



Lichtkogel | 2016 | no. 2

# > Life cycle thinking

during the installation, maintenance and replacement of infrastructure

- 12 Thinking in values versus thinking in costs
- 16 Asset management meets circular economy
- 28 Beauty creates sustainability

Trend book by and for professionals in Accessibility, Safety and Liveability

The theme number Lichtkogel 2016-2 on Life Cycle Thinking is a Special Edition. For The 5th International Symposium on Life Cycle Civil Engineering (16 - 19 October, Delft – The Netherlands), a part of this edition is translated into English.

For more information www.IALCCE2016.org.

### EDITORIAL

#### Dear reader,

It's an old joke, but very appropriate: on the Situations Vacant page of a newspaper a museum is looking for a 'Bridge-builder', which is placed next to the vacancy for a 'Head of *Kunstwerken*', which Rijkswaterstaat\* is looking for. In Dutch we use the same word 'kunstwerken' for both 'work of art' and 'civil engineering structures'. At the same time a 'bridge builder' can be a person who builds bridges and a person who can bridge conflicts. If you're not careful, you might find yourself applying for the wrong job.

The museum in this example makes good use of the metaphor from the civil engineering sector, while RWS uses the correct technical title. It would not be considered strange to refer to a bridge or viaduct as a 'work of art'. In addition to technical tours de force, many civil engineering 'works of art' are a feast for the eye. They give environments an identity and make us receptive to beauty. Our engineers and architects are artists and our country a large open air museum.

Look at infrastructure managers, such as RWS, as if they were museums; they manage a collection of old and modern works of art and open them up to the public to make them wiser and happier. This is not such a strange comparison. However, unlike the museum, there is no depot. Everything is hanging 'in the hall', in the open air, where the climate cannot be controlled. And where vandals can freely deface these infrastrutural 'works of art'.

The Staten Tunnel, part of the Maas Tunnel network and built in the style of the long-demolished Rotterdam Central Station, is located in Rotterdam at the end of the street where I live. This beautiful tunnel effortlessly controls the traffic on three levels, providing space for trees and plants and yet elegantly taking up little space itself. But it is now in disrepair and losing its dignity, while it deserves the same care as if it were a work of art 'in the hall'.

It pleases me to read in this trend book that the infrastructure managers share this concern with me. I therefore wholeheartedly support the ambition in these articles to increase awareness of the collection and to responsibly preserve 'works of art' for the future!



Siebe Weide General Director Museums Association

\* (RWS, a government agency within the Dutch Ministry of Infrastructure and the Environment)

### COLOPHON

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Concept and design Gloedcommunicatie Print Total Graphics, Oss

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De Lichtkogel, issued by Rijkswaterstaat (RWS, a government agency within the Dutch Ministry of Infrastructure and the Environment), offers a platform for engaging in dialogue with partners on new trends and developments in our environment and the consequences for our organisation(s).

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### INTERVIEW

# Playing with complexity **Future-proof replacement of our infrastructure**

By Ingrid Zeegers

Many bridges, railway tracks and locks have seen better days. Should they be demolished, restored or replaced? How do we actually make that choice? "On the basis of Life Cycle Management," says Marcel Hertogh, Professor at TU Delft. This involves sustainability, as well as adding more functions and redesign.

"A lot of infrastructure is at the end of its life cycle. In the Netherlands we are ready for a large replacement project," says Marcel Hertogh, Professor at TU Delft and Senior Advisor at RWS. Many of our waterways date back to the 20th century. It's the same with the railway lines. After World War II, an additional network of roads and highways was developed, along with bridges, viaducts, locks and dams, which all deserve the designation *diehards*. They have a physical life cycle ranging from 50 to sometimes as much as 100 years.

The end of the technical life cycle is now in sight. In a few years time, the quality of many constructions will no longer be guaranteed. It is a matter of ageing and wear. But that's not all. The environment is also changing. Vehicles are getting bigger and heavier. It therefore also means the end of the functional life cycle. Hertogh: "The government, municipalities, provinces and water boards will have to make important decisions in the coming years. Should we demolish, restore or replace? The main questions here are: what do we actually want from our future infrastructure? What requirements should it meet? And what demands do we make? This way of thinking about the whole life cycle of infrastructure is called Life Cycle Management. The term life cycle is of central importance." Because circular thinking is popular, also in terms of infrastructure. We need to use materials and energy sustainably. It's not just about the costs, but also about future value, and that seems to be a major challenge. "Life Cycle Management helps when it comes to making strategic decisions."

### How should the infrastructure perform?

According to Hertogh, Life Cycle Management is the way to manage factors such as performance, costs and benefits, risks and opportunities over the entire life cycle of the infrastructure. "We are getting better at applying Life Cycle Management for the cost factor. The greatest challenge now is weighing up the factors that determine the performance or, in other words, the value. For that matter, weighing up the risks and being receptive to new opportunities also still form a challenge." It always revolves around the question: what performance do we want from the (future) infrastructure? Time for a crash course in asset management: How are the decisions about management and maintenance actually organised in practice? "The Ministry of Infrastructure and the Environment determines the performance outcome of the national infrastructure. It must, for example, meet the requirements for the traffic flow, availability, safety and predictable travel time. >

How do you design infrastructure so that it is flexible enough to move with the changing requirements of the environment? These factors are taken into consideration during the maintenance of roads and constructions and translated into performance contracts with service levels. Performance requirements change over the years. We might want to facilitate more traffic, or make infrastructure more sustainable, for example. Or do both at the same time."

### Sustainability as a performance requirement

Besides the familiar performance requirements, sustainability is becoming increasingly more important. But what exactly is sustainability? Hertogh: "Sustainability is often narrowed down to two elements: energy-neutral and circular construction. In other words, the smart use of energy and raw materials. Those are the hard facts of sustainability. They are very important. But actually it is all about the people, the planet and profit, so also about the environment and the people who are involved in the project. Are the people enjoying the tunnel or the bridge?" As a practical example of sustainability he mentions the design of the Rotterdamsebaan, the new access tunnel

#### **Marcel Hertogh**

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Marcel Hertogh is Professor of Infrastructure Design and Management at TU Delft and Senior Advisor Construction at RWS. Hertogh is also Managing Partner of Triple Bridge (a knowledge and network organisation) and Chairman of the Delft Deltas Infrastructures & Mobility Initiative (DIMI). to the city of The Hague. "The tunnel has to be an icon of sustainability, not only physically, it also has to radiate the concept itself. In other words, a journey through the tunnel is a sustainable experience for the user. That task has been fully embraced. Architects and designers have been involved from the outset with the sustainability expert team. This has resulted in contractors competing with each other on the sustainability factor. An example: half of the tunnel's energy requirements is needed for the lighting, in particular for the lighting at the mouth of the tunnel. Architects and designers came up with a sustainable and beautiful solution: a louver in the roof of the tunnel, resulting ultimately in no energy requirement whatsoever for the lighting at the mouth of the tunnel. Beauty also creates sustainability. Take the 17th century canal houses in Amsterdam. They are still standing today." See also the article Beauty creates sustainability on page 32 to 35.

#### **Adaptive design**

Another practical example of integrated Life Cycle Management is a project named "Grip op de Maas". This concerns the replacement of seven barrages across the River Meuse. "They were built a hundred years ago and need to be replaced in ten to twenty years time. If we now look at the river Meuse as a corridor we need to ask ourselves whether we will still need seven barrages in future. Perhaps five barrages are enough? Or are there other solutions than barrages? This requires some thought." But there is more. "Perhaps we can link other functions to the barrages in the river at the same time. Functions such as recreation or energy supply. The river will then become an energy buffer, or even an energy supplier. Thinking about the life cycle of infrastructures also means focusing on linking them to other functions.



The car park built into a dune in Katwijk is a good example of linking functions.

