Drone potentiale ved drift og vedligehold af store brokonstruktioner, samt anvendelse af kunstig intelligens til skadesregistrering

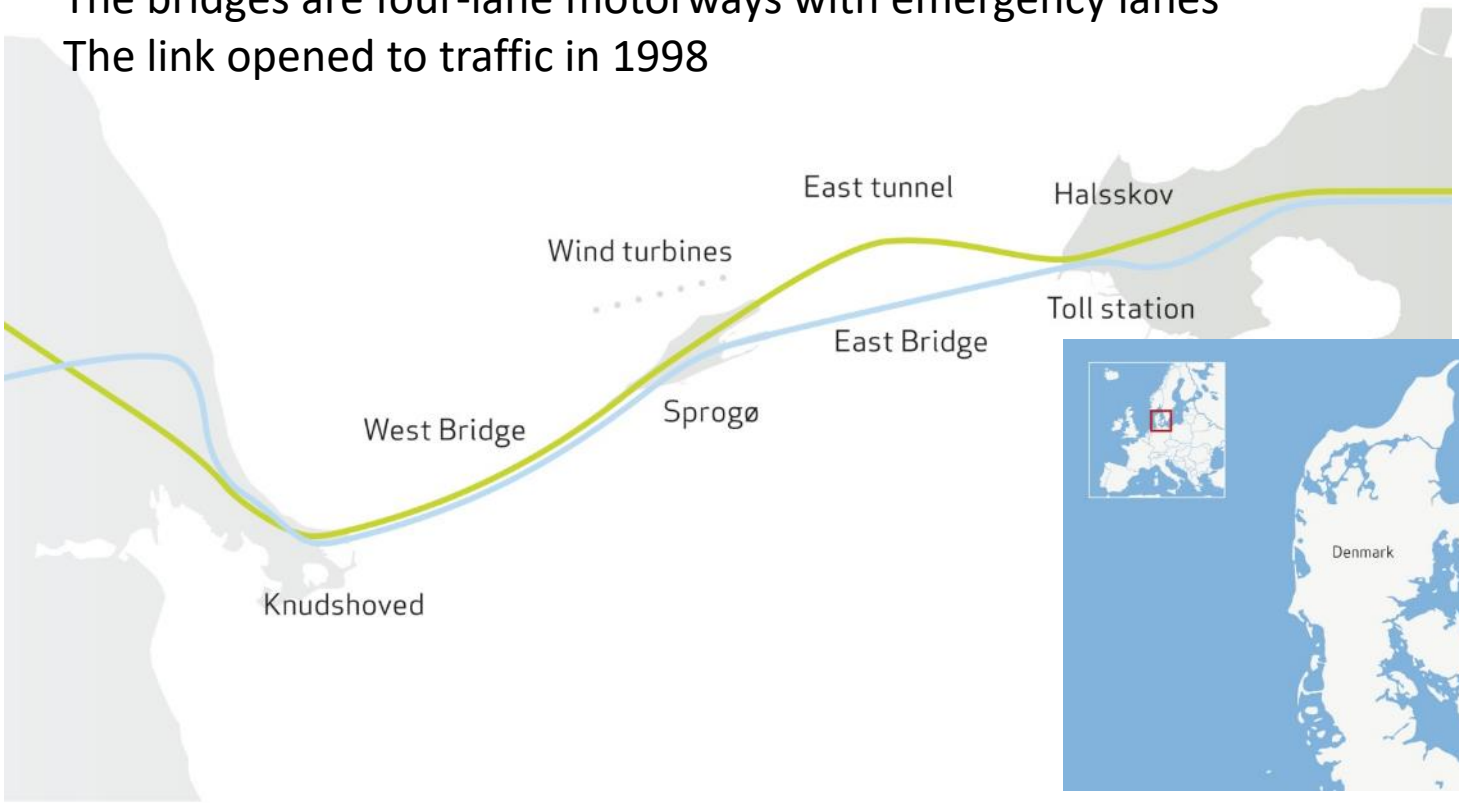
Storebælt
Sund≋Bælt

DANVAK dagen 2019

Finn Bormlund

The Storebælt Link

East Bridge, 6.8 km
West Bridge, 6.6 km
Sprogø, 3 km
The bridges are four-lane motorways with emergency lanes
The link opened to traffic in 1998



The Storebælt Link

The Storebælt Link

The Storebaelt Link

Inauguration:

Railway June 1997

Motorway June 1998

Average daily traffic (2018): 35.000
Record: 52,938 (August 12, 2018)
10 lanes eastbound
12 lanes westbound
Toll cars: 38 USD
Toll lorries (Length >10 m): 152 USD

