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INTERVIEW

HOW TO MAKE STEEL TRUSSES TALK

Can 30,000 assets be connected for condition-based maintenance? A conversation with Bengt Hergart, Property Director of Øresund Bridge, about smart devices that link two states.

Yes, there is a kind of magic in concrete. For example, at this moment when the sunlight falls from an overcast sky onto the pylons of the Øresund Bridge and is reflected in the sea below. Or when heavy rain clouds envelop the gigantic structure, unique natural spectacles are guaranteed for travellers between Denmark and Sweden.

However, for the maintenance and safety management of the world's longest cable-stayed bridge for combined road and rail traffic, all weather conditions, the salt water and the traffic primarily represent potential risks. A special IoT solution ensures efficient and fast maintenance.

> “Our strategy is to transform from a calendar-based to condition-based maintenance.”

DIALOG: Mr Hergart, Øresund Bridge is more than just a bridge – the entire facility includes roads, rails, a tunnel, toll stations and even an artificial island. That probably requires logistical masterpieces from your maintenance team?

BH: In general, we want to avoid the situation where employees are constantly on the road and have to react spontaneously to damage reports. Intelligent planning is much more important to us because it creates more efficient maintenance processes, not only in terms of logistics. The key to this is a data-based maintenance strategy, but this is much more difficult to design and to transfer to operational use as in other public facilities or industrial buildings.

We come from a position where most of the maintenance activities are based on calendar. You check, repair or do something else once a month, once a quarter, once a year

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– but you can't be sure that the maintenance activity does follow that frequency. So, it's better to understand the actual condition on the bridge and the components of the bridge.

Therefore, our strategy is to transform from a calendar-based to a condition-based maintenance. Of course, we have a lot of condition-based maintenance already today. But most of the conditions are still stated by a human: someone goes side by side with a railroad track, inspecting and maybe starting maintenance activity.

Our target for the whole piece of property is to change such processes step by step to condition-based maintenance. In this context, deploying resources at the right time is as crucial as a constant uptime of the assets.

DIALOG: Since there is no reference project anywhere in the world, this seems to be a particularly demanding task. What are the main challenges and what is your technological approach to solving them?

BH: Essentially, it is about getting a grip on spatial distances and hurdles when using measuring tools. Consider the dimensions we are talking about: along the 16 kilometres of the entire plant there are numerous maintenance facilities, measuring stations and sensors, which are operated and provided by different suppliers. Out of, in total 30,000 assets, we are talking about over 20,000 connected assets that provide over 220,000 signals with information twice a second.

Those equipment data are delivered via a PLC interface, which are part of a SCADA system. The exciting question from our point of view was: could the system be trained to 'learn' the normal behaviour of each asset so that it is enabled to predict need of maintenance or suggest corrections in control parameters for the equipment by itself?

That is exactly what we have achieved with a machine learning solution. We evaluate detailed real-time data right where it is collected, and even more. After learning the normal behaviour, deviations, e.g. drift or anomalies in the railway network or other infrastructural parts, can be detected by a algorithm that informs the SCADA system, which in turn generates appropriate work orders.

DIALOG: How should one imagine this networking and which starting points were crucial for condition-based maintenance?

BH: We have many devices on the bridge that are already connected to the network. They give us a lot of information about weather conditions, signal errors etc. But this is not the whole picture of the bridge. There are still parts that could but doesn't "talk" to us now: concrete, steel, bridge bearings, expansion joints, cable system and so on. So, we had to decide, where to start this kind of conversation. One option was to start with concrete and bridge bearings. In this case, we first would have to equip them with sensors. The sensors must talk to us – that requires that we have to have some kind of fiber or wireless connection to them. By planning that it was important to map the connected devices that are already existing.

One crucial point was to understand that from the condition-based perspective. For example, if we measure in some areas, that the temperature and pressure are above or below the normal level – could that be a trigger for maintenance activities as well? In general, this was a very import breakthrough in our project: to recognize, that measuring and comparing the parameters in the surrounding of a component could be more effective than upgrading the component with a new IoT-device.

DIALOG: Please give us an example.

BH: We use dehumidifiers to lower the percentage of humidity

“Measuring parameters in the surrounding of a component could be more effective than connecting the component with a new device.”

in the steel truss. That's the reason why it's there, to keep the humidity below 40 percent. If it goes above 60, you'll get corrosion. If the humidity level of a devices suddenly goes up, it could be okay because it's raining outside. So, it goes up momentarily and then goes down. But imagine we might have seven different dehumidifiers, six of them shows one level of humidification and the seventh shows the higher level. Now, without measuring internal parameters in the dehumidifier, you can see the performance of this equipment is poorer than the six colleagues of it. And that's bad news, now we have to look at this piece of equipment, and maybe it’s an indicator for corrosion in the steel truss.

DIALOG: What are the next steps? Could you make the system even more precisely?

BH: It's not beneficial for us to have a more precisely algorithm, that is expensive to scale to the whole property. By the way, this is the big difference to other Industry 4.0 use cases in predictive maintenance. Mostly every downtime for minutes or hours in the industry is a disaster. This scenario is not on our agenda, we have extremely few errors. The passage was closed ten hours last year and most out of those ten hours, this was wind and accidents on the road. And there might have been 30 minutes technical error. So, we have not a very good business case to reduce down-time. Could we improve its availability? Of course, we could. But going here from 30 to 15 minutes is not valuable. Instead, our business case is to reach more cost-effective maintenance.

And yes, there’s still one unsolved question: how could we state the condition of an area or component if the equipment there it's not running? Many important parts of our equipment like the jet fans in the tunnel are only running in course of emergency, so it’s not possible to integrate them in a condition-based, real-time monitoring. Unfortunately, this is a huge difference to other maintenance scenarios like power plants, where things are always up and running and its condition can be monitored. But I am optimistic that this can also be solved.

“Downtime is not a worst-case scenario for us.”


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Bengt Hergart, Property Director of Øresund Bridge

Field of Application: Construction

Challenge: Maintenance on the world's longest cable-stayed bridge for combined road and rail traffic causes very high efforts, as personnel is usually not on site and access to equipment requires much time and interferes with operations of the infrastructure

Solution: Delivering of sensor and actuator data via a PLC interface to IoT-gateways, which are part of a SCADA system that enables the operator to a condition-based maintenance