A good exemple is the integration of a fish migration river in a dyke renovation project (the Afsluitdijk). Or the car park built into a dune in Katwijk. Or the area development project near the A2 in Maastricht combined with a tunnelling project. The focus should also be on redesign. As a basis for the redesign of civil engineering structures RWS is now developing the Dutch Lock, a standard lock. Work is also being carried out on new materials and applications such as 'self-healing asphalt'." Thinking about future functionality brings many new challenges. How do you design infrastructure so that it is flexible enough to move with the changing requirements of the environment? "That requires adaptive design. Making room now for future adaptations. This is an entirely different sport. An example? Plans to build a deepened, open section on the ring road around Antwerp already take into account the possibility to cover it at a later stage. In short, my main message is that, not only is the replacement project a cost item, it is also an opportunity

to make our network ready for the future. Life Cycle Management is therefore an important philosophy."

#### **Playing with complexity**

The question is: are we not making it far too complicated? "Many managers prefer to keep it simple, because technical management and maintenance are difficult enough. That's understandable. Organisations want to do what they are good at. But the question remains: are we doing the right things? The integrated approach of the replacement project creates more complexity, but if you look further down the road you will see that solutions are becoming more future-proof as a result. This will create more support and new opportunities, for instance cofinancing of projects with multiple stakeholders. I call that 'playing with complexity'. Always searching for an answer to the question: how far can we go without compromising too much on manageability? What matters is that we start on time with an open mind." <

# Different analyses help each other

**By Ingrid Zeegers** 

INTERVIEW

A recurring question in the decision-making process on infrastructure is: how do we achieve the best social outcome? The answer is hidden in the sum of information – information about technology, costs, benefits and sustainability. How do you compare these very different types of information? An interview with Carl Koopmans, Professor of Policy Evaluation and Research Director at SEO Economic Research.





Different analytical methods are used for making a well-balanced decision. What are the similarities and differences between the Life Cycle Management (LCM) method and the social cost-benefit analysis (SCBA) method?

"Both are analytical methods for comparing different types of information. Previously, much attention was given to technical considerations. These were gradually replaced by economical considerations, in which the costs play a distinct role. Today, the SCBA method also takes social effects into consideration. Furthermore, all the effects of a project are expressed as costs and benefits, including sustainability aspects. In terms of LCM, if you take all social costs (including emissions, effects for the users, etc.) into consideration in addition to life cycle performance, risks and financial costs, then LCM looks very similar to SCBA."

# How important are these analytical methods for decision-making?

"Professional policy preparation requires that you provide accurate information. Not only for your own organisation, but also for society. That is the value of analytical methods such as SCBA and LCM. That does not mean to say that decision-making is dominated by these analyses. A study conducted by the KiM (Netherlands Institute for Transport Policy Analysis) shows that projects with a positive SCBA (more benefits than costs) almost always go ahead. However, projects with a negative SCBA (more costs than benefits) often go ahead too. A negative SCBA seems only to be the determining factor for projects

"We should not only make an economical analysis, but also a technical and an explicit sustainability analysis" with investments of over half a billion euros (Zuiderzee railway, IJmeer railway). In that case, such projects are not carried out."

# Is an SCBA for the railway different to that of roads or waterways?

"The method is the same, but when you apply it you are confronted with other types of direct benefits: travel time, comfort (railway), traffic flow (roads), size of the ships (waterways) or safety (dykes)."

#### The life cycle factor is an important factor in Life Cycle Management, but how does that work exactly? What if the technical life cycle is 50 years, but the functional life cycle is reached much earlier?

"Uncertainty is always a dilemma. Who knows how intensively a railway will be used over a period of 50 years? Or how fast the development of the autonomous car will progress? In an economic analysis, the life cycle is not determined by the technical life cycle but by the moment it becomes cost-effective to replace an object. A sensitivity analysis can determine the impact of uncertainties to be included in decision-making."

# What about sustainability and the circular economy: are other criteria applicable when something is cost-effective?

"Sustainability has a lot to do with discounting. A specific interest rate is used to determine the net present value: the actual value of future effects. With a low discount rate, the long-term costs and benefits are greater. As a rule, in an economic analysis the long-term effects are not taken heavily into account. However, there has been a lot of discussion about it lately. According to the concept of sustainability, the next generation must not suffer from what we are doing now. That's why physical investment analyses now take a discount rate of 3 per cent into consideration for the environmental effects, and 4.5 per cent for the other effects of physical investments. Consequently, environmental effects weigh more heavily than other effects." >

# Can sustainability always be factored into the analysis?

"Sometimes is difficult to express environmental effects in terms of money. Effects are also sometimes forgotten, which is why it's better to work using multiple approaches. We should not only make an economical analysis, but also a technical and an explicit sustainability analysis. I am therefore in favour of looking beyond the borders of your own field. Place several analyses next to each other so that they can help each other."

#### Does adaptive LCM already exist?

"That goes a step further than working with fixed investments. An adaptive policy responds optimally to future uncertainties. The Delta Programme, for example, aims for investments that depend on rising sea levels among other things. Making an investment flexible often comes with a price tag. You are making costs now for something that might happen in the future. That has to be carefully weighed up." <



#### Carl Koopmans

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Carl Koopmans is a specialist in the field of social cost-benefit analysis (SCBA). He is Professor of Policy Evaluation at the VU University and Research Director at SEO Economic Research. He is also Chairman of the Sounding Board Group Economic Analysis for the Delta Programme. From 2006 to 2009 he was Director of the Netherlands Institute for Transport Policy Analysis (KiM).



#### Replacement Tasking for Hydraulic Structures (νονκ)

A large part of the hydraulic infrastructure must be replaced in the coming century. Locks, dams and barriers: in total it involves 650 hydraulic structures. This replacement project raises a number of strategic questions. How will this operation be organised? And how do we ensure that sufficient money is reserved for this project in the national budget? To ensure transparency, RWS has launched the project **Replacement Tasking for Hydraulic** Structures (VONK, Vervangingsopgave Natte Kunstwerken). Antea Group has developed a type of LCM system for this project, in close cooperation with Rijkswaterstaat and Berenschot. "In this system we portray the replacement of hydraulic structures for the short term (5 years) and the long term (100 years)," says Erik Deuring of Antea Group. How does it work? "This system enables RWS to program the replacement tasking, make strategic choices with a view to long-term uncertainties and identify environmental needs, and allocate them in the national budget. Subsequently, specific investment paths with defining moments can be developed," says Deuring's colleague Geert Roovers.

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#### COLUMN

# The future is overtaking us

If I had a crystal ball, I would know. What we need to teach children in 2032 so that they are ready for society. Whether I will invest my savings in solar energy or in wind. How the infrastructure of the future should look. And from which material you should build sustainable bridges.



#### **Stine Jensen**

Stine Jensen is a philosopher and writer. She makes programmes about philosophy for the Dutch broadcasting company Human. She has written a number of books including *Dus ik ben* (together with Rob Wijnberg) on our quest for identity and has made a television series on the same subject. Her latest book, recently published, is entitled *Go East*.

Contact www.stinejensen.nl But with that future there is something strange going on. We try to control it by planning as much as possible. We plan the risks, the potential developments and hence we plan schedules, but the future is overtaking us. The fact that we rack our brains over future scenarios is deeply embedded in our society. In A Geography of Time (1997) the American sociologist Robert Levine divides the world into three different societies: future-oriented (Europe), past-oriented (South-America) and noworiented (Asia). Each of these societies has a different relation to time. Although there are individual differences, as a European it is very likely that you look at the clock more often, rush through traffic and don't like waiting. Or that you are a professional planner, producer, designer or risk manager. That you are busy investigating what actions need to be taken today in order to manage reasonably well in the future. In this futureoriented society, the economy is rushing by and 'time is money' is an important metaphor. This society also has its own paradox: the movement speed and the level of development are so high that this same future is becoming increasingly better but also increasingly less predictable, because recent developments are overtaking the predicted developments. Every advantage has its disadvantage, as the famous late soccer player Johan Cruijff was fond of saying. Because we cannot predict the future with any certainty, in my opinion you should not only address the (im)possibility of the planning or the changing nature of technology but also concentrate on the people who are undergoing these developments. What skills do people need in order to manage the long development period of new infrastructure in the years ahead? Flexibility, resilience, perseverance, a sense of reality (a 'here and now' check), creativity and interdisciplinarity, and a team that literally represents different life cycles, so that knowledge of the past, present and future exists. The French philosopher Diderot once put it so beautifully: the present is pregnant with the future. Whoever wants a healthy future must continue to feed the present.



