clearly a process of familiarisation.

To explain the differences in energy consumption of the different participants an extensive search for possible causes was carried out. It is remarkable that there seems to be no direct relationship between the average speed of a trip and the energy used. The length of a trip can have a significant impact on the energy use of a vehicle. Most vehicles followed the trend that the longer the trip the lower the energy use per kilometre driven. The possibility to recuperate braking energy is an important characteristic of electric vehicles. For an electric vehicle it presents a possibility to extend its range on one battery charge. Recuperation percentages of 5.9 to 15.9% were measured during the demonstration project.

During the period over which measurements of the energy consumption from the grid were taken, the actual primary energy use of the electric VW Caravelle was higher than for a conventional diesel version. The most important reason for this finding is the fact that the total losses in the charging process of the traction batteries are so high (55%). Even if a period is taken in which the electric VW Caravelle was at its most frugal, the primary energy use was still slightly above that of the diesel version. The charging process of the traction battery as specified by the battery manufacturer is mainly responsible for the substantial losses. Further investigation will be necessary to reduce the losses in the charging process of the battery. Fast charging is already a possibility to reduce the charging losses.

*Source: Publicatie Energiegebruik Electrische VW Caravelle (October 1999)*
7.11 PML Mini

The Hi Pa drive system used in the Mini gives each wheel 120kW of power and therefore a total vehicle power of 480kW. The greatest technology breakthrough is with the inverter drive which is housed inside the motor and has a mass less than 2kg. NOTE: A full 120kW inverter drive with a mass of less than 2kg. This represents at least 10 times the power to mass ratio of any currently existing 120kW inverter in the world today.

Source: http://www.pmlflightlink.co.uk (June 2007)
7.12 TNO Hybrid Volkswagen Beetle

It's a bright yellow Volkswagen Beetle with a twist. One of TNO Automotive's Carlabs, it is a test environment in which experts are investigating how to achieve future CO2 levels while maintaining performance and reliability.

Officially named the Hybrid Carlab, this Beetle is a product of the Advanced Powertrains project set up in 1997 to investigate options for cleaner, more fuel-efficient powertrains. Focusing on both conventional and electric power, a series hybrid powertrain was devised, the forerunner of the Hybrid Carlab. The hardware work on the Beetle began in August 2002 and further development work will take the project through to April 2003, when final testing will have taken place.

So far the Hybrid Carlab has enabled the development of a number of techniques, all of which will contribute to the goal of cleaner and more efficient mobility.

Source: Website TNO Automotive (July 2007)
It have been 7 good years in Delft, thanks
- Gijs Coppens -