The Eefde Locks Living Lab

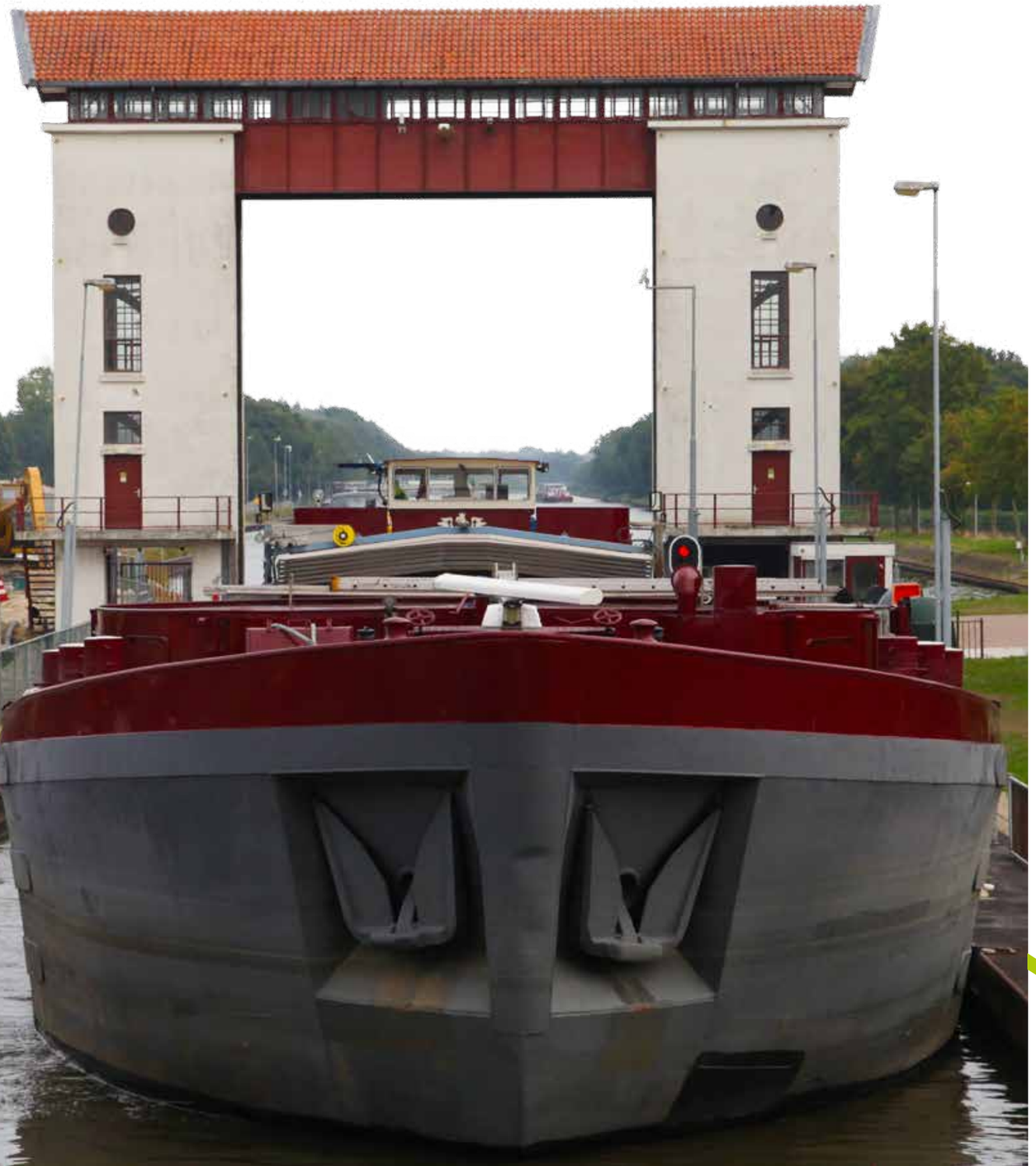
TOWARDS PREDICTIVE MAINTENANCE IN THE INFRASTRUCTURE SECTOR

WORLD CLASS MAINTENANCE

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Field lab CAMINO

Content



Predictive maintenance

What is the ideal moment for carrying out maintenance? That is the central question in Rijkswaterstaat's 'Vitale Assets' (Vital Assets) programme. In the CAMINO Field Lab, Rijkswaterstaat (the Directorate-General for Public Works and Water Management) is researching the predictability of maintenance. This magazine tells you about what we've learned from the Eefde Locks Living Lab.

Infrastructure maintenance is facing a challenge: the traditional solutions of regular preventive maintenance or repairing whatever has gone wrong are no longer good enough. A transition to just-in-time maintenance is needed - in other words, doing the maintenance before the system starts wasting energy and before things break. But not too soon, as that just wastes money.

Smart Maintenance

So how do you tackle this? The answer to that question is Smart Maintenance. Using modern techniques and technology such as sensors, Big Data, predictive modelling and the Internet of Things lets you estimate required maintenance much more accurately, so that it can then be done more efficiently. Vitale Assets and the Water cluster of the CAMINO Smart Industry Field Lab are working together on learning how to predict the maintenance needed on hydraulic civil engineering works.

A successful project

The Eefde Locks were one of the first hydraulic engineering structures to be used as a learning environment. The experiment in these locks started in 2017. Now, three years later, we can look back on a successful project. We found out, for instance, that merely measuring and monitoring could yield substantial improvements in lifespans and energy consumption. We also discovered that innovating is more fun and that you learn more from it when you're working together. You can read more about what we learned from the living lab in the rest of this magazine.