#### INTERVIEW

# Thinking in values versus thinking in costs

To future-proof the Dutch rail network ProRail has to take a number of things into consideration. What are the costs of maintenance to the network and what are the benefits in terms of transport capacity? "The concept of rail network flexibility takes on a new meaning," says Klaas Hofstra, Senior Consultant infra development at ProRail. With Japan as a source of inspiration the motto becomes: *more transport value of our assets.* 

By Ingrid Zeegers



The value of the railway is determined by its capacity. We need as many trains as possible on the rails, preferably at high speed. The capacity has to increase, because there is a great need for transport. ProRail is faced with the task of maintaining the railway system and, at the same time, increasing its capacity.

# Don't throw anything away, keep everything

"The lay-out of our current rail network sometimes dates back to the period before World War II. "That was when the steam locomotive still ran," says Klaas Hofstra, Senior Consultant infra development at ProRail. "We used the railway very differently then, mainly for freight transport. Every village had its own freight connection. It's different now. Yet there are still some very old functionalities (rails, points, signals) in the current infrastructure, while they sometimes no longer have a function. Even on the busy junctions." If it's not in the way it won't do any harm, seems to be the case. You never know, it might come in handy one day. A little extra infrastructure makes the railway flexible? "That's a fallacy. Our rail network has almost reached its maximum capacity; there is no room to actually use that flexibility in the operation. If we do, the delays will quickly create a snowball effect. Furthermore, management and maintenance of infrastructure is expensive. Maintenance also requires qualified people to do the job. Don't forget that we have 7,000 kilometres of railway and 70 different types of switches in the tracks. It therefore makes sense to think about replacement or even the reorganisation of (unused) rail infrastructure."

# Japanese philosophy as a source of inspiration

ProRail uses the Life Cycle Management (LCM) calculation method. It is structurally applied in the planning of the replacement tasking. But thinking in terms of the life cycle goes much further than a calculation method. Hofstra is talking about the > (future) value and the costs of the entire rail network as a system. What, then, is the value of the railway system? "In addition to the capacity it is determined by the performance of the trains that run on them. Indicator: punctuality. Therefore, the more delay, the less performance." According to Hofstra, delays are caused by 'implicit tension between planning and implementation'. In other words, due to a lack of flexibility in the transportation process. If, for whatever reason, things do not go according to plan, it will immediately have an impact. But that problem can be resolved through further optimising the timetable and also through adjustments to the infrastructure itself.

How does that work? Hofstra regularly visits Japan where he gains new insights. "It is remarkable that in Japan more trains run on much less infrastructure than we have. Not only are there less railway lines, but also significantly fewer points. But they have many more signals than we do, sometimes every 100 metres. The railway network is extremely effective. It is more like a national metro system." According to Hofstra, the



#### Klaas Hofstra

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Klaas Hofstra is Senior Consultant infra development at ProRail. In 2005 he joined the Traffic Department where he established the Performance Analysis Office. Hofstra visits Japan regularly where he carries out benchmark studies at several Japanese railway companies. He studied at the University of Twente and at the Collège des Ingénieurs in Paris, Stuttgart and Montreal. Netherlands is also heading in that direction. But we will then have to think differently about flexibility. "Look at Utrecht Central Station. The basic principle there was always that every track had to be simultaneously accessible from every corner of the station. That requires an enormous amount of switches in the tracks. We want to get rid of this so-called flexibility, because it is getting in the way of what we really need: more capacity and higher punctuality. We want to redirect the system towards a different kind of flexibility, one that is more future-proof and more affordable in terms of future management and maintenance."

#### **New flexibility**

How? "We want more trains on the stations. That means adapting the distance between the signals so that trains can run closer together. Only one train is allowed between two signals. Currently, that distance is often more than 1,000 metres. In Utrecht it will now go back to the legal minimum of 400 metres. Furthermore, we want to increase flexibility by increasing the speed at stations from 40 to 80 kilometres per hour. This will make staying time shorter and improve the flow." That all this will be realised at Utrecht Central Station after consultation with all rail partners is considered by Hofstra to be a unique achievement. "It is one of the most radical and complex railway projects ever. Its progress has generated a great deal of interest from far beyond the Dutch borders. We have fully addressed the design process of the railway system from the outset, together with the rail operators and the managers of the train material. It's a difficult one to assess: reorganisation of the switches in the tracks means, for example, that the cleaning process of the trains becomes less efficient. It's a question of weighing up the pros and cons."

# 5b

#### Time is the enemy

The integrated planning for Utrecht Central Station is thus a success. But that is not the case everywhere. "The more complex you make it, the more time it costs. Time is our greatest enemy. Following years of study, fantastic integrated designs for the stations in Eindhoven and Gouda were produced, which everyone was happy with. But there was no time to realise our carefully thoughtout plans. The points had reached the end of their technical life cycle. This means the current tracks will be replaced one by one after all."

#### Navigating between interests

Sometimes a type of LCM approach is undermined by other interests. In that case, the interests of rail operators outweigh the costs. The station at Amersfoort is a good example. "Additional points are being designed for that station, on top of the optimum LCM layout, because that particular train has a social value. 'Thinking in values versus thinking in costs' is sometimes determined by politics. ProRail is an organisation that has to negotiate between the interests of rail operators, governments, travel organisations and contractors." <

#### IN PRACTICE



#### Additional cycle path or not?

The Waal Bridge near Nijmegen dates back to 1936 and is ready for a major renovation. The road authority (the municipality of Nijmegen) would like an additional cycle path on the west side of the bridge. RWS is the owner of the bridge and is responsible for its structural safety, management and maintenance. Value Engineering (VE) was applied in the decision-making process to determine whether upgrading the bridge with an extra cycle path will be profitable. This was necessary due to the different opinions about the value of the bridge. Consequently, the decision-making stagnated. What is Value Engineering? Ed Antoine, Senior Consultant at Royal HaskoningDHV: "VE is based on a systematic, multidisciplinary method to improve the value of an object through function analysis and creative technology. The value is defined as the delivered performance divided by the required costs." What does the VE study have to offer? "From the assessment of the values for the various parties it was decided not to widen the bridge construction but to sacrifice the bus lane on the bridge for the wider cycle path."

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INTERVIEW

# Asset management meets circular economy

By Ingrid Zeegers



Jacqueline Cramer, former Dutch Minister of Housing, Spatial planning and the Environment (VROM) and figurehead of the circular economy, and Jenne van der Velde, Senior Advisor Asset Management at RWS, on the question: what is needed to make asset management circular?

Sitting on the desk of the Director-General of Rijkswaterstaat, a government agency within the Dutch Ministry of Infrastructure and the Environment, there appears to be a *biobased* egg carton made from roadside grass fibres. It is meant to inspire and symbolises the new circular thinking. What is needed to make modern asset management circular as well? That is the topic of discussion between Jacqueline Cramer, Professor of Sustainable Innovation at Utrecht University and Ambassador of Circular Economy in the Amsterdam Metropolitan Area, and Jenne van der Velde, Senior Advisor Asset Management at RWS.

#### First of all, what does 'circular economy' mean?

**Cramer:** "It means that raw material flows and products are recycled at the highest possible quality. The aim is closed-loop recycling and the prevention of raw material waste, including water and energy."

Calculations show that the circular economy in the Netherlands can create over seven billion euros in turnover, plus over 50,000 jobs and a number of spin-offs, such as a strong knowledge position. How does that work in practice, for example the Circular Region Utrecht?

