Facilitating maintenance of existing bridges through Digital Twins

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Purpose of the project

Bridge Management System using digital models and Digital Twins

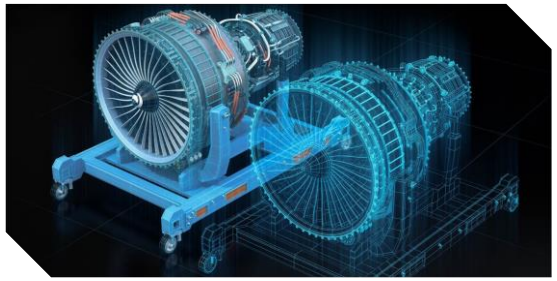
Bridges: current inspection and management

Time-consuming

Even inaccurate

Technology constantly advancing

Digital Twins: common platform to these technologies, so they can interact and be used to their optimal performance.



Other industries: significantly advanced

Construction industry: still many gaps and room for improvement

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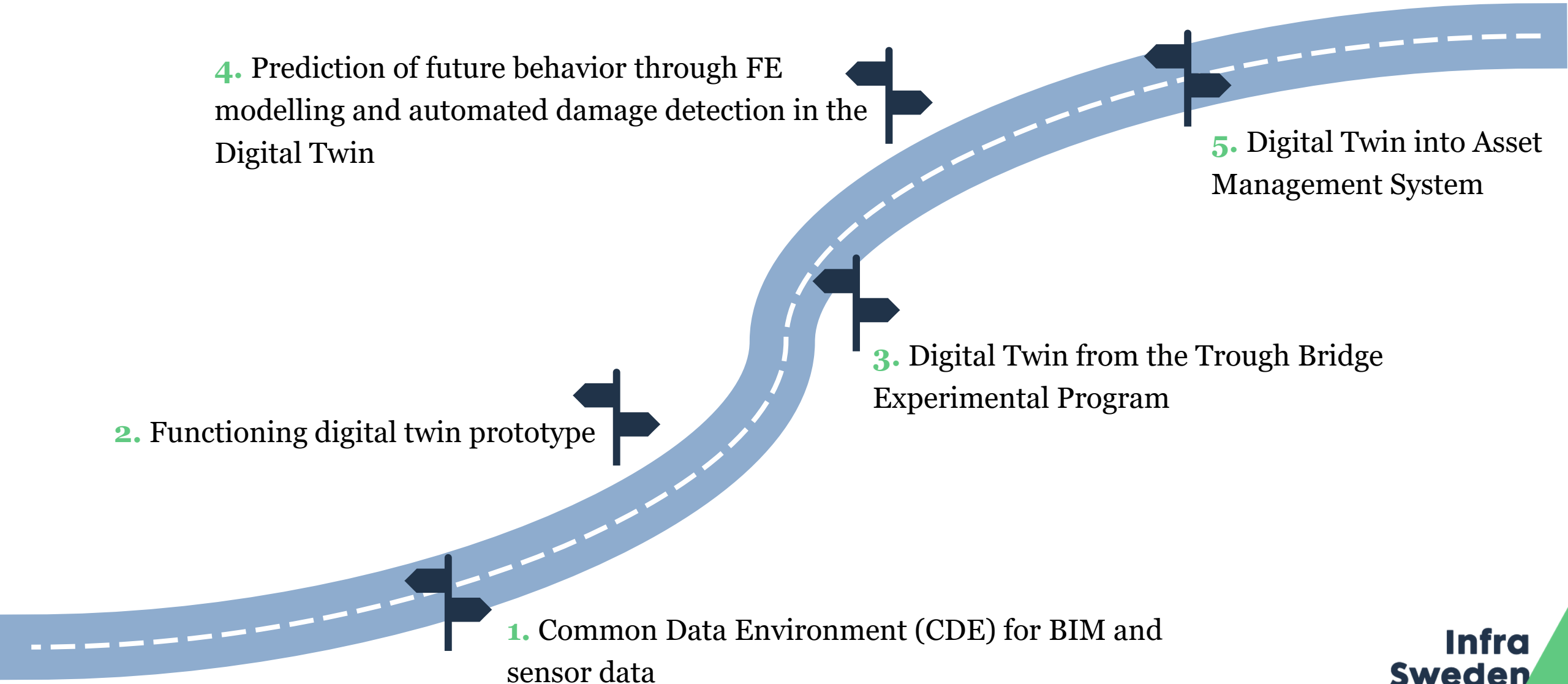
Goals of the project



