Why Do Bearings Fail?

What do we mean by good bearing life?
Bearing life is defined as the length of time, or the number of revolutions, it will take for the metal to ''fatigue''. This life expectancy depends on a number of factors, eg loading, speed, lubrication, fitting, setting, operating temperature, contamination, maintenance and other environmental factors. The usual life rating for industrial bearing applications is called L10 which typically relates to 25,000 hours in continuous operation or 16,000 hours at maximum axial and radial load at rated speed.

To understand the term ''fatigue'' we will conduct an experiment:

- Straighten out a standard paper clip.
- Flex it a little and let it go. You'll notice it returns to the straightened position. You could repeat this cycle many times (over many years) without breaking (fatiguing) the metal because you're cycling the metal in its ''elastic range'' (it has a memory similar to a piece of rubber).
- Now we'll bend (stress) the paper clip a lot further and you'll note it did not return to its straightened position. This time you stressed the metal in its ''plastic range'' where it did not have a memory.
- If you continue to bend the metal back and forth in this plastic range it will crack and break in less than twenty cycles. The metal fatigued more quickly because it ''work hardened'' and became brittle. The more you stress the metal by flexing it the quicker it will work harden and break.

You've just demonstrated that fatigue is a function of stress and cycles. When the bearing is pressed on a rotating shaft the load passes from the inner race (inside ring) through the balls to the bearing outer race (the outside ring). Each ball carries a portion of the stress as the balls roll under the load. It is this stress that will eventually fatigue the metal parts and ultimately result in failure.

When operating at their optimum the load the bearing has to carry is:

- The weight of the rotating shaft.
- The stress caused by the interference fit on the shaft.
- Any bearing pre-load specified by the manufacturer.

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The fact is that most bearings become overloaded because of:

- The wrong interference fit between the bearing and the shaft (shaft was out of tolerance).
- Misalignment between coupled open drive arrangements.
- Bent shafts.
- An unbalanced rotating element.
- Operating outside manufacturers' specification.
- Shaft radial thermal expansion.
- Axial thrust.
- Vibration of almost any form.
- A bad bearing was supplied (this does happen).
- The overloading will cause heat to be generated, and heat is another common cause of premature bearing failure (see below).

Heat will cause the lubricant to:

- Decrease in viscosity, causing more heat as it loses its ability to support the load.
- Form a ''varnish'' residue and then ''coke'' at the elevated temperature. This ''coking'' will destroy the ability of the grease to lubricate the bearing. It will also introduce solid particles into the lubricant.

In addition to the heat generated by overloading we get additional heat from:

- Poor alignment.
- Over-greasing.

The presence of moisture causes several problems:

- Pitting and corrosion of the bearing races and rolling elements that will increase the fatigue of the metal components.
- Water and oil emulsion does not provide a good lubricating film.

We also get solids into the lubricant from several sources:

- Metal seal cage wear. This is the part that separates the balls that are held between the bearing races. It is often manufactured from brass or a non-metallic material.
- Abrasive particles leach out of the bearing housing casting.
- Often particles were already contaminating the grease we are using for the lubricant.