We are hoping that other pioneers can learn from our lessons and successes, letting us speed up our progress towards pure predictive maintenance in the infrastructure sector.

We hope you enjoy reading it!

Perry van der Weyden
Chief Information Officer, Rijkswaterstaat

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Eefde Locks: A national heritage structure and the gateway to Twente

The Eefde Locks have been the gateway to the Twente Canal since 1933. The traffic on the water and the water levels are managed from the lock complex, which has also been a living lab for the CAMINO Field Lab since 2017.

Bron: ifm Ruben Boom

1. Eefdesebrug
2. Almensebrug
3. Ehzerbrig
4. Dochterensebrug
5. Lochemsebrug
6. Exelsebrug
7. Mogezompsebrug
8. Grensbrug
9. Markelosebrug
10. Diepenheimsebrug
11. Weldammerbrug
12. Hengelerbrug
13. Dorrebrug
14. Sint Annabrug
15. Vossenbrinkbrug
16. Oelerbrug
17. Boekelosebrug
18. Lonnekerbrug

A. Sluiscomplex Eefde
B. Sluiscomplex Delden
C. Sluiscomplex De Waarbeek bij Hengelo

U. Uitmonding IJssel

Listed as National Heritage

The Eefde Locks were built almost 90 years ago to a design by the architect Dirk Roosenburg. They were renovated thoroughly in 2003. The raising mechanism was still in good condition at the time, so it was not replaced but several emergency repairs have been made since.

There is another piece of national heritage on the southern side of the elevator lock: the pumping station, which pumps water back and has the crucial task of keeping the water level up.

Gateway

The Eefde Locks are a key inland navigation link for shipping between northern and eastern Europe and the ports of Rotterdam, Amsterdam and Antwerp. Every year, barges take a good 70,000 containers and 60 million tons of cargo through the Eefde Locks.

Three years ago, the Eefde Locks were designated as a learning environment for Smart Maintenance Within this living lab, organisations are investigating technology such as the Internet of Things, aiming to make maintenance on the locks more predictable.

New lock

Increased traffic and longer waiting times led to a decision to build an entire new lock in addition to the existing national heritage structure. The Lock to Twente contractor consortium - a venture involving the civil engineering companies Mobilis and Croonwolter&dros - is carrying out that work on instructions from Rijkswaterstaat.

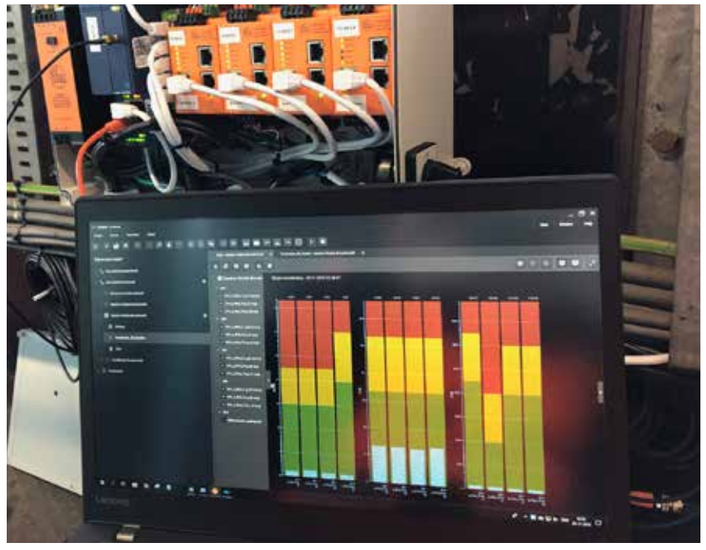
Activities

The following work has been carried out over the past three years:

- Renovation of the existing lock (from April/ May 2020)
- Construction of a second lock chamber, on the northern side of the existing lock
- Construction of a new operations building
- Laying a bridge over the new lock and maintenance work on it
- New layout for Kapperallee
- New layout for the area to the north of the new lock and maintenance work on it
- Relocating the primary and regional water barriers on the northern side

The Eefde Locks as a learning environment

The idea of using the Eefde Locks as a living lab for studying Smart Maintenance arose in 2017. Rijkswaterstaat saw the expansion of the lock complex as a unique opportunity to innovate, as the project was a perfect fit with the 'Vital Assets' initiative: a Rijkswaterstaat programme focusing on scaling up Smart Maintenance effectively and sustainably.



In collaboration with the civil engineering companies Mobilis and Croonwolter&dros and the World Class Maintenance Foundation, Rijkswaterstaat took the initiative to use the Eefde Locks as a living lab. All those involved benefit directly from getting a better picture of the lock's behaviour, so that the maintenance that is needed can be predicted better.

Goals

Tangible goals were set at the start of the project, intended to help understand the factors that predict the need for maintenance. The following issues were tackled at the Eefde Locks:

1. **Energy consumption**
   Monitoring energy consumption and investigating whether there are patterns in it. If we keep discovering the same consumption pattern before a component fails, that pattern can be a good predictor of impending breakdown.
2. **Corrosion**
   Determining at an early stage whether a component is going to corrode. Signalling this in good time and making repairs can lengthen component lifespans.
3. **Vibration and oil quality**
   Analysing the amount of vibration in the lock and monitoring the oil quality. If we observe more vibrations before a component fails, this can be a good indicator of degradation in that component. The more accurate the information we have, the better we can predict the requisite maintenance.
4. **Data**
   Collect, process and visualise all the measurements and control signals from the lock (known as SCADA data). Examining this data from the machinery closely lets us discover patterns that predict the need for maintenance.