1. Common Data Environment (CDE) for BIM and sensor data

2. Functioning digital twin prototype

3. Digital Twin from the Trough Bridge Experimental Program

4. Prediction of future behavior through FE modelling and automated damage detection in the Digital Twin

5. Digital Twin into Asset Management System

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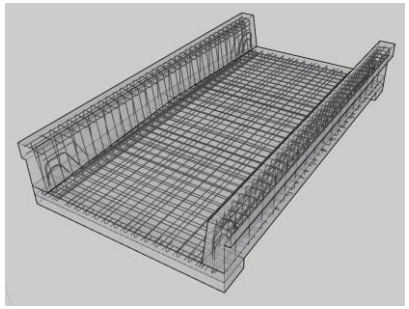
Project results

Technology Readiness Levels (TRL):

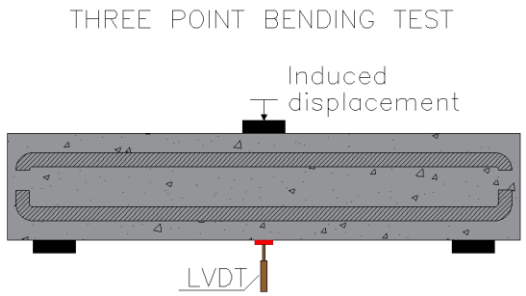
1. **Initial research:** basic principles are observed and reported, scientific research begins to be translated into applied research and development (R&D).
2. **Formulation of concept and applications:** practical applications are defined, but still speculative, without experimental proof.

Literature review and methodology

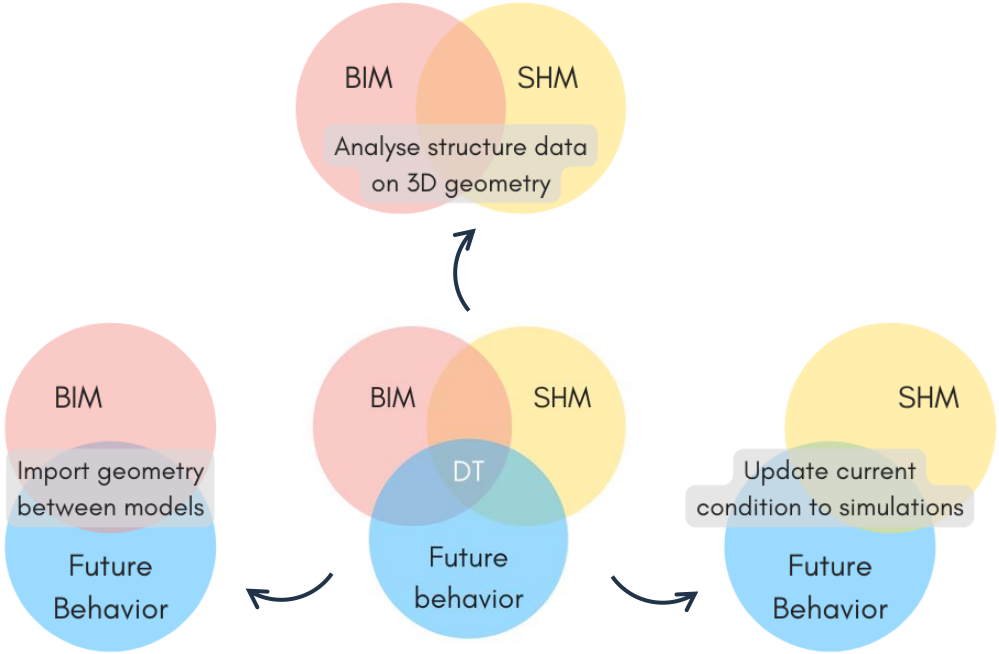
Design of experiments and definition of CDE: Sensor data for the Digital Twin