Approach Bridge platform

West Bridge Platform

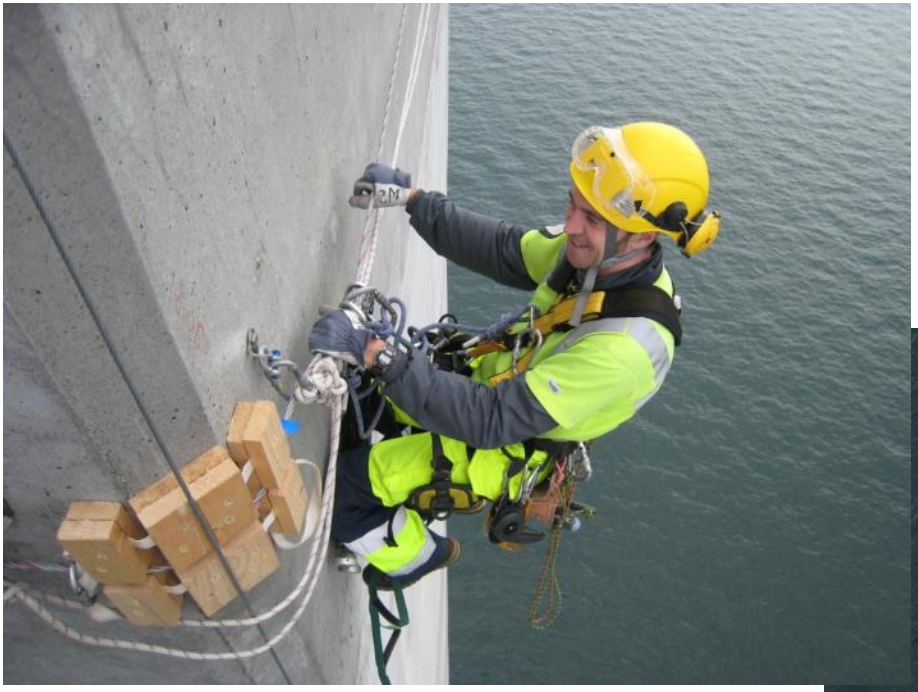
Cable inspection platform

Sky climber platform at pylon

Sky climber platform at pylon

Abseiling

Abseiling

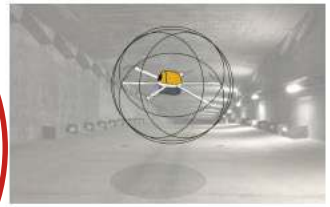


Roadmap project

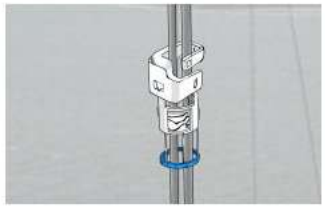
- Yearly operational and maintenance cost is more than 60 mio. USD.
- Our goal is a 2 % savings on maintenance cost every year
- Road map project together with Blue Ocean Robotics

Roadmap project

RPA 1
Outdoor Inspection Drone



RPA 2
Indoor Inspection Drone

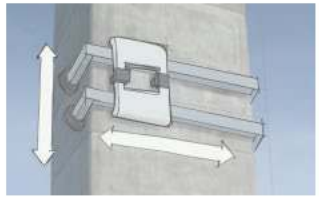


RPA 3
Cable Climbing Robot

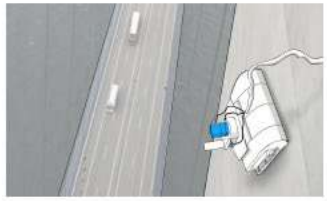
RPA 4
Mobile Inspection Robot

RPA 5
Tunnel and Railway Inspection Robot

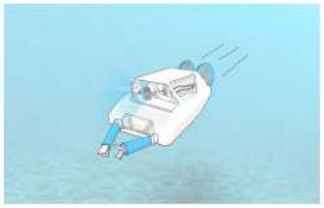
RPA 6
Steel Surface Inspection and Treatment Robot



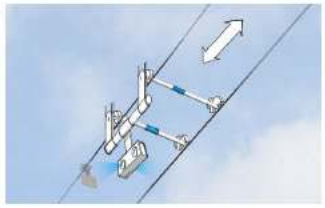
RPA 7
Concrete Surface Inspection and Treatment Robot



