Asset Care Counts September 2015

Innovative Condition Monitoring of Damaged Gear Teeth

Can you be confident you understand the condition of your complex gear systems without frequent disassembly?

With ALS Industrial you can.

The performance of gearboxes is often critical to the production processes large and small. Their failure often leads to costly down time and lost production.

Within gearboxes, gear teeth are typically the most highly stressed components and often most at risk of unexpected / premature failure. This combines with the fact that replacements are often expensive, and have long lead-times.

Further exacerbating the problem is that gears are also often the most difficult gearbox component to monitor the condition of whilst in operation

ALS has been innovatively dealing with the challenge of monitoring deteriorating gearboxes awaiting repair by providing a solution that maximises available production time and avoids unnecessary disassembly for inspection.

The Challenge

ALS was approached to examine a gearbox with many compromised teeth on multiple gears. New gears had been commissioned but the lead time to delivery was several months.

Considering the damage already evident and the short period until gear set replacement, the key failure mode of most concern was fracture of the gear teeth.

Visual examination had been the most effective inspection method for this condition, however as this can only be done at intervals (due to the need to keep the gear box operating for production), ALS was consulted to implement a method of monitoring the gears in operation between the visual inspections.

We identified that one of the leading symptoms of the key failure mode was a change in the energy associated with the gear teeth meshing.

Figure 1 – Damaged Gear Set

If a gear tooth condition deteriorated, the energy associated with that tooth meshing would change by either increasing or decreasing. If the energy associated with one tooth meshing decreased, the energy associated with the subsequent tooth meshing would likely increase.

The Solution

ALS identified that a Time Synchronous Average (TSA) of acceleration data would allow each gearbox shaft to be monitored in isolation. This was done by:

- **Amplifying synchronous signals**, such as gear meshing, and
- **Minimising non-synchronous signals,** such as alternate shaft gear meshing signals.

For the input shaft, this technique was simply implemented using a photo-tachometer to provide the synchronous reference required for the TSA.

The Innovation

For intermediate shafts, no synchronous reference was easily available as there is no photo-tachometer access to such internal shafts.

Innovation was required and we developed a technique to perform a TSA using a non-synchronous reference. This method was proven and subsequently used to process the data acquired on the gearbox.

Baseline Vibration data was collected immediately following visual inspection and thereafter on a regular basis until the new gear set was installed.

The Results and The Benefits

The intermediate shaft waveform shows individual tooth meshing events (figures 2 and 3). The spacing of these events correlates with the number of teeth on the gear generating the signals.

Comparison of the baseline survey with results 4 weeks later showed only minor variations in the nature and amplitude of signals. This showed that gear deterioration had not progressed significantly.

By using this novel approach, ALS closely monitored the gearbox over the period awaiting replacement without shutdown for visual inspection.

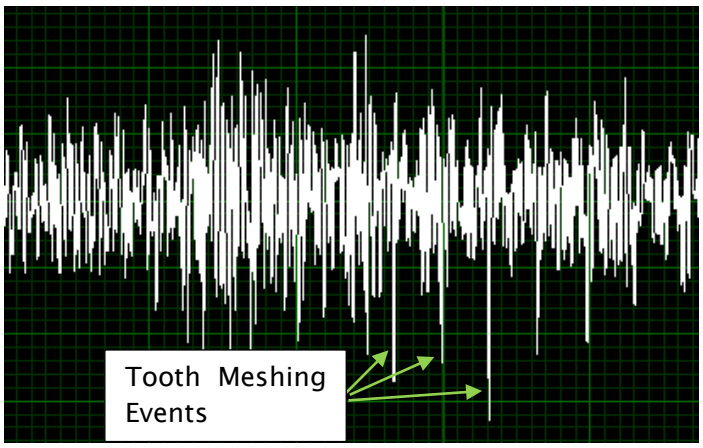

Figure 2 – Baseline TSA

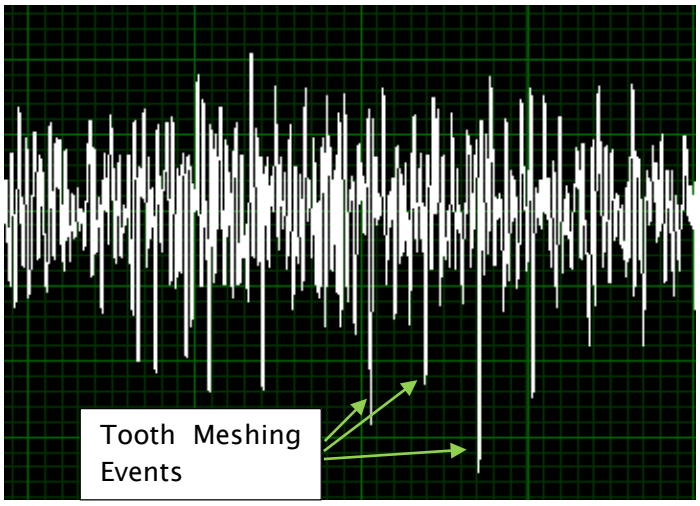

Figure 3 – 4 Week Subsequent TSA

Our Engineering Team

ALS Industrial's engineering team capable of designing and implementing a data-acquisition and processing programmes that can save substantial inspection and maintenance costs, just as in this example.

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