Expansion

Over the course of the living lab period, we concluded that including the pumping station in the monitoring would be a good idea. On the one hand, this was because there is a direct connection between the pumping station and the locks - neither can work without the other - and on the other because the pumping station had recently been renovated and fitted with all kinds of built-in sensors. This presented a great opportunity to add new insights relatively quickly. We looked not only at the use of SCADA data, for example, but also at how the station and its pumps are used in practice as compared to the intended use that they were designed for.

Open data

The aim of this project is not only to predict the maintenance needed at the Eefde Locks but also to implement these ideas at other structures and works in the Netherlands. The parties involved are therefore in favour of open data: not only sharing the understandings obtained but also making the underlying data available to market players.

A major benefit of open data is that everyone - including parties not involved with these locks - can develop their own innovative solutions more quickly and more simply. This is how we are helping make infrastructure maintenance needs more predictable.

Working together in a living lab

Good ideas don't have to come from inside your own organisation. They don't have to stay within your own organisation either. More and more companies and other organisations are realising this, seeing that collaborating to think up and implement new ideas is the perfect way to make progress. In 2017, various organisations joined forces to promote open innovation. The companies involved in the CAMINO Field Lab would like to introduce themselves to you.

Croonwolter&dros and Mobilis | civil engineers

The civil engineering companies Croonwolter&dros and Mobilis work together on the Netherlands' infrastructure. In this case, Mobilis are responsible for the civil engineering infrastructure and Croonwolter&dros for the design, construction and maintenance of the electrical, technical and mechanical systems.

In a consortium named Lock to Twente, Croonwolter&dros and Mobilis are responsible for the construction and future maintenance (for 27 years) of the new lock in Eefde. Lock to Twente are also responsible for the upkeep of the existing lock and the major (and variable) maintenance work on it.

With a view to guaranteeing availability and minimising costs, Croonwolter&dros and Mobilis have set up a joint asset management organisation, where they are investing heavily in predictive maintenance and the data that is needed for it.

"Asset management is all about the optimum balance between costs, risks and performance," says Ruud Schoenmakers, the Maintenance Company Manager at Mobilis. "You can see the goalposts shifting: preventive and corrective maintenance are no longer enough. We want to move to a situation in which we can completely predict the management and maintenance that are going to be needed."

"We see predictive maintenance as a dot on the horizon," adds Celeste Martens, a Maintenance Manager at Croonwolter&dros. "We're doing pilot projects for that. Doing the actual work instead of just talking about it keeps bringing us another step closer. It's important for us to get answers to essential questions about monitoring assets and about gathering and analysing data."

"Taking part in this living lab was a unique opportunity for us to take a step in the right direction," adds Ruud. "We can take on board what we're learning and what we've already learned in CAMINO when we carry out new projects."

Ruud Schoenmakers

Celeste Martens

EnerGQ

EnerGQ supplies the intelligent software and the plug-and-play energy sensors that let us see discrepancies in the energy consumption very early on. Observing and analysing energy consumption patterns is making it increasingly easy to prevent faults.
"How well assets are functioning can be seen from their energy consumption and factors that affect it," says Rob Burghard, director of EnerGQ. "We're often asked why the energy used matters so much. It's because a system's overall energy consumption is the only all-inclusive parameter, in terms of the physics. It changes with the condition of the equipment as well as the system operations and environmental factors."

Rob Burghard

Ifm electronic

ifm electronic develops and produces sensors. The knowledge about sensors that they have acquired from other sectors is being used in the innovations at the Eefde Locks.
"Many sensors that are out there in the field are capable of much more that what they're used for," says Ruben Boom, the Smart Industry project manager at ifm electronic.
"Digitising that last part of the communication chain lets us connect sensors directly to ERP systems, which enhances the opportunities for research and innovation."
"After this living lab, we'll be doing more work on spin-offs," adds Vincent Hubbers, "using our sensors for vibration analysis in tunnels and locks. On top of that, we've signed a new cooperative agreement with EnerGQ as a result of the Field Lab."

Ruben Boom

C-Cube and KE-works

C-Cube and KE-works have joined forces in the Eefde Locks living lab.
"C-Cube specialises in corrosion, helping customers throughout the world with corrosion problems," says Guus Coolegem, the director of C-Cube International. "The best and cheapest method is always to stay one step ahead of these issues. Measuring the condition of components lets predictions be made about corrosion occurring underneath the coating as well as visible corrosion. Doing the maintenance in good time can avoid a great deal of expense.

"To help translate our understanding of corrosion issues into an online service, we brought in KE-works. We developed a 'predictive corrosion service' together that shows the current and future corrosion status on a dashboard. It lets the maintenance be planned in advance, before there's corrosion damage, and gives a picture of the quality of the structure and how that quality is going to evolve in the future."

Guus Coolegem

Consortium: BAM Infra / Van den Herik Twentekanalen

The mission of BAM Infra is using digital resources to add value to its clients' assets. Even before the start of the living lab, the BAM Infra / Van den Herik Twentekanalen consortium was responsible for maintaining the pumping stations. When the chance arose to take part in the living lab, they said yes.

"The setup of the living lab fits nicely with our digital vision and our aim of building ecosystems where everyone learns from everyone else," explains Stefan Ossendrijver, the consortium's project coordinator. "We were familiar with a lot of the material to do with Smart Maintenance from other projects. Even so, cooperating with all the other parties involved has taught us a lot about other people's processes and technology. We've also discovered what our existing systems are capable of when we use them in a smart maintenance process. We're now using that knowledge in new projects."