Trough Bridges experimental program



Pilot study



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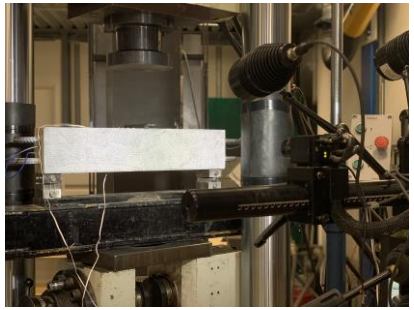
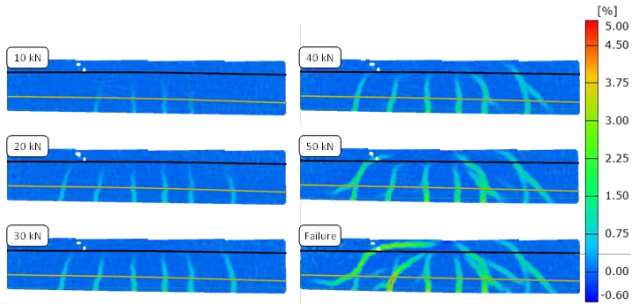
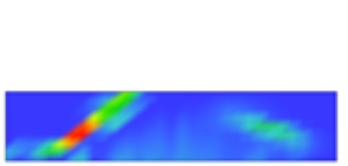
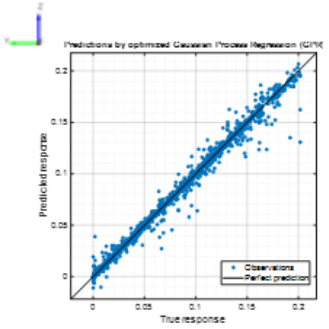
Laboratory studies: fiber optic sensors and digital image correlation

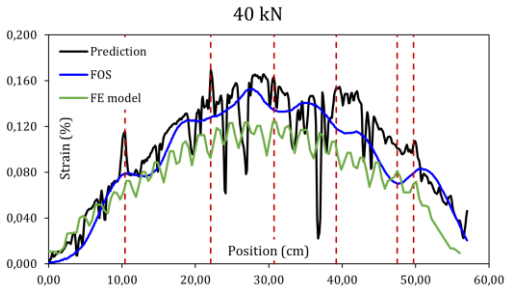




Analytical predictions: Finite Element and Machine Learning models







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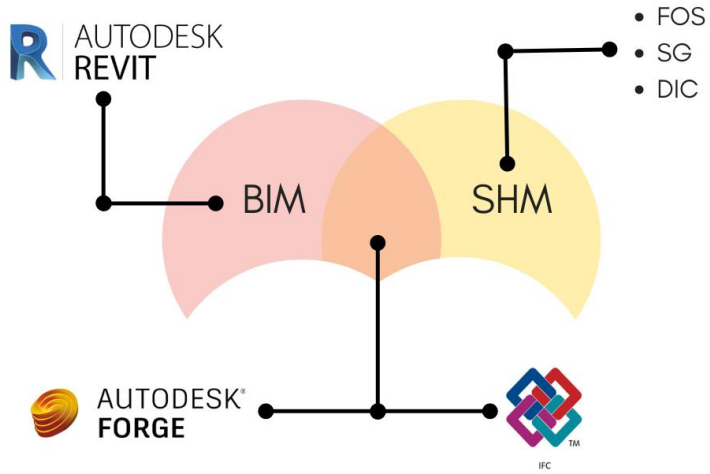
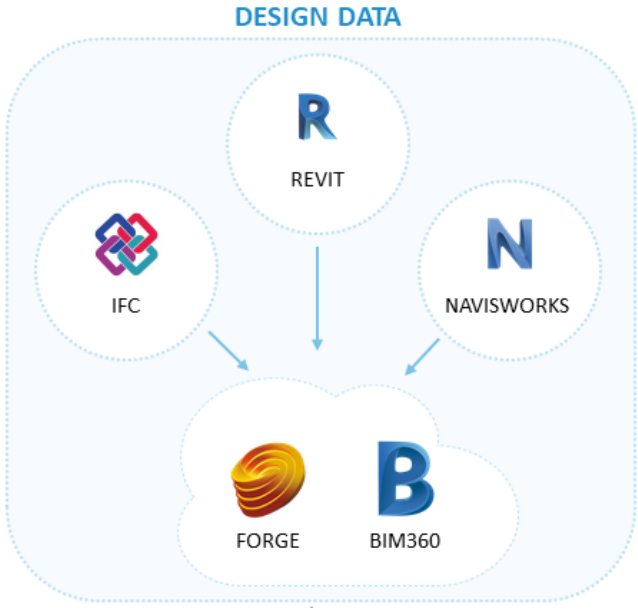
Project results

