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Construction machinery life estimation - Machine load parameters monitoring

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Essential component of successful product on a market is accurate knowledge of machine life cycle. This knowledge is based on several components – machine properties, customer's requirements and usage. At Doosan Bobcat Engineering, Doosan Company R & D facility located at Dobříš, Czech Republic, lifetime monitoring of components, assemblies or whole machines is done in two phases:

- Laboratory tests: static, short term and/or long term cyclic tests, noise test, vibrations, etc.
- Field tests – real life tests of machines during actual landscaping on special test polygon

The goal for all tests is accurate monitoring and analysis of specimen properties and prediction of behaviour over time – life cycle definition. Stress analysis and lifetime prediction calculation is one of very essential task.

Finite element analysis (FEA) provides basic list of critical points on the structure. Next step is static test using brittle coat (special paint) which enables to verify critical points location provided by FEA and also serves as input to improve mathematical models. Major disadvantage of brittle coat is high temperature sensitivity and its application is very expensive and time consuming. Two special chambers with temperature and humidity control are needed to successfully apply brittle coat. Both chambers are available in Doosan Bobcat Engineering Innovation Center in Dobříš.

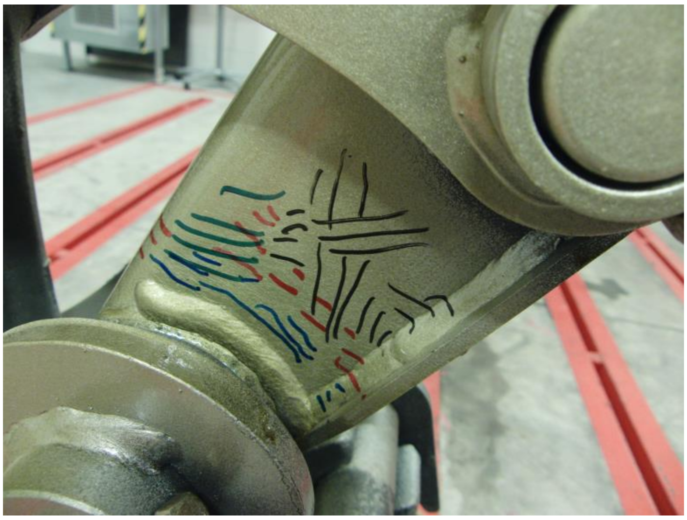

Fig. 1 Brittle coat results - critical point mark, each colour represents different load case

Final positions of strain gauges are determined after careful result analysis from both methods – brittle coat and FEA. Strain gauges are supposed to monitor all critical point on the structure. Additional reference points are added for mathematical model validation purposes.

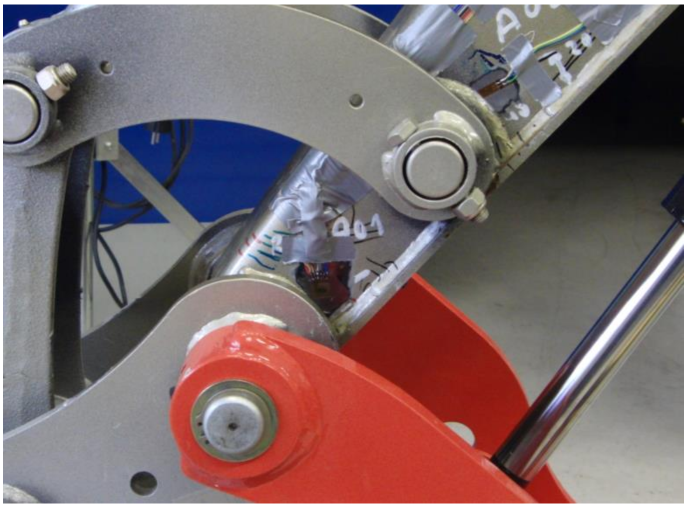

Fig. 2 Strain gauges installation ready for tests

Additional machine parameters are recorded aside of mechanical stress in the structure. For example hydraulic pressure, engine speed, positions, vibrations, etc. All parameters are recorded synchronously at rate of several hundred samples per second. This way of data acquisition is essential for stress analysis, machine behaviour and life estimation calculations. Tests are performed either in simulated laboratory environment or in real life landscaping on test polygon. Measurement units are configured as “measurement nest”. Measurement units are located at various locations over the machine and are using common synchronization channel and wireless configuration and control. Synchronization is at the moment via cable, but we are working on wireless variant, that would allow us more flexibility with “measurement nest” locations over the machine. Synchronization is based on value change detection signal.

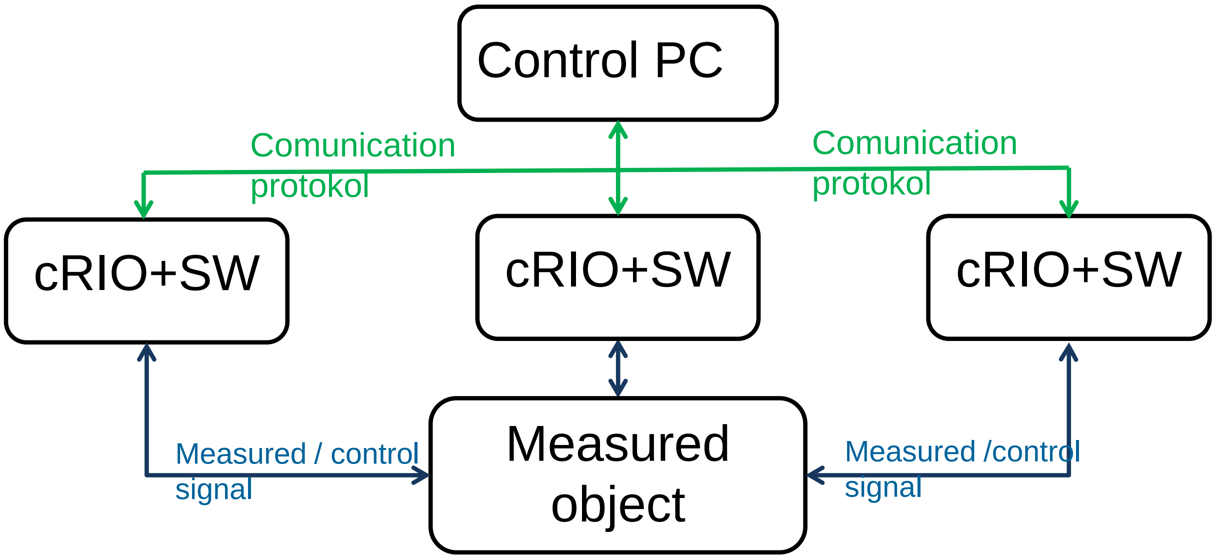

Fig. 3 Measurement system architecture

This approach is very flexible and can be used to synchronize several dozens of channels on different measurement units, different inputs and different sampling frequencies. Major advantage of this is detailed knowledge of stress and other monitored parameters. Drawback is large amount of data (several Gigabytes) that has to be processed and analysed.

Result of life estimation analysis is simple table (Tab. 1). Free capacity of department is available for external clients.

Gauge name	Target life [Hr]	Life Estimation [Hr]
A01	5 000	11 355
A13	5 000	29 358
A04	5 000	41 547
A02	5 000	96 096
B03	5 000	139 052
H11	5 000	206 769

Tab. 1 Life estimation analysis results

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