**Cramer:** "The Circular Region Utrecht is an alliance between the municipalities of Utrecht and Amersfoort, Economic Board Utrecht, Utrecht Sustainability Institute,



Elephant grass as a raw material for bitumen and asphalt (www.wageningenur.nl/nl/artikel/bioasfalt.htm)

and the Nature and Environment Federation Utrecht. This alliance works in cooperation with the Dutch Ministry of Infrastructure & Environment. The aim of the Circular Region is to cash in on economic opportunities through recovering raw materials from waste flows. The initiative in Utrecht is based on what I have previously set up with the Amsterdam Economic Board in the Amsterdam Metropolitan Area."

### How does the circular economy work in the Amsterdam Metropolitan Area?

**Cramer:** "The Amsterdam Metropolitan Area has a population of approximately 2.4 million people and includes Almere, IJmuiden, Zaanstad, Gooi & Vecht, Amsterdam and all the places in between. The Amsterdam Economic Board not only wants to distinguish itself economically but also ecologically and socially. The region has therefore embraced the circular city theme and asked itself: what should be done regionally to ensure that the circular economy takes off when a municipality cannot accomplish this on its own? It mainly concerns the coordination and direction of regional initiatives to enable scaling up and the creation of economically viable business cases. A factory only becomes profitable when there are sufficient supplies and markets."

# What kind of projects does it involve?

**Cramer:** "To start off with the raw materials: organic waste, for example. Every municipality can compost waste itself, but as soon as you want to 'enhance' the material further along the chain, for example to make proteins or bio-aromatics, you will need to build a sizeable factory. That also applies to textile that is no longer wearable. If you want to recycle it, you will need to sort it into subtype and then fibreise and centrifuge it. That requires a continuous supply of material that has to be regionally coordinated and organised. But it also involves the reuse of products, such as repair or refurbishment companies that refurbish products. Those are mainly local initiatives. Through the purchasing policy of the cities we can ensure that circular products and services get a better outlet in the market. We are also focusing on scaling up the cultivation of crops, such as flax, hemp or elephant grass. The aim is to encourage the biobased economy as an alternative for the fossilenergy based economy."

"Through the purchasing policy of the cities we can ensure that circular products and services get a better outlet in the market."

#### Is it correct that the priorities of the Circular Region Utrecht are different to those of the Amsterdam Metropolitan Area?

Cramer: "Yes, because you look at what the main material flows are per region and at the regional economic structure. In the Amsterdam Metropolitan Area we were able to reasonably quickly identify several important raw material flows that fit with what could be technically and economically recycled in the region at high quality. Examples are organic waste, textiles, nappies, metals and electronic waste. Utrecht has a different economical structure. High-quality reuse of construction and demolition waste is obvious here, because a lot of building and renovation work is being carried out. Another example is the recycling of mattresses. In the Netherlands this is currently possible in just two factories, one of which is in Vianen. It is increasingly about what fits regional development, or in what specific area the region wishes to promote itself. On that basis we can establish priorities and organise a network of companies and organisations."

Next is the transition of RWS to manager of national infrastructure. The organisation works with Life Cycle Management and is exploring both circular material use and other aspects, such as the future functionality of infrastructure and integration in the environment. These aspects are gaining more ground in asset management. But what is asset management exactly, and how does it work?

Van der Velde: "Asset management is about making well-considered decisions transparent throughout the chain, from commissioning by the ministry to awarding >



#### Jenne van der Velde

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Jenne van der Velde is Senior Advisor Asset Management at RWS. He imparts knowledge in the field of asset management and makes it applicable. Keywords: asset management, Life Cycle Management, performance management, infrastructure management. Previously, he worked as Manager Asset Management at Vitens and as advisor at DHV Water.

#### **Jacqueline Cramer**

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Jacqueline Cramer is Ambassador Circular Economy in the Amsterdam Metropolitan Area, Strategic Advisor of the Utrecht Sustainability Institute and Professor of Sustainable Innovation at Utrecht University. From 1999 to 2005 she was a member of the SER (Social and Economic Council of the Netherlands) and of various boards in the field of sustainable construction. From 2007-2010 she was Minister of Housing. Spatial Planning and the Environment (VROM).

"The Netherlands is the only country in Europe that recycles 90 per cent of its asphalt"

> the contracts to the private sector parties. RWS manages three national networks: the main road network, the main waterway network and the larger water systems. The ministry gives RWS instructions, e.g. to ensure an accessible Randstad (the urban conglomeration in the Netherlands) or to maintain the water safety in the Netherlands. We asset managers make transparent how we carry out these assignments. We concern ourselves with the costs, the performance and the risks during the entire life cycle of the network."

**Cramer:** "That relates closely to tendering and procurement."

Van der Velde:" Yes, that is the final part of the story, in the contract awarding phase to the market. But we are also concerned about transparent agreements in the first part, with the ministry. RWS has a number of core tasks on which we are assessed. For example, that the roads are available when we want them to be, and that the cities are accessible and safe. If the ministry says that the work has to be done more cheaply the question then is: which performance can we provide for that price? Do we, as a society, accept more disruptions, or that the street lights are switched off at night?"

# The ministry therefore requires a specific performance; to what extent is sustainability a performance requirement?

**Van der Velde:** "It is certainly a performance requirement. There is an agreement that

our networks have to be energy neutral in 2030. However, we are already working on sustainability. The Netherlands is the only country in Europe that recycles 90 per cent of its asphalt. The asphalt already laid is recycled on the spot. And we continue to innovate on the reuse of asphalt. Bitumen is now heated to much lower temperatures, and that saves an enormous amount of energy."

**Cramer:** "And is it possible, for example, to make sustainable solar roads?" **Van der Velde:** "Technically it's possible, but it depends on the amount of room we are given to do it. We are assessed on the fact that the roads remain accessible, the waterways navigable and that the dykes remain standing. To make the networks sustainable we apply *life cycle costing*. This means that we not only look at the costs of construction, but also at the (energy) costs during the use of the infrastructure, throughout its life cycle."

# How will RWS be working on the circular economy over the coming years?

Van der Velde: "We are exploring how we can make the networks more sustainable and more 'circular', and what that will mean for the quality of the environment for the users and the residents."

The lease concept fits in well with the circular economy. You do not buy a lamp, but you lease a number of hours of light. The producer remains the owner of the lamp. Can you also do that with asphalt and concrete? Van der Velde: "Where there is a healthy market you can hire services. In the aircraft industry they pay for the engines based on the amount of hours they run. Perhaps RWS can also do something with this concept, but I don't expect that to happen on the strategic parts of the network. When it comes to our core business we should always have the freedom to act ourselves." **Cramer:** "The hiring of services could, in my opinion, be a very useful concept, because whoever delivers the service remains responsible for the proper functioning of everything. And service and aftersales is standard nowadays. You can make agreements about that with the hirer during use."

### What is needed to make modern asset management circular?

Cramer: "It's not so much about making asset management circular, but I see asset management as extremely valuable in giving impetus to the circular economy. The point is that the parties concerned need to be brave enough to change their way of working and financing. If circular thinking is included in the purchasing and tendering policy, assets will then be assessed differently. You will take better care of your assets and be more focused on long-term value creation. Consequently, the valuation of assets by the various parties in the chain will also change. In other words: the chains will form a circle." Van der Velde: "Yes, I am familiar with that development. By making clear agreements with the asset owner on the one hand and the contractors on the other, asset management can play a valuable role in the circular economy." <

#### IN PRACTICE



# Market for reusable building materials

Where do supply and demand of good, existing building materials come together? The website Bouwmarktplaats.nl facilitates the trade in building materials between demolition and new construction projects. Various chain partners from the construction industry are working together on this initiative. The initiative came about with the support of the Economic Board Utrecht. Bas Slager, initiator of the online construction marketplace, explains: "At engineering firm Repurpose we noticed an increasing demand for cross-project information on recyclable materials. What is available and where, what is the quality, and what about the logistics? Setting up an online construction marketplace seemed to us to be a logical step."