Stefan Ossendrijver

Consortium: BAM Infra / Van den Herik Twentekanalen IJsseldelta

SPIE and the BAM Infra / Van den Herik Twentekanalen IJsseldelta consortium joined the Eefde Locks living lab at a later point, when it was already up and running. The consortium has a performance contract in which SPIE is responsible for maintenance of the technical systems.

"Our maintenance engineers are busy analysing the SCADA data that's available and connecting it to Ultimo," says Rick Schuller. "The Eefde pumping station is one of the places where that's happening. The analyses lead to optimisation of the maintenance and suggestions for improvements to take the availability and reliability of the assets to the next level. Because we're using sensors as well as simply recording the energy consumption, we're able to monitor potential faults and disruptions at an early stage. Anticipating issues like that appropriately lets us avoid failures, which ensures the availability of the system."

Stefan Ossendrijver and Paul Brincker add, "Together with Flowserve, we want to progress to applying condition-based monitoring. What way of using the pumps will minimise the risk of them failing? One way of doing this is to look at the loads, the pumps' standby times, the available NPSH and the operating hours. On top of that, we're going to optimise the pump controls so that the overall energy consumption of the pumping station is minimised."

Paul Brincker

SPIE Nederland BV

SPIE is all about a better future through innovation and sustainability. Developments such as digitisation, the cloud and smart sensors all help predictive maintenance
Rick Schuller, business development manager and project manager at the CAMINO Field Lab, says, "SPIE are always looking for new, smart ideas. Everyone in the Asset Management department is busy getting Smart Maintenance up and running. Under the motto 'Samen Slim' - Being Smart Together - SPIE is an essential link in the chain for making radical changes to the world we live in."

In the CAMINO pilot, SPIE is accumulating a lot of knowledge that they can use in their own product development. But that's not the only way they are benefiting, according to Rick. "The biggest plus for everyone involved is that we can learn from each other by sharing the information and available data - it's a win-win situation."

Rick Schuller

Rijkswaterstaat

Rijkswaterstaat - the Directorate-General for Public Works and Water Management - is responsible for infrastructure in the Netherlands.

Angelien van Boxtel, the Vitale Assets programme manager, says, "Rijkswaterstaat is facing a major challenge in infrastructure and asset renovation over the next few years. A capacity shortfall is one of the things that will make handling that large peak awkward. Smart Maintenance can help hugely here. At the Eefde Locks, we've learned how we can work in smarter ways to prevent faults and unplanned maintenance wherever possible. The ideas and discoveries we're making here can also be used elsewhere. We're already using some of the innovations for the Afsluitdijk, for example. A lot more work is needed before we can switch entirely to predictive maintenance, though. The challenge is implementing what we've found out on the smaller scale at hundreds of locations."

Angelien van Boxtel

World Class Maintenance

The World Class Maintenance Foundation (WCM) is the network for Smart Maintenance in the Netherlands. WCM's target is to achieve 100% predictive maintenance for industry in the Netherlands.

"The Eefde Locks project is an unusual living lab that lots of parties can learn from," says Ruben Ogink, project manager at the CAMINO Field Lab. "The fact that so many parties are involved and collaborating is positive in its own right - the government, the market, knowledge and research institutes. Everyone provides input, but each gets something out of it too. Precisely that input and the will to learn from each other works well for innovations in a living lab."

Ruben Ogink

Lessons learned: collaboration as the key to success

You learn a lot in three years. Lessons that you hope will benefit others in future too. We have collected the key lessons we learned together for you here so that we can share what we know about Smart Maintenance. Experts in four of the fields at our living lab - energy monitoring, condition monitoring, corrosion monitoring and the pumping station - also tell you what they have learned from taking part in the living lab.

Condition monitoring

Vincent Hubbers, Fluid Sensors & Diagnostic Systems Product Manager at ifm electronic:

"Taking part in a field lab was completely new for ifm electronic. One of the key lessons we learned was that a living lab will only be a success if everyone cooperates. Communication is the cornerstone. From the director to the operator on the spot who lets vessels access the locks: it's crucial that everyone knows what's happening. There were a couple of times that I'd made an appointment to check the sensors but was almost not allowed in because the operator hadn't been told. A lot of people are involved in a living lab. Make sure that all the levels within the company know what's going on: that makes the cooperation run smoothly.

"On top of that, your approach has got to be flexible. We had several instances of block diagrams being produced before the start that turned out to be much more extensive when we got down to work. That was often due partly to the enthusiasm of the people involved and the extensive capabilities of the diagnostic modules, which added a lot of value in this project - all positive reasons, really. But then it's a question of improvising, keeping going and adapting to the situation, which people sometimes play down. Maybe too much. After all, you've got to think on your feet if the original plans aren't right. We've now reached the point where we've drawn up the finalised block diagrams, which I'm glad to say match up nicely with what happens in practice and with the other partners.

"Make sure there is a physical space where equipment can be hung. This will also make the solution more scalable."

"Finally - and this is something to take on board for a subsequent project - I'd like to have had more occasions for sharing what we knew. There were such moments, sure, but there could have been more as far as I'm concerned. There's so much to learn and all the various parties have so much knowledge - for me, that's too valuable an opportunity to miss. Looking back, by the way, it was an absolutely top-class project for us. We'll definitely get a lot from it and use that experience in future."

Energy monitoring and AI

Rob Burghard, director of EnerGQ:

"EnerGQ was already handling energy monitoring for two Rijkswaterstaat locks before we started work at the Eefde complex. One valuable lesson we've learned is how important it is to cooperate with all the other parties involved. That's because we've got to understand the context before we can draw conclusions from the lock's energy consumption. The wind affects the energy use, for instance. That's the kind of information we need for explaining discrepancies in the data.