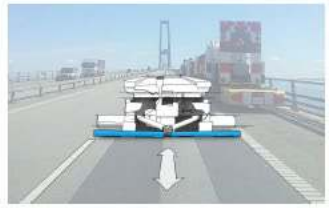
RPA 8
Surface Treatment Suction Robot



RPA 9
Underwater Inspection Drone



RPA 10
Train Overhead Cable Inspection Robot



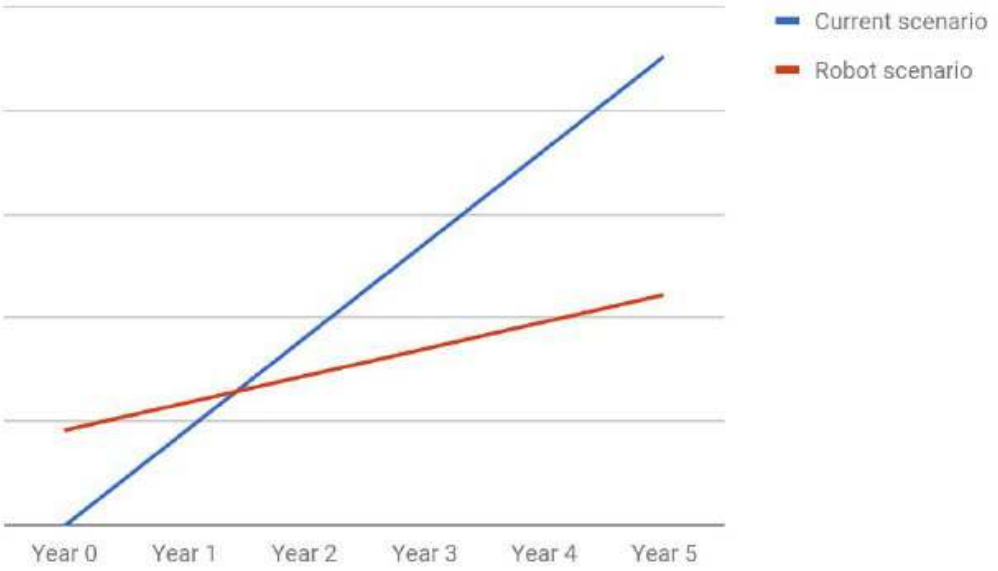
RPA 11
Road Inspection Robot

RPA 1 - Outdoor Inspection Drone

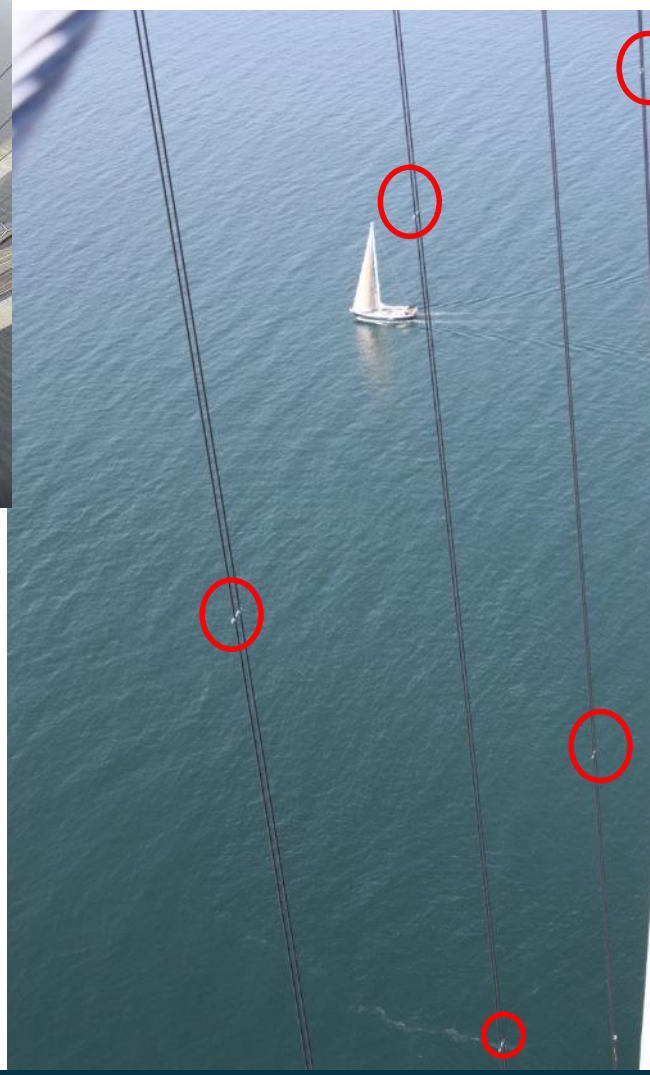
Conclusion

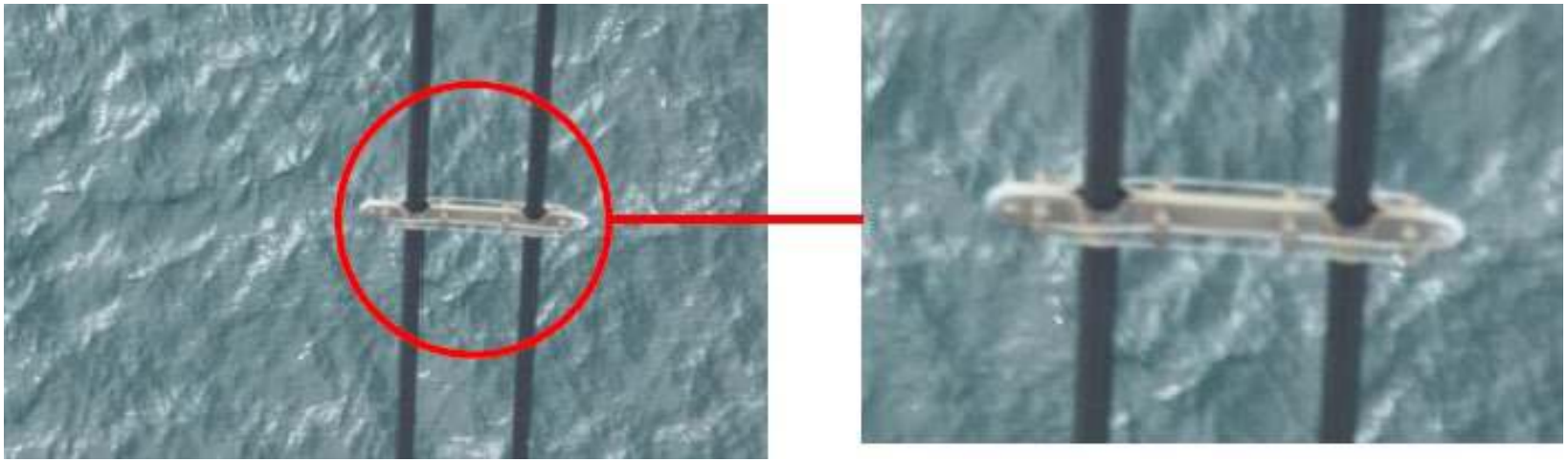
Based on the available data and input provided by Sund & Bælt, the business case for **RPA 1** indicates a **very good** potential, with an **initial investment** of **920,000 DKK** and a **payback time** of **1.43 years** when considering the main business case drivers. This is a significant potential, especially as the unaddressed business case parameters and socio-economic factors would improve the business case even more.

Link for business case data and estimations.