The construction marketplace provides a current overview of building materials from demolition, renovation and transformation projects. Construction and demolition become 50 per cent cheaper. The carbon footprint of reuse is 85 per cent lower than when building with new materials. It also creates shared practical knowledge on circular construction. Slager: "Thanks to the online construction marketplace we get much more out of a building."

Further information www. bouwmarktplaats.nl.

#### ESSAY



Willy Peelen is a physicist and has worked for TNO since 2000. He initiates and leads technical developments in the field of civil infrastructure monitoring and inspection technology for application within modern asset management.

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# Smarter infrastructure maintenance with data

#### By Willy Peelen

Our infrastructure has a very high social value, and the safe availability of it is very important to us. However, through ageing and heavy loads the costs of maintenance and replacement are increasing. Smart monitoring offers the opportunity to have continuous insight into the condition of the infrastructure and to make decisions based on the results, along with the promise of better cost management.

#### **Reflection is necessary**

The value of our roads, waterways and rail infrastructure is huge. Without efficient transport of people and goods, our society becomes inconceivable. The value of civil infrastructure alone in the Netherlands is estimated at over 360 billion euros. Our infrastructure is robustly build, with high safety factors and alternative loadbearing roads, and the availability for traffic is high. However, the infrastructure is subject to ageing: the first wave of construction took place in the thirties and consisted mainly of 'wet' engineering structures. A second wave, mainly for road traffic, occurred in the sixties and seventies. The ever increasing traffic load accelerated the ageing. Heavy goods vehicles over fifty tonnes with



A large proportion of the engineering structures in our infrastructure was built before 1980

a continuous license have increased dramatically in the last decade, and the development of *'platooning'* will lead to even higher peak loads. Engineering structures are usually designed for a life cycle of eighty years. Meanwhile, the degradation of the dominant materials in the infrastructure (concrete and steel) is causing problems with our bridges and locks, especially in combination with the increasing load. The first sign was the occurrence of fatigue in the steel decks of the bridges on the national motorway network. This led to a renovation programme of unprecedented scope. Which degradation will follow and when?

Finally, the effects of climate change are becoming more manifest. We see that in asphalt, which is increasingly being exposed to higher temperatures, and in the effects of higher temperatures on bridges. The impact of extreme rainfall on road and viaduct foundations is currently the subject of study. All in all, this means that the safe availability of the infrastructure cannot be taken for granted anymore. Currently we are already spending between six and nine billion euros a year on maintenance and replacement. In addition, there are indirect costs in the form of road traffic nuisance. The question is, how do we keep this under control?

#### Smart infrastructure

The answer is: with innovative asset management that operates using high quality information about the real-time technical condition of our assets, and from high quality information about the prognosis (the anticipated development) of that technical condition, whereby the link to availability and other performance requirements is continuously established. Instead of routine, and often incident-driven maintenance, RWS will then work towards information and knowledgedriven maintenance, with a stronger preventive >

# The first challenge concerns the information demand itself. How do we arrive at a complete set of information?

character. In my opinion, the development of this smart asset management of the future has three challenges.

# Challenge 1: monitoring and inspection systems

The first challenge concerns the information request itself. How do we arrive at a complete set of information? The information is complete when asset management is in a better position to oversee the technical condition, look beyond the life cycle, and respond to external influences. Moreover, based on this information, the organisation of the decision-making must be supple and transparent, and cost-effective choices should be the ultimate goal. To achieve this we need data on the current condition and the degradation mechanisms, and also on what exactly determines the end of the technical life cycle so that links can be made to the load and maintenance history.

Inspection and monitoring techniques for infrastructure are becoming increasingly more advanced, driven from other application areas such as oil and gas. The tender specification based on the need for asset management - and the problem of ageing infrastructure integrated within - can take advantage of that. Many innovations in monitoring techniques are taking place now on an ad-hoc basis, and functional improvements are often incremental. Business cases are being built, but mostly from direct involvement with a subissue of asset management, and the immediate need for solutions that can be put into operation within the next five years. It is still difficult to build business cases for developments in the longerterm future. However, some nice examples of smart monitoring have been developed along this ad-hoc route. The methods can be characterised in terms of range versus resolution. Techniques with a wide range have a lower resolution and vice versa.

A number of satellites, for example, observe the Earth with instruments that can measure ground deformations accurately to within several mm a year. The frequency of these measurements increases to once every eleven days. The resolution of the recordings varies from data points that represent a few square metres to several tens of square metres. RWS and other organisations are carrying out studies for the purpose of using this data for early warning monitoring systems. These systems monitor deformations of, among other things, engineering structures, bridges and locks, as well as roads and road foundations. Settings are also visible with these measurements. In addition, this method can be used, for example, to better understand 'resilience' of the road network to increasing rainfall and foundation washout. Advancing drone technology makes automated information gathering of high resolution images of roads and waterways possible. Analysis of these images provides information such as the condition of the asphalt (potholes following periods of frost), crash barriers, lighting, etc. This information can immediately be used for maintenance planning, but it can also be analysed to identify trends, quantify degradation, and be correlated to other technical parameters. The information can also be linked to the performance indicators of the network manager, such as for sound, availability and traffic accidents. This is vital information for the actual asset management based on performance requirements.

In recent years an inspection system for road surfaces was placed on a **measuring vehicle** of



AE sensors have been installed on the Van Brienenoord Bridge

RWS. This system can determine stone loss from porous asphalt surfaces. The system uses highresolution 3D measurements through laser triangulation and has already provided predictions for the remaining life cycle of the RWS road network for some years. Partners of RWS in Germany and Denmark have already expressed an interest in working together to further develop the use of this system.

Another example is the monitoring system on the Van Brienenoord Bridge. A small number of **sensors**, about fifty, monitor the condition of the approximately 10,000 m<sup>2</sup> steel deck for signs of fatigue. Acoustic sensors register cracks of just a few centimetres based on the sound they make as they slowly continue to develop. These signals, together with those of stretch sensors, are interpreted to arrive at the total number of cracks on the entire deck with the aid of advanced models, and all with just one sensor per 200 m<sup>2</sup>!

# Challenge 2: information management systems

A second challenge is the development of information management systems in which not only the data on the technical condition and the performance of the infrastructure can be stored, but also the design information. The requirements of such a system will be that it must be standardised and easy to analyse and that enriching the data must be possible with, for example, interpretation models. This is in line with developments in the field of building information models.

# Challenge 3: interpretation and predictive models

In addition to information about the current condition, smart asset management needs predictions of the future condition, including predictions of the future structural safety and availability. This is still uncharted territory. Predictions are now carried out based on >



Example of the prediction of the number of critical cracks on the deck of the Van Brienenoord Bridge

expert opinion, and are thus often subjective and at object level. To be well prepared for the changes described above, objective insight into the future performance of the acreage is required. Experiments with methods for combining the information from the monitoring systems and predictive models are now being carried out. The measured information on the number and size of the fatigue cracks in the Van Brienenoord Bridge, for example, is interpreted to arrive at the number of critical deck plate cracks on the deck of the bridge with crack growth models from the fracture mechanics. This provides objective information about the future deck condition, which can be used in the decision-making process on the renovation of the bridge deck.

#### Conclusion

Strengthening our grip on the infrastructure with smart measuring methods will give us great benefits. The available budget for management and maintenance will be used where required and will result in high availability and road safety. And, if possible, in less money spent on concrete and steel for replacement. That will require investments in smart inspection and monitoring systems, good information management systems and intelligent prognosis systems. Furthermore, it is important to incorporate these systems in our asset management in a structured manner. That way, we will not only develop a working method to maintain our infrastructure against acceptable costs, but also innovative products to earn money internationally as Dutch companies. <

### BOOK REVIEW

### Infrastructure as part of the solution

How can our infrastructures play a role once again as 'agents of change' in the sustainability policy? According to Weijnen, Correljé and De Vries institutional reforms at different levels are essential.