"Input from the people on the spot is part of that context too. What they see and hear helps us explain variations in the energy consumption. In the early days of the living lab, for example, we were hit by a relay failure. With hindsight, after a rollout for the other motors, it turned out that a particular algorithm could have prevented that failure. We can now already detect discrepancies before the contractor can hear the effects.

"Although new algorithms and AI have been added that are making our measurements more and more reliable, we still

need that kind of information. One idea we're investigating at the moment is using an app that will let the contractor send messages, photos and videos to us directly. The human factor is massively important in innovation. Discussing things like this face to face beforehand gets everyone thinking the same way.

"Use all the available data sources. There are vibration sensors built into the pumping station, for instance, but this was only discovered and included in the analyses at a later date."

"All in all, EnerGQ can look back on a successful living lab. A nice side effect is that this project has put us on the radar for a large data centre company, where we're now using our energy monitoring to detect abnormalities and make the systems as economical and as green as possible."

Corrosion monitoring

Guus Coolegem, director of C-Cube International:
"What getting involved in a living lab meant for us is that we came into contact with customers and other parties in a creative environment. A major benefit of working together in an informal environment is that you get feedback straight away about your technology. This has let us align our products even better with customer needs.

"On top of developing our technology for software monitoring, we also discovered during the living lab just how valuable the people are in that kind of project. At first, our market approach was integral and focusing on client companies as a whole, but the individual people working at the Eefde Locks turn out to be very important. That's why we decided as the project progressed to involve them much more in our activities. Interacting with these decision-makers let us improve the quality of our activities even further.

"We've learned a lot of new stuff in terms of the process too, for instance about how to tackle tendering. At the moment, there's often not enough time to get an impression of the current condition of the components, but you need to know that if you're going to write a good proposal. If the client - Rijkswaterstaat in this case - can from now on create a clear picture of the status of the items before the tender, everyone will be working from the same baseline, which is an important step if smart maintenance is to be scaled up.

"Taking part in the field lab was a very positive experience for me. I'd definitely recommend it to others if they get a chance to join one. It teaches you a lot, you meet new people and you improve your own products. On top of that, it has generated various spin-offs for us. We're using our sensors in the Zeeland Bridge too, for instance, where we're measuring the residual protection of the concrete covering. It's a new application of our existing product, letting us develop it further."

Pumping station

Paul Brincker, business consultant at the BAM Infra / Van den Herik Twentekanalen consortium:
"The BAM Infra / Van den Herik Twentekanalen consortium's responsibilities in the Eefde Locks living lab included signalling and handling faults, condition monitoring for the old and new pumping stations, plus the data processing and tooling. The most important lesson we learned? Just get going. Lots of time is spent on formalities and meetings during the initial stages but there's no way you can foresee everything when innovation is involved. Starting on a small scale means that poor estimates or mistakes don't have major consequence. You learn as you go along.

"We also discovered that you need all kinds of people if the ideas are to be put into practice. The technology is often already available, but you have to wait for approval to actually use it. Involving people in your processes, showing how your technology works in practice and letting them get used to innovations prevents this kind of decision-making from becoming the bottleneck. We made a big effort within the consortium to get those people on board. It's worthwhile in the end, because the project then progresses more quickly.

"Check regularly to see what data is useful and what isn't. Measuring the oil quality turned out not to be worthwhile at the Eefde Locks, for instance. The ambient temperature and air humidity, conversely, did provide valuable information."

"What we ought to approach differently in future is establishing what people's expectations are. They need to be expressed very explicitly, for example to encourage data sharing. It was all a bit too optional in the Eefde Locks project at first, so that not everyone was comfortable making

their data public or felt any need to do so. If the scope is thoroughly clear and everybody's interests are the same, it avoids discussions and eliminates the doubt.

"My advice to organisations that are considering taking part in a living lab is to go and look actively for new opportunities and then make your actions suit the words, because the indirect benefits of a living lab can be hugely valuable. That's what we've found."

One of the parties that saw just such an opportunity during the project was Flowserve, who supply pumping station pumps. They joined in later. Although Flowserve was already involved in condition monitoring and predictive maintenance, they weren't yet doing it for these pumps. The living lab was a wonderful opportunity for them to make a start.

Other lessons

Practical

- Make sure there is a physical space where equipment can be hung. This will also make the solution more scalable.
- Think carefully about practical aspects before starting, such as installing the cabinets. They were put together on the spot, whereas this could have been done beforehand.
- Keep the scalability of the solution in mind. The power supplies for the sensors are one good example: a location-specific solution was used this time, but Rijkswaterstaat prefers solutions that will work anywhere, for instance using solar collectors or energy from the lock itself.
- Investigate what the smartest solution is. In the Eefde Locks, the amount the chain can sway (more than 2 cm) is bigger than the standard sensor's measurement range. For the scalability, changing the configuration at the lock was not a feasible option because of the major costs that would be involved.
- Apply the experience gained during pilot studies to new projects. The understanding that the CAMINO living lab has given us about renovation is now being used in e.g. the Afsluitdijk, a bridge over the Hollands Diep and mooring posts in the port of Rotterdam.