Common Data Environment: webapp created in local server using Autodesk Forge and JavaScript





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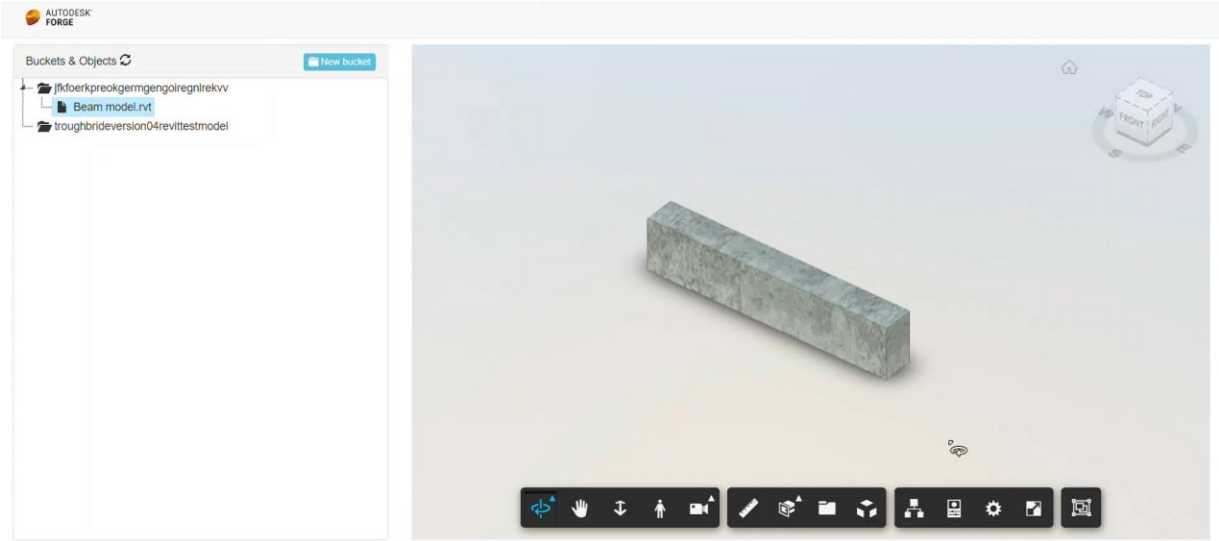
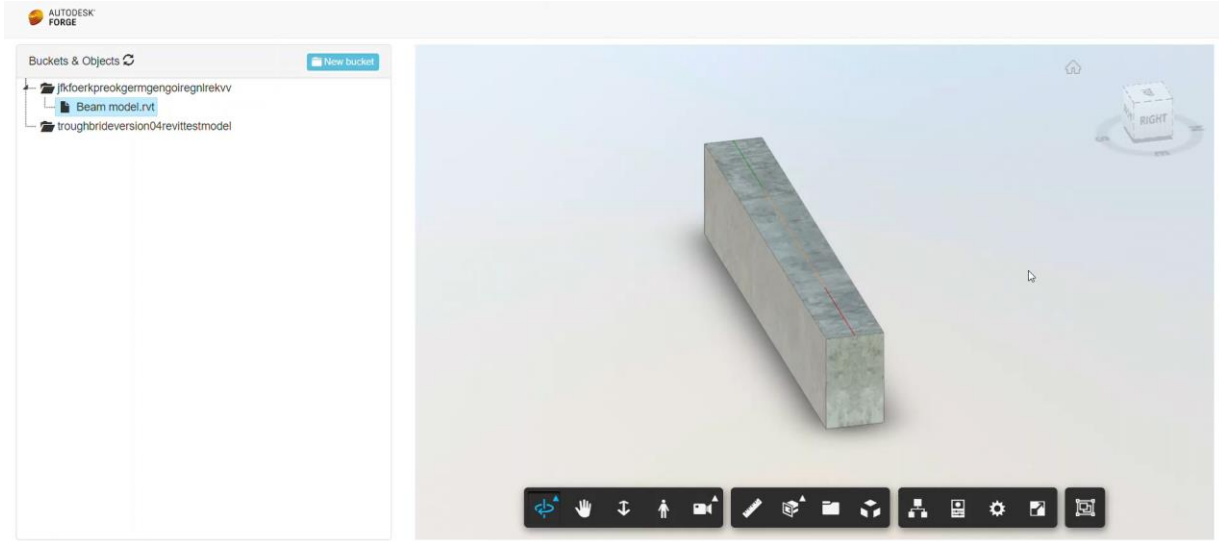
Project results