The three authors wrote a paper for the Scientific Council for Government Policy about the dense network of infrastructures in the Netherlands. They describe infrastructures as 'static basic facilities that make certain locations suitable for business, residence or other functions,' and also as 'dynamic facilities that connect economic and social activities at different locations with each other through the



transportation of people, goods and information'. These infrastructures have become self-evident to us. But this self-evidence easily leads to underinvestment.

#### Sustainability problem

Infrastructures are often regarded as part of the sustainability problem. But infrastructures can also be seen as part of the solution. Infrastructures for drinking water and sanitation, for example, were built at the beginning of the 20th century and made healthy and safe living conditions possible for the growing population in cities. How can our current infrastructure, which is ready for upgrading and replacing, form part of the solution to the sustainability problem once again?

The challenge for the future lies in redefining the public role in infrastructure development. The route chosen to date, competitive marketing, does not automatically lead to a stable, sustainable design, because social demands and environmental conditions have changed. The relationship between market, government and society in managing infrastructural developments must be reconsidered. At the same time, there should be consistent policy at European level. Currently, the trans-European infrastructure is developing primarily on the basis of ad hoc horizontal coordination relationships of countries and ever-changing financiers. Furthermore, contractors are confronted with various (national) policy issues, political demands and preconditions. The authors have presented the infrastructure managers a major challenge: how can the spatial and technical interactions between the various infrastructures be used at different levels? And in a way that the development of infrastructure plays a greater role in creating a sustainable society? I wonder whether the infrastructure managers will take up the gauntlet!

Nadinja Hettinga Project Leader Strategic Explorations, Rijkswaterstaat

Infrastructuren als wegbereiders van duurzaamheid Margot Weijnen, Aad Correljé and Laurens de Vries. Working paper number 12. WRR, The Hague, 2015

# Beauty creates sustainability

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By Ingrid Zeegers

IN

TFRVIEW



A bridge, tunnel or canal: valuable parts of the infrastructure. Not only technically, but also in terms of valuable experiences. And beauty creates sustainability: "You do not just demolish a place that people hold dear to their hearts." That is the opinion of Astrid Sanson, Director of Urban Quality and Inner City for the Municipality of Rotterdam, and Aart Oxenaar, Director Monuments and Archaeology for the Municipality of Amsterdam.

Amsterdam and Rotterdam: old and new. Sustainability is well organised in both cities. It is an integral part of all activities. But sustainability means more than energy conservation and recycling. It also involves creating values, and thus the quality of urban development.

#### **Amsterdam monuments**

When you think of Amsterdam, you think of the canal belt, which has existed for hundreds of years and is the epitome of sustainability. The Municipality of Amsterdam has over 9,000 monuments: buildings, urban structures and infrastructure elements. Aart Oxenaar is the Director of Monuments

"The fact that we do not economically write off monuments, but carefully maintain and cherish them, involves a huge amount of sustainability" and Archaeology. Why is monumental infrastructure so important for a sustainable city? "A monument tells the story of the city. It gives the city identity. The fact that we do not economically write off monuments, but carefully maintain and cherish them, involves a huge amount of sustainability. But it also involves the interaction between residential quality, public spaces and historic buildings. That also includes water and urban greenery. The interaction in particular generates attraction and residential value. And that, in my opinion, is sustainability."

# New infrastructure with historic appeal

Oxenaar mentions the renovation of the Amsterdam Central Station as an example of sustainable infrastructure. "The architect Cuypers designed the main building in the 19th century as the culmination of the building of the railway system at that time. That was a major operation in those days, as it is now. Back then it involved just as much discussion about how the new infrastructure would fit in with the existing cityscape. All kinds of design demands were made. The bridges had to be built in traditional Dutch style because it suited the city." The fact that Cuypers made a sustainable design at that time is obvious. "The historic main building will once again be the figurehead of the entrance to the city, but now with a brand new infrastructure. The station will have two faces: old and new. The rear of the station building will receive a spectacular contemporary appearance."

Another illustrative example is the renovation of the Hogesluis Bridge over the River Amstel near the Amstel Hotel. Oxenaar: "There was much debate about this renovation. Technically the bridge needed to be replaced. The question was: should we demolish or renovate it? > "Sustainability is not only a technical consideration, it is also about social aspects, about user enjoyment, about pride"

> Ultimately, a restorative approach was taken, which involved the renewal of the entire bridge construction while retaining the heritage value of the bridge. The water piles were not renewed because they contain original material dating from 1662. The natural stone balustrades and obelisks were not replaced but repaired and restored."

#### City motorway as part of the heritage

Even in Amsterdam it is not always possible to preserve historic infrastructure. How bad is that? "In the 19th and 20th century, many canals were filled in. Transport over water made way for car traffic. After the war there were even plans for a four-lane road through the centre of the city. The four-lane road on the Wibautstraat was the only one realised. Until recently, this road was seen as the



#### Aart Oxenaar

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Aart Oxenaar is Director Monuments and Archaeology for the Municipality of Amsterdam. Previously, he was director of the Academy of Architecture Amsterdam and member of the management team of the Amsterdam University of the Arts. He is also Chairman of the Advisory Committee Spatial Quality Haarlem. ugliest street in Amsterdam. However, for the younger generation this street is their heritage, mainly because of the clubs that were established in the empty office buildings. The city motorway represents a vision of the city's development." In the current city profile everything revolves around residential value. "The value of the city is not only determined by the design of a bridge, but also by the quality of the water around it. No one had imagined that the water in the harbour would become so clean that you could swim in it in summer. Today, the Borneo Bridge (built in 2000 by the architect Adriaan Geuze) is a popular 'diving board'. In short, monuments of the future are already being built."

#### Rotterdam monuments

The Erasmus Bridge, the Markthal and the new Central Station; It's not without reason that Rotterdam is famous for its architecture. The city is bursting with new icons. Rotterdam also has many monuments, such as the Van Nelle Factory and the Groot Handelsgebouw. Astrid Sanson is Rotterdam's Director of Urban Quality and Inner City. She explains why spatial quality is so important in the concept of sustainability. "Quality is not about beauty or ugliness. It's about identity. Once a building or place becomes dear to people's hearts it has intrinsic value. It then represents quality and remains preserved. A monument is an extreme example of that. But that also applies to other good quality buildings."

#### Demolition? 'No, unless'

Rotterdam has a relatively large amount of new architecture. How come? "The people of Rotterdam prefer to look ahead. Rotterdam's building mentality still relates to World War II when the city was almost completely destroyed by the aerial bombardment and everything had to be rebuilt. In recent years, a new understanding arose that the city should also have a historical stratification, otherwise people cannot identify with a place. In Rotterdam we are beginning to appreciate more what we have. Nowadays we always carry out a cultural and historical exploration first before developing an area or monument. We have introduced this to maintain the cultural and historical value of an area or building, but also due to sustainability aspects. Not demolishing is much more sustainable than newbuild."

### Is quality expensive? It's a matter of choice

According to Sanson, quality stands or falls with the choice of architect and the approach. "The right architect for a welldefined task. Subject to that, you determine whether it will be an integrated project or that you first make a conceptual design and then select the builder. Or another method of working somewhere in between." Yes, but isn't quality too expensive? "If you already think from the outset that quality is always more expensive it would be better to stop immediately, because you do not have the right attitude. It depends on what you wish to consider investing your money in. Technicians tend to invest all the money in technical solutions, often underground. They are seldom willing to invest in user enjoyment. And yet, sustainability is not only a technical consideration, it is also about social aspects, about user enjoyment, about pride."