Process

- Cooperation needs regular and proper fine-tuning. Delays occurred several times at the Eefde Locks because of miscommunication or unclear agreements. This can be prevented by being smarter about working together.
- Use all the available data sources. There are vibration sensors built into the pumping station, for instance, but this was only discovered and included in the analyses at a later date.
- Figure out how you're going to deal with the new discoveries that innovation generates. The corrosion monitoring in this living lab turned out to be so unique that there was no way of standardising the valuable aspects. Innovation here therefore has to be based on assessment criteria.
- Make the knowledge available to all. The understandings gained - in this case about setting up local SCADA systems - all too often go no further than a small number of people, whereas that knowledge in fact needs to be shared more widely in order to encourage innovation.
- Share the data with the right people. At the Eefde Locks, the lockkeeper got more information about the fault reports than the contractor did. That meant that the contractor was often unable to send the correct technician first time because they did not have the requisite information to do so.
- Write down the agreements about what action should be taken when the 'early signals' appear. At what point is the contractor allowed to act (and by what point must they take action)? What financial agreements apply here? Do you want there to be bonuses for preventing faults? If so, how is that going to work? Agreements like these are difficult to encapsulate in general contracts, but they need to be specified nevertheless.

Contents

- Check regularly to see what data is useful and what isn't. Measuring the oil quality turned out not to be worthwhile at the Eefde Locks, for instance. The ambient temperature and air humidity, conversely, did provide valuable information.
- Combining datasets can let you draw new conclusions. Heat and dampness turned out to cause degradation in the electrical cabinets. The weather details from the KNMI (Royal Dutch Meteorological Institute) could be combined with data from the electronics to discover these kinds of patterns.
- Look back at data from the past to make predictions about the future. There was a blockage in the lock on 8 October 2019 that hindsight showed was due to an incorrect relay - a defect that could be seen in the data. Making the link between the fault and the symptoms means this can be prevented in future.
- Put what you've learned from the data into practice. The sensors at the Eefde Locks give a clear picture of the lubrication cycle after the chain is replaced. This gives scope for ideas such as introducing an automatic lubrication system, which can create very significant savings.
- Use AI and neural networks for detecting patterns. It may be possible to spot faults at various places before they happen, but we may not always make that link ourselves. Artificial intelligence can identify patterns and link them to physical models to show what they signify. Discrepancies can be easier to detect that way and we can respond to them more quickly.
- Don't just look for the peaks: keep an eye on gradual changes too. There were two occasions in August 2019 when extreme wear was noted in the chains - not as peaks in the vibrations, but as a gradually increasing continuous vibration.
- Make allowances for teething problems but resolve them as quickly as possible. SCADA data was already being collected in the locks, but the new goal of using it for fault analysis showed that not all the data was being correctly tagged. That causes delays. Setting things up correctly straight away is the most efficient solution, but that may not even be an option after the event. Which is why it is crucial to get everything in order as soon as possible.

The Eefde Locks in the media

The Eefde Locks have regularly been in the news over recent years. Here's a look at the headlines.

7 November 2018

Civil engineering structure disappears under water

Rijkswaterstaat has given instructions to increase the accessibility of the Twente Canal by building a second lock. The lock will not only have a unique gate but it will also be an impressive piece of concrete engineering that will soon largely disappear below the waterline. The walls at the downstream side, which are 3 metres thick and 12 metres tall, will still be visible for you to admire, though.

Read the whole article (in Dutch) using this link:
https://www.cobouw.nl/infra/artikel/2018/11/civiel-kunstwerk-verdwijnt-onder-water-101266487

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18 December 2018

Faster and smarter innovation with open data

Six parties have been working together on Smart Maintenance in the Eefde Locks living lab for some time now. And two new parties have recently joined them. One of the agreements made at the start of this cooperative venture was that the partners would have access to all the data gathered. The aim was in fact to share that open data with the market, one of the benefits of which would be that everyone could develop new and innovative solutions more quickly and more simply.

Read the whole article (in Dutch) using this link:
https://www.worldclassmaintenance.com/twee-nieuwe-partners-voor-slimme-sluis-eefde

24 October 2019

No more 'suggested' maintenance: getting to grips with corrosion

Maintenance of ageing infrastructure works is very expensive and not workable in the longer term. Rijkswaterstaat has given nine parties an opportunity in the living lab at the Eefde Locks to switch from preventive and corrective maintenance to predictive maintenance. A key predictor is corrosion. C-Cube and KE-works are joining forces to let asset owners get to grips with existing and future corrosion. The pilot suggests that cost savings of about 40% are possible on corrosion-related maintenance.

Read the whole article (in Dutch) using this link:
https://www.worldclassmaintenance.com/geen-suggestief-onderhoud-meer

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12 December 2019

The northern side of the Eefde Locks site is taking shape

Three hundred trees and hedges are being planted to the north of the locks. Now that the trees are being put in place, the site layout is really starting to take shape. The area around the lock will shortly be a spot where people can not only play or go for a walk but also watch the boats sailing through the new lock. As well as the trees and hedgerows, the northern part of the site will also be getting an amphitheatre, a slide and a viewing point at the beginning of 2020.

Read the whole article here (in Dutch):
https://www.rijkswaterstaat.nl/nieuws/2019/12/noordelijk-terrein-sluis-eefde-krijgt-vorm.aspx

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11 February 2020

The CAMINO Toolbox helps make innovation easier

The WCM CAMINO Field Lab has now been up and running for 3 years. We accumulated a vast amount of technical knowledge during that period, but not only that: it kept teaching us things about the processes too. We have summarised that knowledge in a handy toolbox that everyone involved or coming on board can take what they need from. The goal of the toolbox is to make innovating as easy and as efficient as possible.

Read the whole article here (in Dutch):
https://www.worldclassmaintenance.com/camino-toolbox-met-gereedschappen-die-innoveren-makkelijker-maken

The CAMINO Field Lab: working towards future-proof infrastructure

The Netherlands is facing major infrastructure-related challenges. Our prosperity is increasing, the climate is changing and existing components are ageing. Those factors add up to a substantial investment and maintenance task, one that we have to be smart about tackling if the infrastructure is to be made future-proof. It's a challenge that the CAMINO Field Lab is eager to get its teeth into. The goal? Fully predictive maintenance in the infrastructure sector.

