


Do you know how your machines fail?

What is machine failure? In the classical sense, it is the failure of the machine to perform its function. If a centrifugal pump is to provide 250 gallons of flow per hour, failure may be defined as flow less than 200 gallons per hour. What causes the pump to fail?

There are two broad categories of machine failure: designed-in failure modes, and process driven failure modes. Designed-in failure modes are not the work of a mischievous engineer, rather they are the normal wear out patterns of all the components and component parts that make up the machine. For example, a roller element bearing will wear out under designed for use at or about its L10 life. Without a working bearing, the pump shaft will fail to rotate, and the pump will fail to produce flow. The same principle applies to all other parts and components that make up the pump, from the motor to the coupling to the pump itself. Process driven failure modes include those operating conditions that are not supposed to happen. For example, low suction pressure causes cavitation which quickly degrades the pump impeller and the bearings supporting the impeller. Poor installation issues can also cause pre-mature failure. Installation issues include mis-alignment of the motor and pump shafts, cocked bearings, and so on. The list of designed-in and process or environment driven failure modes is lengthy. So, what are we to do?

We start with a failure modes and effects analysis. We list all the failure modes of all the parts and components. We then determine what the effect of the failure mode is. We also consider the likelihood of the failure mode. In many common equipment, or balance of plant equipment, the common failure modes can be discovered in literature and conference materials. More critical equipment may need a more extensive failure modes analysis.

Once we have the likely failure modes at hand, we ask what defects in the component or component's part will lead to failure? What sensor can detect the defect? With an understanding of the defects that map to the failure modes, and the sensory data that can detect the defects, we are well on our way to prevent machine failure.

As an example, let's consider the centrifugal pump component of a motor driven pump, Figure 1. The pump is built from several parts, with each part have a likely failure mode. If we focus on the Roller Element Bearing failure modes, we can identify sensory measures that can detect defects causing failure, Figure 2.