#### **Stations with allure**

Sometimes beautiful infrastructure improves an area. "The new generation of stations



#### Astrid Sanson

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Astrid Sanson is Director Urban Quality and Inner City for the Municipality of Rotterdam. Previously, she was Director Urban Development, also for the Municipality of Rotterdam. Prior to that she worked for the NIROV (Netherlands Institute of Housing and Planning) and the real estate organisation of the TU Delft.

and their environments are a good example of that. Those hubs are made attractive to make people want to live, work and stay there. Some bridges also contribute to sustainable city development, such as the Erasmus Bridge and the development of the trendy Kop van Zuid district." By contrast, tunnels are an eyesore. "Some tunnels are so beautifully illuminated it is a pleasure to drive through them. But there are also some horrendous tunnels that you want to drive through as quickly as possible. They are technically fine but they do not contribute to the identity of a region. Infrastructure design determines the practical value of the environment. Quality contributes significantly to sustainability in the broadest sense of the word, and thus also increases economic spin-off." <



#### INTERVIEW

# Dynamic urban Life Cycle Management

By Ingrid Zeegers



The life cycle of infrastructure in the city is not usually determined by the technical life cycle, but by the dynamic development of the city. How do you deal with the organisational fragmentation and financial barriers? According to Johan Vermeer, Director Project Management and Engineering of Urban Development Rotterdam, it is merely a matter of public entrepreneurship.

The Engineering Bureau of the Municipality of Rotterdam realises projects in the field of infrastructure, and civil and environmental engineering. They make calculations, provide advice, arrange permits and ensure that the work is put out to tender and implemented. It increasingly involves complex urban tasks, with the involvement of various parties. Director Johan Vermeer: "Organisational fragmentation and financial barriers? I see it differently. We should not just look at individual projects, but at the social task. That principle then determines how you organise the work. It differs from project to project. At the municipality we are used to forming coalitions with people that represent something very different. Our project management bureau excels in public entrepreneurship." What does that mean? "Actively searching for people with new ideas. Learning from the market and from colleagues in other organisations. Starting the conversation and looking for someone, a launching customer, who wants to try out the idea. Turning parts of the city into a laboratory to test new ideas. With the approval of the Municipal Executive, of course."

#### Test bed for sustainability

How do we see this philosophy reflected out on the street? A few examples:

 The floating island in the Buizengat, an old harbour in Kralingen. The innovative floating park provides more greenery in the harbour, and immediately contributes to improving the water quality. The idea comes from a company called Urban Green and was made possible by >



The floating island in the Buizengat

the Municipality of Rotterdam and RWS.

- Future-proof water plazas. Special plazas designed as basins where excess rainwater can be collected. That is necessary due to climate change. The plazas have been made possible through cooperation with the Water department of the municipality, submunicipalities, district water boards, designers, housing corporations and users of the plaza.
- Heart for beautiful streets. This involves an integrated street renovation approach. The street is broken up only once instead of for each separate job. Once the street has been broken up, works on the sewer system and gas and water pipes are simultaneously carried out.

# Organisational complexity of urban infrastructure

According to Vermeer, the city is a conglomerate of social and economic ecosystems. "That people can live there and work together is due to the relationship between all kinds of different infrastructures, i.e. the road network, the sewer system, the IT infrastructure, the air, the water. If one system doesn't work, it immediately has an impact on the other systems. That's why we always take the cohesion between the different infrastructures into consideration." Urban tasks are, by definition, complex. Vermeer mentions the climate challenge as an example. "Rotterdam is a low-lying city on weak soil. The water is rising. Moreover, it is raining more often and harder." What will we do? This is the idea: link sport, nature and water. "When it seemed like the 2012 Olympic Games could be held in the Netherlands, an Olympic rowing course was set out near the Municipality of Rotterdam. We thought: if we build the dykes just that little bit higher we could also use the rowing course as a retention area. That would mean a substantial saving on the renovation costs of a pumping station. Moreover, the sewer system of part of Rotterdam would not need to have a larger capacity." That means profit through cross-border thinking. But what is the situation with the financing?

#### Who is paying?

According to Vermeer there is no set formula for the financing. "Every project is, by definition, paid from multiple sources. Money comes from the water manager, the Metropolitan Area, the City Management department, sometimes there is European subsidy, sometimes money comes from the World Wildlife Fund, and sometimes RWS contributes money." And the market? "For the sake of clarity: real estate development and regional development are carried out in Rotterdam by the market itself. The municipal Engineering Bureau is not the manager of that. And if we outsource work to the market ourselves we do not do that with contracts in which we outsource everything, from design to maintenance." Why not? "To keep a grip on the entire system. We have 2,000 kilometres of

sewer system in the city. Just suppose that we were to outsource 500 kilometres of our sewer system and something went wrong. It would immediately have an impact on the rest of the system. As the responsible municipality you would have to immediately deal with it yourself. In short, we look after the management and maintenance of infrastructure ourselves."

#### **Municipal Life Cycle Management**

To manage the performance, the costs and the risks over the entire life cycle of the infrastructure, many contracting authorities work with Life Cycle Management. Does the Municipality of Rotterdam do that too? "If you broadly define Life Cycle Management it comes down to the following question: how can infrastructure add maximum quality to a region? Then it becomes interesting, because it involves linking various social tasks which, together, result in liveable cities. It is, for example, logical to link sewage issues from the outset to innovations, such as the arrival of the automatic vehicle in the city. After all, they both involve a shortage of space in the city. You will have to start considering that kind of cohesion at an early stage."

#### Life cycle

In the narrower sense, Life Cycle Management is often about the length of the life cycle. Is the life cycle of urban infrastructure different to that of national infrastructure? "We maintain the same principles. But there are differences. The life cycle of infrastructure in the city is primarily determined by the dynamics of the city, and not so much by the technical life cycle. Projects change continuously because the city changes. In addition, urban and rural infrastructure differs, also in terms of technical life cycle. Thanks to research, we can prove that both steel and short concrete bridges in the city wear less rapidly than bridges on motorways. You then arrive at the point of risk-controlled asset management. To estimate risks, the same generic calculation rules are used for all infrastructures. This is unjustified,

because for steel bridges and short concrete bridges the uniform rules applied by the Netherlands appear to be too strict."

The question that arises is: who or what determines the ultimate life cycle of urban infrastructure? "We, the municipality, are for cohesion. If you think from that perspective, it is not always about extending the life cycle. It's about the quality of life in the city as a whole. It is, for example, conceivable that the technical life cycle of a bridge has not been reached, but that it has to go because the environment is changing."

#### From rules to principles

What do we have to do specifically? "We must learn to deal with a shift from rules to principles. That means integrated thinking about social tasks. That is something the government can do much better itself first. No one knows the infrastructure in the city better than the people of the municipality. The market can subsequently respond to the vision of the government. Private sector parties often come up with spontaneous ideas to which we respond. Look at the floating island of Urban Green. That is just one of the many examples. As far as I am concerned, Life Cycle Management is not about supercontracts, but about a broad and flexible view of the joint social task." <



#### Johan Vermeer

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Johan Vermeer is Director Project Management and Engineering at the cluster of Urban Development of the Municipality of Rotterdam. He is also a member of Het Opdrachtgeversforum in the construction sector. Previously, he was Director at Roteb (Municipality of Rotterdam) and worked from C Plus Management as manager for various public clients.

#### PORTRAITS

# Learning from other sectors

By Erna Ovaa

What can infrastructure managers learn from other sectors? An introduction to Cargill and the Leiden University Medical Center.

### Cargill

Various products that have previously passed through the processing plants of Cargill can undoubtedly be found in the kitchen cupboards in your home and mine. Because Cargill processes agricultural products into food ingredients on a global scale. The company has branches in about 70 countries, including the Netherlands. We spoke to Nico Cornelius, Maintenance & Reliability Leader, who is regularly to be found in the branch in Sas van Gent.

# What type of assets does Cargill deal with?

"In the Netherlands we have about 12 factories, in which we process cocoa beans, seeds and wheat, and we also have a transhipment company. So you can understand that we deal with very many different types of assets: reaction tanks, centrifuges, gas turbines, silos, unloading facilities, quays, roads, etc. In total we can distinguish about 500 types of assets and from the central Maintenance & Reliability organisation we develop standard strategies for them. For example, a maintenance strategy for a chemical tank or a centrifuge based on the errors or malfunctions that can occur. When we inspect and assess, we do that as much as possible while the machines are still running. We also cluster the repairs as cleverly as possible to minimise production loss."