Common Data Environment: BIM model in webapp created in local server using Autodesk Forge and JavaScript

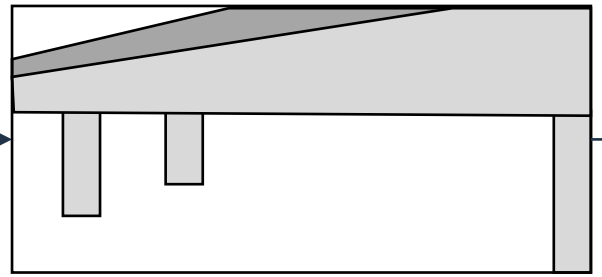




Project results

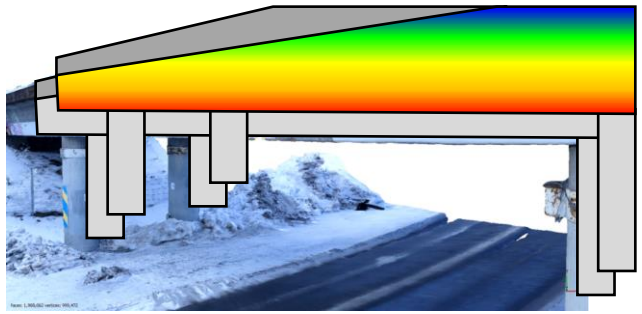
For existing structures:
Development of point cloud scanning practices and following steps:

Photogrammetry scanning:
Point cloud 3D model of exterior

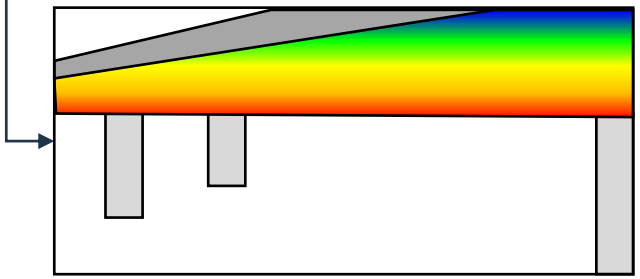


BIM model

Non-Destructive Testing:
Complement 3D model



Layers
in the DT



Structural analysis model: FE
Updated with current condition information

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Project results

Development of point cloud scanning practices:

Upcoming steps

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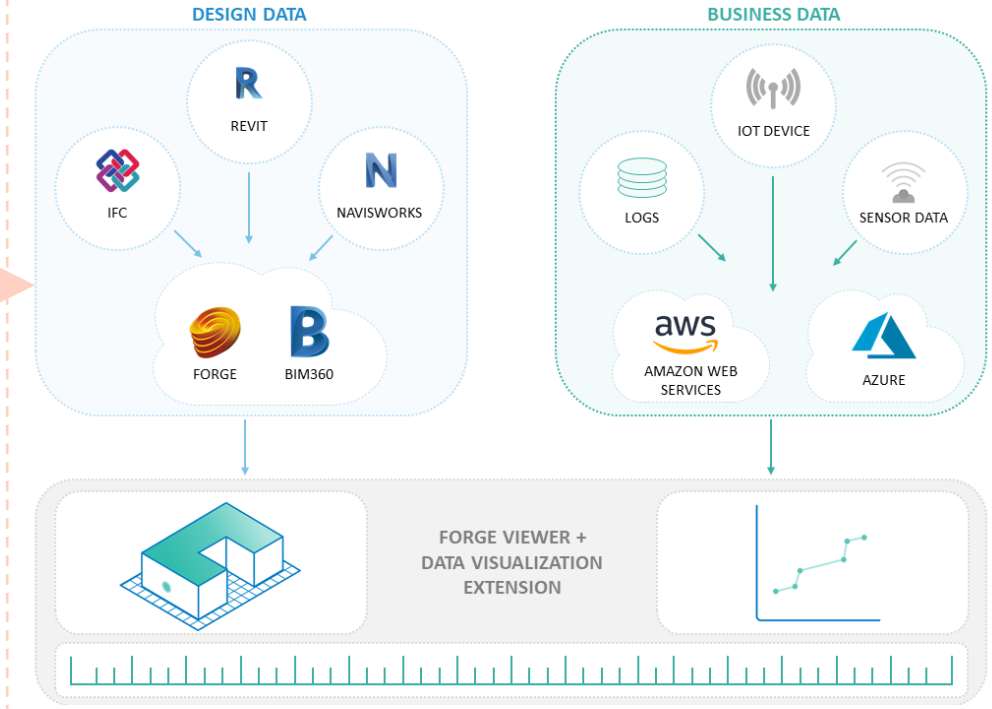
4. **Experimental pilot:** validation in laboratory, potential system applications consistent with eventual system requirements, but still relatively low-fidelity.

Data Visualization Extension added to the webapp: sensor data from the beam experiment connected to the BIM model.



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Upcoming steps

Example of Data Visualization Extension in webapp: sensor data visualized in an interactive BIM model

https://hyperion.autodesk.io/

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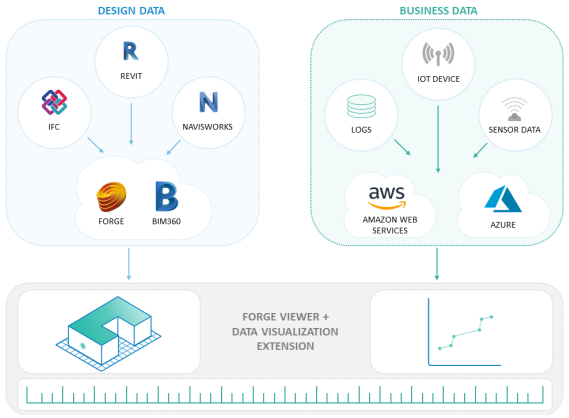
5. **Demonstration pilot:** the fidelity of the tested component increases significantly, the total applications are tested in a simulated or somewhat realistic environment.

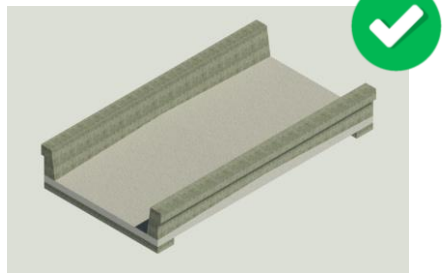
"Trough Bridges" test data in the webapp



"Trough Bridges":

Instrumented

Cast



BIM model

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Upcoming steps

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6. **Prototype:** demonstration of an actual system application, or a similar one using th same technologies.
7. **Field test:** system prototype demonstration in its environment.
8. **System qualified:** system completed and qualified through test and demonstration – this is the end level of true system development for most technology elements.
9. **Implementation:** system proven through successful operations, end of last fixes to address problems found following operation, system ready for commercialization.