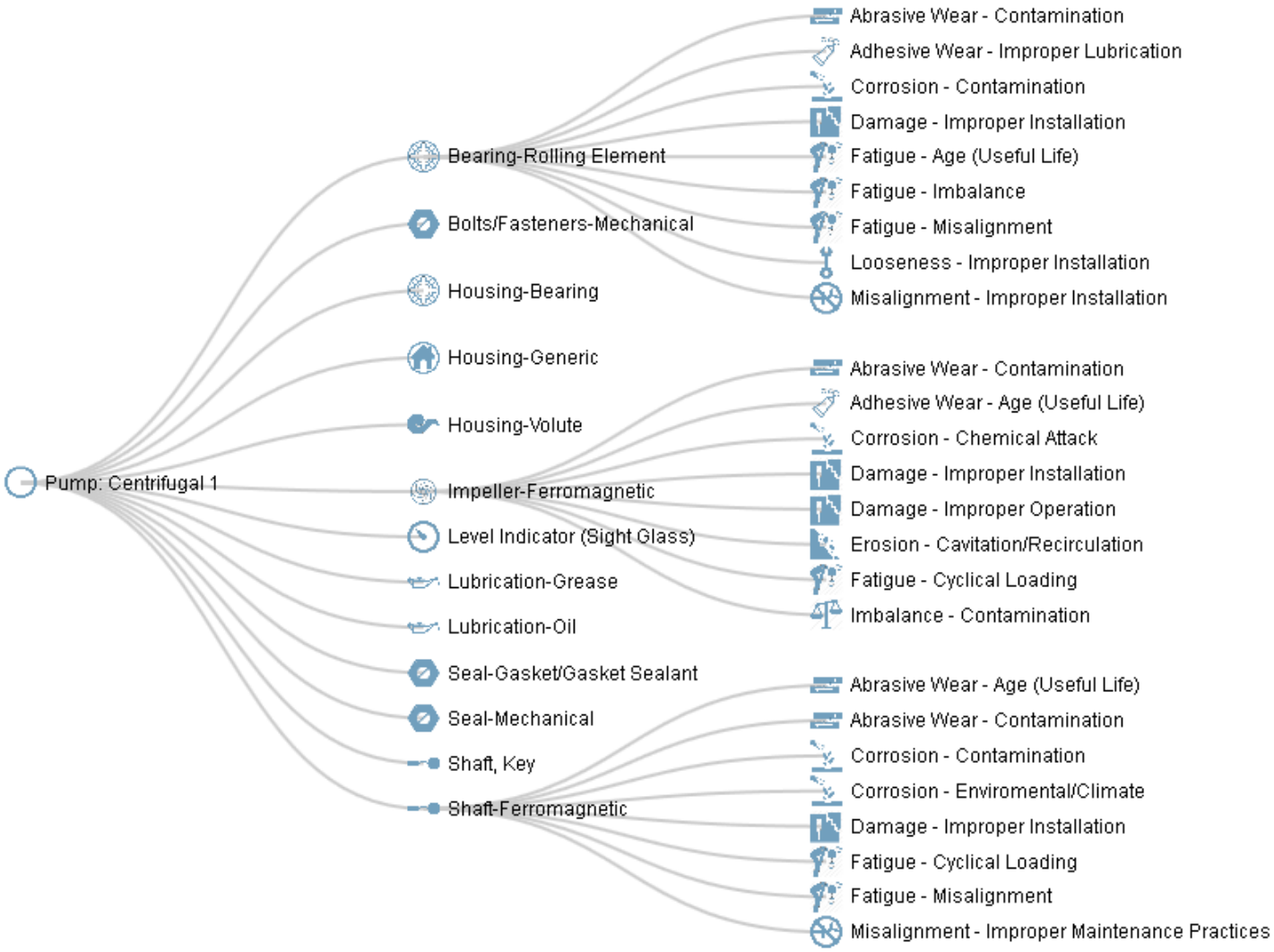

Figure 1: Centrifugal Pump, Parts and sample failure modes.

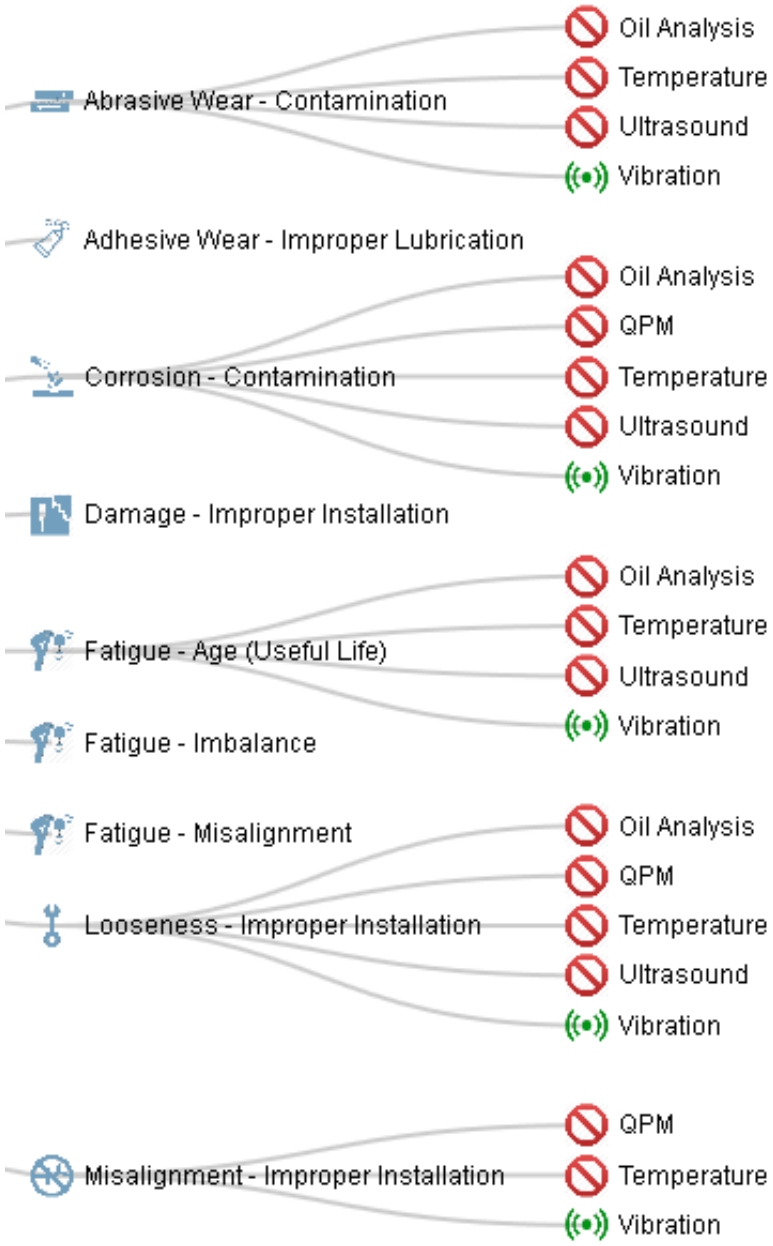

Figure 2: Sensory Measures useful in detecting defects leading to particular failure modes.

We can do the same for the motor, coupling, base, and electrical supply. With sensory measures, we can detect defects well ahead of failure. Early detection of defects gives us plenty of time to plan and then schedule corrective action to remove the defect and prevent failure. Proper planning and scheduling of defect removal is much much less expensive than reacting to an unforeseen failure. Detection of defects, with planning and scheduling is core to condition based maintenance (CBM). Data shows us CBM is the least expensive of reactive (run-to-failure), time and usage based maintenance, and CBM. Not only does CBM cost less, CBM also works to improve uptime, allowing more production with the same team of assets.

Join the MFPT team at our 2019 conference in King of Prussia, PA to learn more. Our collection of technical presentations, tutorials and focus groups provide a cost effective three day education, which helps you prevent machine failure in your own facility.