The Netherlands has over 183,000 kilometres of traffic infrastructure. Add 1.8 million kilometres of underground networks such as gas pipes, sewers and electricity to that and you can soon see: it's a lot! Maintaining that infrastructure costs an average of 2.5 billion euros a year. That makes the infrastructure sector number one in terms of size, bigger than any other sector.

Ageing assets

It's not only the Dutch population that's ageing. The majority of the infrastructure items are old or outdated too. These ageing assets need extra attention. To avoid situations where unexpected and expensive replacements or emergency repairs are needed, the CAMINO Field Lab started various pilot projects. The main aim of these projects was to move entirely to predictive maintenance. Additionally, CAMINO wants to improve the innovation arrangements within the infrastructure sector and create new - and more sustainable - earnings models.

Joining forces

The CAMINO Field Lab is all about measuring the condition of infrastructure using sensor technology and data analysis. Infrastructure asset owners for rail, road, water, the electricity grid, sewers and the gas network are joining forces with innovative SMEs and knowledge and research institutes. There are now more than eighty people working in one or more projects as part of the CAMINO Field Lab.

Just do it

CAMINO has already taught us a great deal over recent years. A fourteen-piece toolbox has been created, for instance, with ideas that help make it easier to innovate. Both new and existing parties can use the items in this toolkit for putting flesh on the bones of their own innovations. On top of that, perhaps the most crucial lesson that the parties involved have learned from CAMINO is simply to get started on implementing the ideas. Just do it!

Scaling up

The living lab at the Eefde Locks has yielded many valuable insights, of course. However, the aim is to implement smart maintenance much more widely and that will probably be quite a challenge. How are we going to scale the elements that have now been tested in small numbers up to the level of 500 assets, company-wide? Time will tell.

Join a living lab

The parties who have worked on the Eefde Locks living lab have learned a lot about smart maintenance. If you also want to be involved in infrastructure innovations, go to the website https://www.worldclassmaintenance.com for more details or contact the project manager Ruben Ogink directly via ro@worldclassmaintenance.com or on +31 (0)6-41490456.

Fewer faults and lower costs through Vitale Assets

Infrastructure maintenance is crucially important. It makes sure that our bridges, tunnels and locks remain safe and functional. It does cost a lot of money, though. To make infrastructure maintenance more efficient, Rijkswaterstaat created the Vitale Assets programme, which is targeting fewer faults, higher availability and lower costs.

Maintenance work has a narrow window: doing it too soon is a waste of money, but doing it too later - repairing what's already failed - means unnecessarily high costs. Predictive maintenance is therefore the key to success for Vitale Assets.

Gathering and analysing data

Predictive maintenance demands a new way of working. Gathering and analysing measurement data for key mechanical and electrical items makes it possible to predict the failure of a component. Instead of regular inspections of objects and maintenance on them, the data means that action is only required when a component genuinely needs replacing.

Accurate predictions

Vitale Assets is yielding benefits in various fields, as it is not only making the maintenance more efficient but also extending the lifespans of critical elements. On top of that, we are getting a better picture of how the assets are being used, which means that we are accumulating valuable knowledge about how components behave in the longer term. This lets us predict the maintenance increasingly accurately.

Fewer faults, lower costs

The initiative for Vitale Assets was taken by Gilbert Westdorp, a senior consultant at Rijkswaterstaat. Together with the data scientist Martijn Koole and programme manager Angelien van Boxtel, he wants to achieve the following:

1. Minimising the risk of unplanned failures of mechanical and electrical components
2. Determining the optimum moment for conservation measures

The results being targeted by this are fewer faults, higher availability and lower costs. Because maintenance can be postponed until shortly before failure, components have longer lifespans and the labour required is less as well. Additionally, the maintenance can be planned at moments when people will be affected by it as little as possible.

Working more efficiently

A great deal has been learned after working in the living lab for three years.
"It often used to be difficult to work out what was causing a fault," says Gilbert. "First of all, someone had to get out there to inspect the component; only then could the technician start the repairs. Using sensors means it's all much easier now. Components are monitored continuously, which lets us see a fault coming sooner. On top of that, we know what we've got to look out for and problems can be resolved more quickly. That saves on the costs."

The new normal

Gilbert hopes that smart maintenance will become the new normal in the future.
"Sensors mean that we can now follow what is happening to our assets. That alone is a major step forwards. Our aim is to learn what makes components break down in each of our assets and how we can predict the failures. That will let us schedule infrastructure maintenance in the Netherlands more intelligently, so that we can reduce the interference it causes and reduce the costs."

Inventive ideas about maintenance at the WCM Summer School

Fifty-two students, professors from seven Dutch universities and an interesting case study about the Eefde lock complex: smart maintenance innovations were what it was all about when the WCM Summer School was held for the eighth time. The participants were split into teams to tackle the question of how Rijkswaterstaat and the asset owners could improve the maintenance of the locks.

Before the WCM Summer School started, Rijkswaterstaat drew up a case study that could be presented to the students.
"We decided pretty quickly to focus our question specifically on the maintenance of the pumps," says Angelien van Boxtel, the programme manager at Rijkswaterstaat. "How could we apply smart maintenance innovations to the maintenance processes here? We were keen on getting the students to think about how we could improve the maintenance performance."

Theory and practice

A week before the Summer School started, the students were given detailed information about the locks, the current processes and the innovations that had been studied. After a visit to the locks and various workshops about the theory of predictive maintenance, they were able to get down to brass tacks with Rijkswaterstaat's practical case.