Inspection of separators and clamps





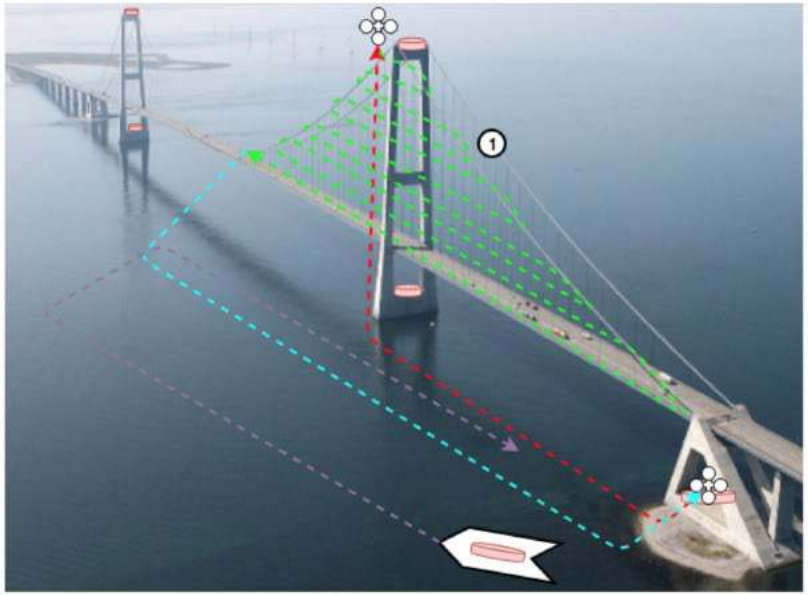
Phantom 4 Pro

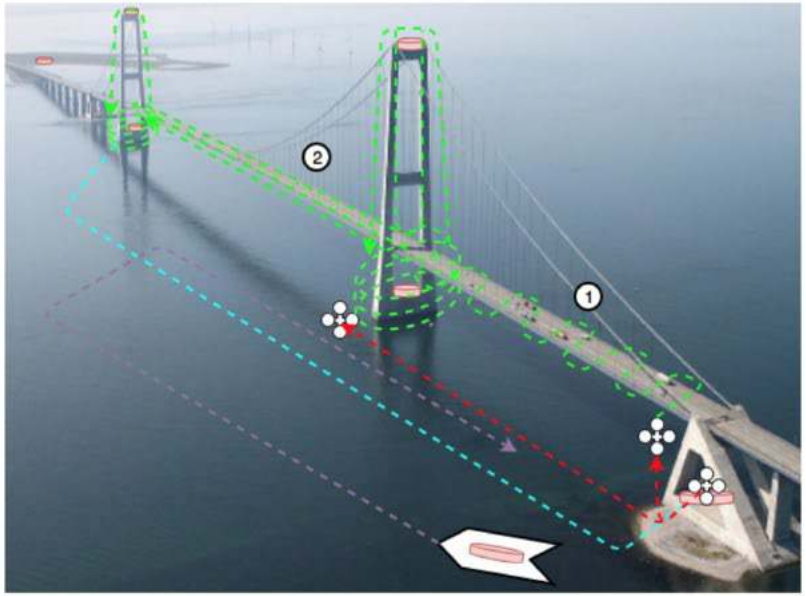
- First Anchor block completed using standard DJI Phantom 4 Pro
- Unable to look up and low GPS accuracy (1-2 meters)

Matrice 210 RTK, ver 2

- Option to mount camera on top and look up underneath the bridge
- better GPS positional accuracy through RTK (15-20 cm)

Semi/full automatic drone flight navigation

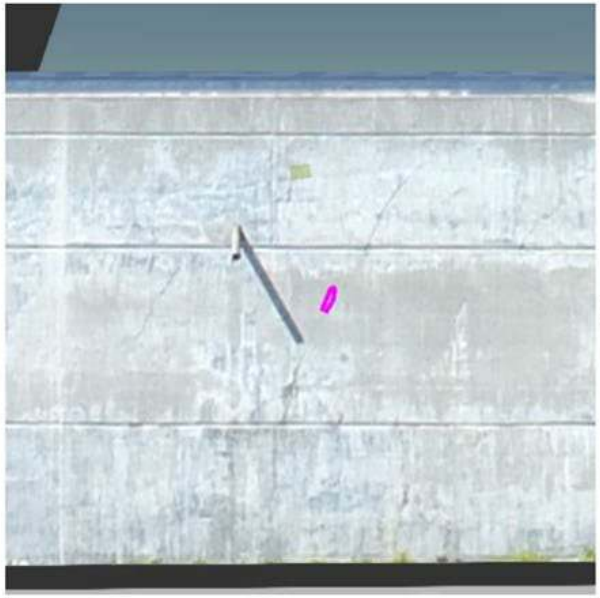




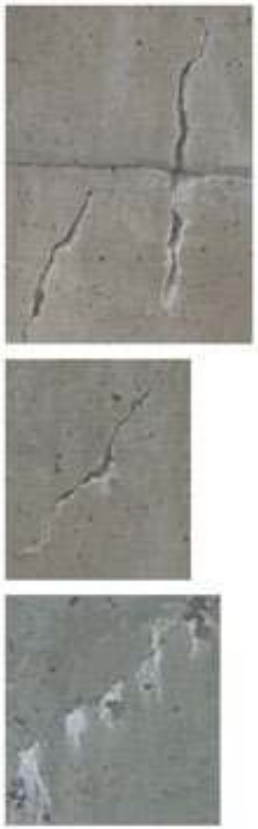
Drone inspection of the anchorage

Video showing the system

Observation #14

Inspector	SAJN	Detailed view from Image	Overview from 3D Model	Comment
Defect	Afskalning\x2fdelaminering - Spalling\x2fdelamination			Afskal ved revne, måske pga. bevægelse.
Lenght (m)	1.082			
Area (m2)	0.0465			
Rating	3A			

Group of damages



Cracks

Rust

Algae

Conclusion:

New approach using UAV (Unmanned aerial vehicles) for data sampling and virtual inspection tool to inspect structures has shown its potential by:

- Reducing man hours spent in the field
- Reducing costs for expensive access equipment
- Reducing traffic interruption
- Applicable for many different kinds of structures

Data based automated integrated systems are the future leap at Sund & Baelt but it will never be a complete substitute for good, professional engineering knowledge. Even the best trend prediction systems do not supersede our civil engineers. We still need manual inspections on a regular basis.