Additional aspects of asset management included in the Digital Twin

DT system prototype demonstrated in a case study

Asset management system through BIM and digital twins completed and qualified

DT system improves to be implemented or commercialized for real structures

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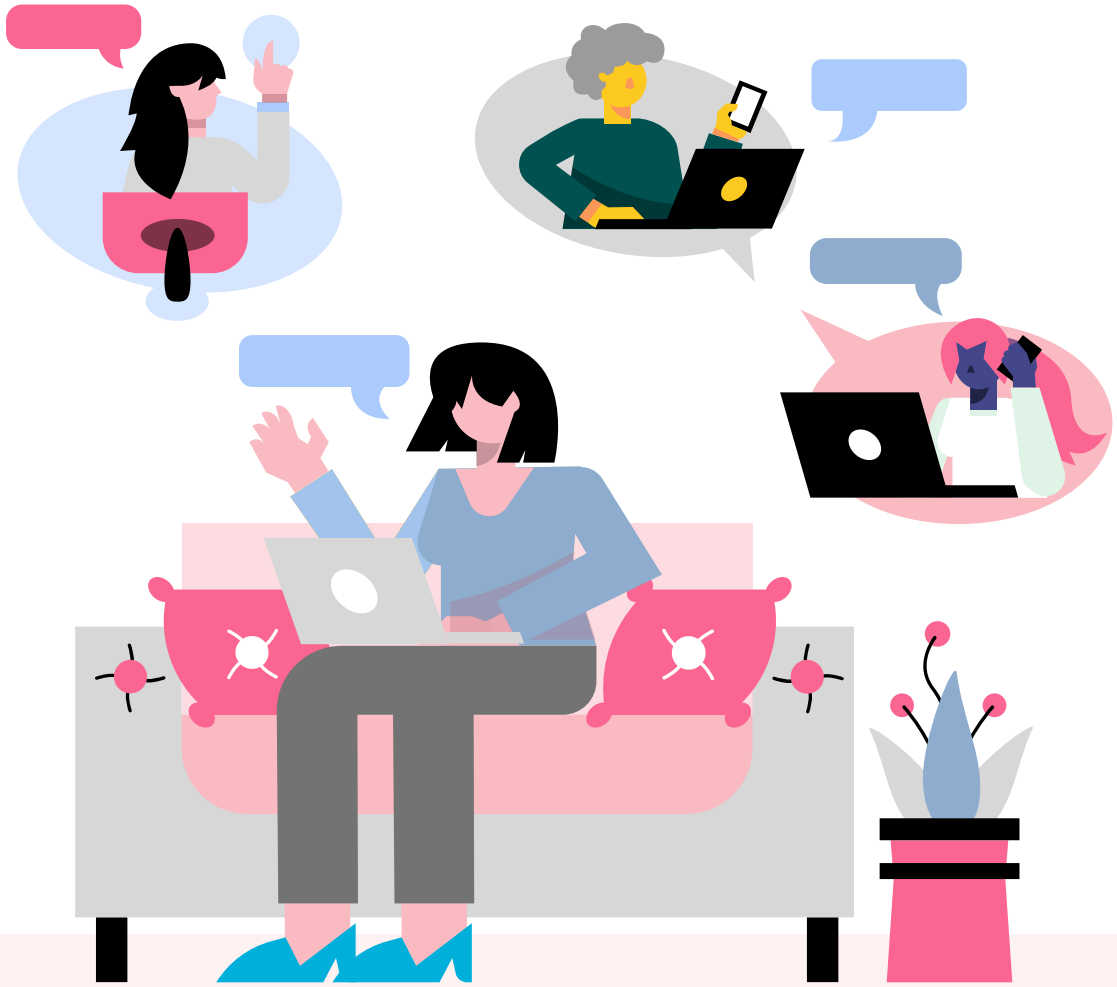
Questions?



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Discussion:

- How can existing BMS adapt to the technology?
- What is the contribution to a sustainable environment and society?
- What is the potential benefit of the innovation, i.e. the BMS?
- Which parties would be involved in the operation of the final product? TRAFIKVERKET SKANSKA
- What feels most difficult right now?
- What measures are required disseminate results and reach a broader market?

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