Reliability first

At the end of the Summer School, Team Two was chosen as the winner. Their solution? Reliability first, maintenance second. The reliability of the pumping station at the locks is even more important than the actual maintenance. The ideas the team came up with included the following:

- Improve the contracts with the maintenance contractors and agree a scheme of condition-based bonuses and penalties with them
- Monitor the locks using a traffic light system that represents the current status
- Fit sensors to vessels that regularly sail the same route so that e.g. the status of the quays can be monitored

Team Two (which contained members from Heineken, Tata Steel, the armed forces, TU Denmark, Croonwolter&dros and SPIE) also proposed an integrated approach that Rijkswaterstaat could also use for other assets.
"This team understood the case well and came up with a lot of good ideas," says Angeline. "Reliability first suits us well, because we're always in the public eye. The idea of a sensor ship is nice because it saves us the expense of having to hire boats specially for the purpose."

Refreshing

Looking back on the day, Nienke Bagchus, the director of Rijkswaterstaat, says, "It was like speed-dating on the market. There were ideas with original angles. And one team also included the user in its narrative, which I thought was refreshing."
"All the teams paid attention to the human side of the story," adds Paul van Kempen of World Class Maintenance. "The need for change management to be part of the approach was clear too. We're looking forward to getting down to work with the solutions they thought up."

Sharing ideas

The first steps for moving ahead with the ideas from the Summer School have now been taken.
"We discussed all the participants' ideas at the two-monthly Communities of Practice at Rijkswaterstaat," says Angelien. "Although we don't yet know what pace we'll be introducing them at, we're definitely going to be taking them further. So the input from the students was really useful for us."

Work on the new lock

“The question isn’t if we’re going to do it, but when”

How are we going to use smart maintenance for Dutch infrastructure? That’s a question that we don’t yet have a definite answer for. What we do know, though, is that smart maintenance is the future. So the question isn’t if we’re going to do it, but when. And as far as we’re concerned, it’s a case of the sooner, the better.

The Netherlands is facing a major challenge in terms of infrastructural renovation. We already know that there will be a peak in the maintenance that is needed in a few years’ time. It’s a peak that we simply don’t have the capacity to cope with. It will of course be possible to postpone some of the activities so that the peak is spread out more, but that’s not a definitive solution. The key to future-proof infrastructure is smart maintenance.

Smarter working

Smarter working will let us limit the effort needed to find the cause of a defect, so we’ll need less manpower and we’ll save money. Investment is needed to achieve this, of course, but it will pay for itself in time. Smart maintenance could save 600 million euros for infrastructure in the Netherlands over the next seven years.

Does that sound too good to be true? Not at all. Just think how much it costs to close a tunnel off to traffic because emergency repairs are needed. Or consider how many people are needed for carrying out maintenance on a bridge - work that may not even have been needed.

The power of predictability

Smart maintenance makes these activities predictable. That also means that we can carry them out at moments that suit us. Or postpone them if the data shows that all the elements are still functioning properly. Setting up the maintenance work more intelligently means we can work more efficiently and save on the costs.

Extra benefits

And that’s not all. Energy monitoring helps make the components more economical, letting the infrastructure take a useful step towards becoming greener. Research into smart maintenance is creating more job opportunities. The Netherlands can even become a role model for other countries in this. On top of that, it makes our work safer and less stressful because you can see potential defects coming.

“Smart maintenance is a big challenge but it’s one that we’re ready to tackle.”

Dinant Schippers
Asset management consultant at Rijkswaterstaat

Rijkswaterstaat
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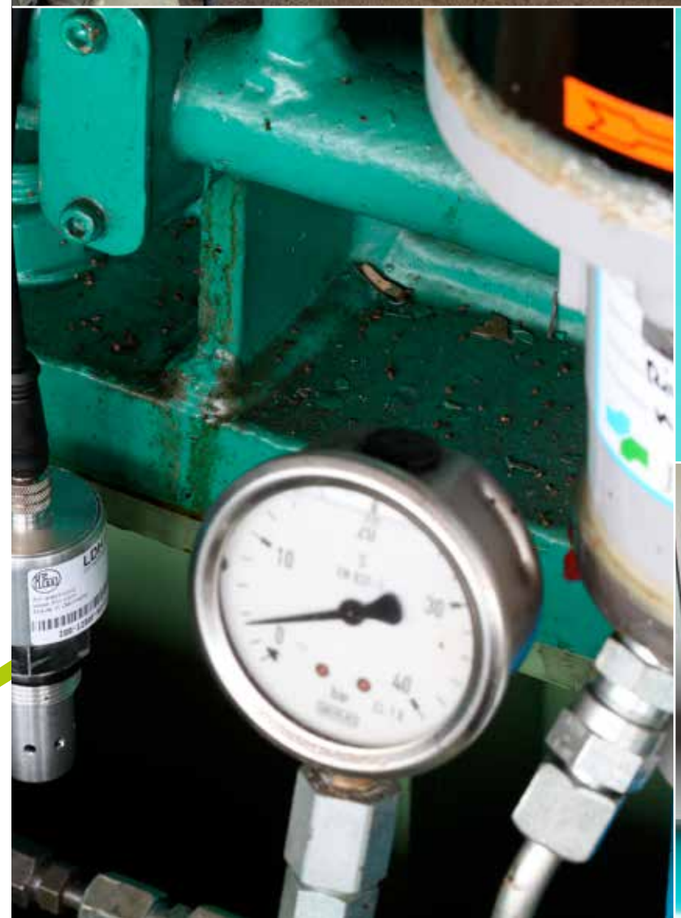

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