# What happens if a large replacement task arises?

"We always have assets that reach the end of their life cycle at some stage, such as machines, tanks and buildings. That is quite similar to the situation with infrastructure managers. For the larger replacements we draw up a plan in advance at the European level to spread the costs as much as possible." Cargill keeps an eye on the assets very closely. "We continuously monitor how critical each asset is on points like safety, environment, impact on the client, impact on production and operational expenditure. An asset turns green in the assessment programme when all standards are met. If a centrifuge vibrates too strongly, for example, it will become red. The results form the basis for the Multiannual Programme for maintenance and replacement."

#### Do you also look at the life cycle of the assets when making investment decisions?

"In the distant past, only the investment costs were looked at; now we look more at the total life cycle costs and the long-term consequences. If we acquire a new type of asset, not only do we want to know the reliability and the technical operational costs, but also the energy consumption, the emissions and the noise production.

		Cargi	
Cargill in the Netherlands			
		Zaandam, Wormer, Deventer	cocoa beans -> cacao mass and cacao butter
	uul uul uul	Amsterdam (2x), Rotterdam Botlek	seeds -> oil, proteins, etc.
	m	Swalmen	barley -> malt
	mi mi	Bergen op Zoom and Sas van Gent	wheat and maize -> glucoses, starches, alcohol, etc.
		Rotterdam, Kerkdriel	composition and production of animal feed
	<u></u>	Amsterdam	transhipment company Igma

In terms of the permit we also look slightly ahead; if we produce noise with an asset, we try to compensate it with other measures." The differences in life cycle per type of asset sometimes demand extra attention. Automation systems, computers and measuring instruments all have a short life cycle, while silos, tanks and buildings have a much longer life cycle. "In the past we bought machines from a supplier and the (PLC) control came with them. That makes it difficult to move to a single operating system for a factory. Now we have an automation master plan for the long-term and everything has to be connected to our operating system. Our aim is to sign contracts with the supplier that include a guaranteed number of service and support years."

#### Sustainability and circular economy are high up on the social agenda. How does this affect the asset management at Cargill?

"We are busy improving the energy efficiency of our processes, with heat recovery and >



#### Nico Cornelius

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Nico Cornelius is Maintenance & Reliability Leader at Cargill Starches and Sweeteners (SSE) Europe. He is responsible for monitoring and continuously improving the work processes to ensure reliability and operational expenditures of the SSE plants. Previously, he was maintenance manager at various Cargill branches and took part in various European Best Practice teams as Subject Matter Expert. with the development of special filters for cleaning air. Waste and demolition materials, such as steel and sludge, go to recognised (certified) recycling companies. Sometimes we receive money for it, sometimes we have to pay for it. If you look at the production itself, we are already a step further; almost all waste materials are reused at Cargill. From the waste materials from wheat, for example, we make ethanol, and the biogas from the waste water treatment plant is used to generate electricity."

# What could the infrastructure mangers and Cargill learn from each other?

"I think we can learn from each other in many areas: the way in which a multiannual plan for replacement is drawn up; determining selection criteria for replacements; ensuring the controls of a new bridge, for example, fit into your control philosophy; the development of intelligent sensors that automatically indicate when something is not right. I notice from this interview that our organisations have more in common than I first thought."

### "We can learn from each other in many areas"

### Leiden University Medical Center

Two girls chatting away walk into the Leiden University Medical Center (LUMC). Jeans, trainers, ponytail, backpack. They don't look like patients and they aren't visitors, and yet they belong here. Besides patient care the LUMC also focuses on education and research. Peter Wortman, Manager Operation Center, allows us a glimpse of what this broad work field means for considerations in terms of the assets.

# The type of assets that LUMC has to do with seems to be a wide range...

"To begin with, we do not call them assets here. Hospitals are generally averse to such management terms; doctors are in charge here and they mainly use medical and Dutch terms. But in this interview we can refer to them as assets. You should think of operating theatres with accessories, laboratories, consulting rooms, medical equipment, beds, a pharmacy, IT, lecture halls, a centre for laboratory animals, etc. Organisation of the ownership is complicated: the LUMC has four substantive divisions that carry out the policy for their own assets themselves. A number of central facilities, such as the hospital information system, reports directly to the Executive Board. The technical infrastructure is centrally monitored. It is my job to manage 20 operating theatres, both in terms of material and staff (approximately 300 employees). We try to take a crossdivisional approach as much as possible. But sometimes the interests are not aligned and the communication and mutual agreements are not easy.

In recent years we have strived for more unity, and try to get the divisions to look further ahead. But to make good medium-



term plans you need good data. Unity and careful registration are still an issue. Doctors have difficulty with this when it takes up their time; time that they would rather spend on patient care, education and research."

# What happens if a large replacement task arises?

"The material registration system Ultimo records when equipment has been purchased, the date of maintenance, etc. Before each operation all equipment must be checked for safety and maintenance status. In another hospital I have experienced that all respiratory equipment was out of service at the same time; in other words, the supplier no longer carried out maintenance. Tons of money had to be brought forward for the replacement, because something like that should not interfere with continuity of the hospital. The assets have to be available and reliable at all times. In the LUMC we are aware that we have to have a good overview of the material stocks and a timeline. We set an amount aside each year for the buildings but for equipment this is not yet general practice. That certainly also has to do with the constantly changing financing structure, of cash flows from health insurance,

#### Peter Wortman

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Peter Wortman is Manager Operating Centre in the Leiden University Medical Center. Previously, he has worked in various other hospitals in (interim) management and business consultancy. Wortman is also advisor for CoperniCare, a company that focuses on tracking systems for materials and people in health care and other areas.

### "We include anticipated future changes in investment decisions"

the Dutch Ministry of Education, Culture and Science and research funds, which also differs by department."

#### When making investment decisions do you also look at the life cycle of the equipment?

"That way of thinking is certainly gaining ground. We often have to make a business case for a purchase. We then not only look at performance, risks and costs during the life cycle, but also at the environmental effects and the energy costs. We also include anticipated future changes in the decisions. A good example is the Da Vinci robot. We expect that more and more patients would ask for it, and doctors too, because they believe they can operate more accurately and safely with it. Our research branch encourages them in this regard. However, the cost price per unit of product is very high. The Netherlands has the highest density of robot surgery; there are 11 robots spread out over the Netherlands but they are used inefficiently."

# How does the LUMC involve the social value in considerations concerning investment decisions?

"There is public interest in top specialist care. From a cost point of view you should perhaps not want to carry out some treatments, but we then cover those costs as much as possible through other interventions that have a positive return. We also choose our priorities, coupled with scientific research, and thus try to distinguish ourselves from other hospitals at the same time."

#### And which role does sustainability and thinking in terms of circular economy play?

"We try to reduce energy consumption, the volume of, among other things, radioactive materials and contaminated hospital waste, reduce our emissions, and we consciously work on the quality of life on the premises and the area around the hospital. Reuse of material is difficult in the hospital; it is rejected." Would the concept of the circular economy work here: that the producer remains the owner of the product and optimally manages the life cycle, up to and including taking the product back and recycling it? "That concept could definitely be applied in a hospital."

# What could the infrastructure managers and LUMC learn from each other?

"From infrastructure managers I think we could mainly learn how they think structurally about the long-term. In turn, the infrastructure managers could perhaps learn something about our approach towards innovation; through research and education within our walls and in open communication with the outside world. Such as the students who walk in here quite naturally." <

This trend book is published by Rijkswaterstaat (RWS, a government agency within the Dutch Ministry of Infrastructure and the Environment). For more information, please contact the editorial office via lichtkogel@rws.nl



July 2016

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