

How can sensors be used in a data-driven decision support system for bridge maintenance?

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The probability of a bridge to fail increases over time until it is no longer considered safe for use. Maintenance of a bridge is typically carried out when something goes wrong or according to a preventative maintenance schedule based on expert knowledge, neither approach making the best use of limited maintenance resources. Sensor data can provide useful real-time information without the delay or cost of a manual maintenance check. How sensors can be used in a data-driven decision support system for bridge maintenance is the topic of this research. In particular we will focus on bridge 705 in Amsterdam for which sensor data corresponding to known loads has been collected, and a 3D finite element model is available. We will build a model to estimate from sensor data if damage to the bridge has occurred and will investigate what types of sensors and what sensor placement is optimal for estimating different types of damage. A finite element model will be used to generate synthetic data in order to address the cold start problem. Due to the safety requirements of any bridge it is necessary to quantify the uncertainty we have in our damage estimates. Once the capabilities and limitations of the model in determining damage are understood, we will suggest a decision support system for policy makers which includes the model and present a cost-benefit analysis thereof. Finally (stretch-goal) we will investigate how such a system can be generalized to bridges other than bridge 705.

Date	WP	Rate	WW	Goal/Note (WP = weeks passed, WW = weeks worked)
Apr 1	1	0.5	0.5	Reading
Apr 8	2	0.5	1.0	Research question formulated
Apr 15	3	0	1.0	Time off (catching up on work)
Apr 22	4	0.5	1.5	First draft of abstract and timeline
Apr 29	5	0.5	2.0	Investigated bridge damage types and small scale FE model
May 6	6	0.5	2.5	Project presented to TNO staff
May 13	7	0	2.5	Birthday and father visit
May 20	8	0	2.5	Exam
May 27	9	0.5	3.0	Generated synthetic data under normal conditions
Jun 3	10	1	4.0	Completed literature review
Jun 10	11	0.5	4.5	Mother visit
Jun 17	12	1	5.5	Verified synthetic data against sensor measurements
Jun 24	13	1	6.5	Determined sensors containing explanatory information per damage type
Jul 14	16	1	9.5	Determined optimal sensor placement for bridge 705
Jul 21	17	0	9.5	Time off
Jul 28	18	0	9.5	Time off and move closer to the office
Aug 19	21	1	12.5	Calculated damage to bridge 705 with a data-driven model
Sep 2	23	1	14.5	Calculated damage to bridge 705 with a finite element model
Sep 9	24	1	15.5	Determined useful combinations of data-driven and finite element models
Sep 30	27	1	18.5	Quantified measurement and model uncertainty
Oct 7	28	1	19.5	Outlined a decision support system
Oct 14	29	1	20.5	Completed a cost-benefit analysis of the decision support system
Oct 21	30	1	21.5	Started generalizing the model to bridges other than 705
Nov 18	34	1	25.5	Started writing thesis
Dec 9	37	1	28.5	Finished writing draft of thesis
Dec 23	39	0	29.5	Time off
Dec 30	40	0	29.5	Time off
Jan 27	44	1	33.5	Submit