User Guide for Condition Maintenance Interval Optimization Model

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User Guide for Condition Maintenance Interval Optimization Model

The model is a Microsoft Excel spreadsheet that estimates the optimal condition inspection interval for operating plant and equipment to minimise the number of inspections and the chance of having equipment fail before the next inspection.

Data is entered into selected fields of the spreadsheet and used to populate the calculation tables, which then return the results shown in the remainder of the table.

The curves on the charts are drawn by the model. The upper chart is a high resolution copy of the left-hand side of the lower chart and ‘magnifies’ that section of the plot.

<table>
<thead>
<tr>
<th>Equipment Type &amp; Failure Mode</th>
<th>Main Heat Gearbox</th>
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Nomenclature and Definitions

**TU**  Time Units in weeks – specifies the size of the increments on the horizontal axis

**OTF**  Operate to Failure – running the equipment until it breaks down

Spreadsheet Inputs Explained

The allowed spreadsheet inputs are those fields coloured ‘light green’. These are:

- **Equipment Types and Failure Mode** – the name of the equipment and what failure types being monitored.

- **Condition Based Maintenance Method** – the range of technologies being used to detect the range of failures.

- **λ (lamda)** - the annualised failure rate during the random period of equipment life determined from the maintenance history of the equipment

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• **CBdPF** - the total business-wide cost of a breakdown, which includes all production losses, business impact costs, and maintenance costs

• **CPrPF** - the total cost of doing a planned repair where production and maintenance have scheduled the work and production impact is minimised

• **CMPI** – the total direct cost of doing the condition monitoring inspection

• **CPMPYr** – the total indirect costs of doing the inspection, including all overhead costs and penalties.

• **RTShortW** – the quickest time in which the inspection can be organised, which is also the period when no condition monitoring is possible to detect an initiated failure.

• **FrtInefInspt** – the percentage of inspections that are wrongly done and produce no monitoring of the failure conditions.

• **FrtFNotPred** – the percentage of developing failures in the equipment that the monitoring method will miss. Beginning failures not identified by the technologies used for monitoring will continue to a breakdown.

• **MedWtW** – the time by which 50% (half) of failures have happen. For example, if for an item of plant that failed twice in the past, the longest time to a failure is 100 weeks, and the soonest is 50 weeks, the 50% time is 75 weeks.

• **ShtWtW** – this is the time by which 5% of failures have happened. For example, if for an item of plant that failed twice in the past, the longest time to a failure is 100 weeks, and the soonest is 50 weeks, the 5% time is 51.25 weeks.

• **3% Go-Early** – Because the curves are flat near the minimum, for only 3% increase in cost you may inspect more frequently. By paying 3% more you can be additionally cautious and reduce the time between inspections (like paying a bit more for an extended warranty if you want to be more cautious). You can work to a higher percentage of cost and lower the level of risk to even shorter time intervals.

**Explanation of Theory Behind the Model**
Optimal Inspection Interval

Given an item with a Constant Failure Rate
CbMOpt uses estimates of:

- Cost of an Unpredicted Failure $/Failure
- Cost of a Predicted Failure $/Failure
- Monitoring Cost $/Inspection
- Monitoring Overhead Cost $/Year
- Shortest Response Time (Weeks)

To Compute:

- % Problems not detected by Method
- Typical Warning Time 50% failed - Weeks
- Short Warning Time 5% failed - Weeks
- Ineffective Inspection % of
- Operate to Failure Cost
- Minimum Cost with CM
- Optimum Monitoring Interval (Weeks)

Context - Review of CM Strategies

Problems
- Most inspection and CM strategies remain fixed after they are set.
- Optimisation requires information on failure mode risk, CMWarning times and maintenance windows.

CbMOpt – helps with this step
A more complete implementation of this trade-off

% Effectiveness of CM ↔
Viable

Eg. A gearbox has OA monthly. Total CM cost is $100/sample. Total failure cost $10,000, MTBF is 10 years. CM effectiveness is 60%.
Risk Cost 0.6x$10,000/10yrs = $600/yr vs CM Cost $100x12 = $1,200/yr