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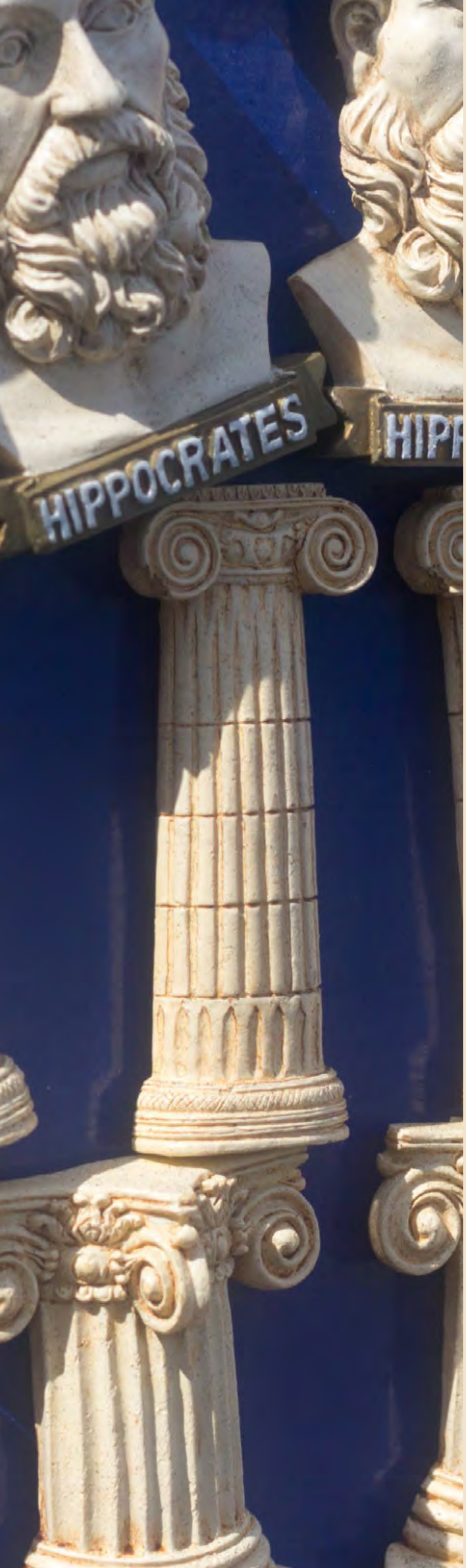
DO NO HARM:

THE HIPPOCRATIC OATH APPLIED TO RELIABILITY

by Alan Knight and Ana Maria Delgado

The Greek physician Hippocrates (c.460 BC – c.370 BC) is credited with an oath that was meant to provide certain ethical standards a physician was to uphold. While maintenance is not of the magnitude as being a doctor, organizations would do well to apply portions of the Hippocratic oath to their maintenance practices. Two such examples are: "*…to teach them this Art, if they shall wish to learn it, without fee or stipulation; and that by precept, lecture, and every other mode of instruction, I will impart a knowledge of the Art to my own sons, and those of my teachers, and to disciples...*" and "*I will follow that system of regimen which, according to my ability and judgment … and abstain from whatever is deleterious and mischievous.*"[1] This article focuses on the latter, "*and abstain from whatever is deleterious and mischievous,*" or in 21st century vernacular: Do no harm.



Two key ingredients of any reliability effort are precision installation and maintenance practices.

Maintenance reliability professionals have a responsibility to their superiors to deliver results that improve the bottom line via increased uptime and productivity. But they also have a responsibility to those technicians who are expected to assist them in the process of increasing asset uptime and improving reliability. Regardless of your certification or the acronym attached to your signature block, without the technician's solid understanding and performance of the basics, you will not achieve either goal. Two key ingredients of any reliability effort are precision installation and maintenance practices. Without them, you will find yourself replacing the same motors, pumps, etc., repeatedly.

From the reliability-centered maintenance (RCM) teachings of Stanley Nowlan and Howard F. Heap, both engineers at United Airlines, and John Moubray, the originator of RCM2, it is learned that there are six distinct failure curves. Furthermore, as many as 68 percent of failures can be attributed to infant mortality or failure induced at start-up/installation.

More recent studies by RCM practitioners, such as Doug Plucknette in the manufacturing industry in the early 2000s, are consistent with these early studies at 67 percent. Regardless of the study or your preferred practitioner, the fact remains that infant mortality is the largest contributor to component failure and its largest contributor is inducing failure modes as a result of improper installation. Experience in the trades can attest to the fact that what people don't know, they don't know. Or to reference psychologist Abraham Maslow, if all one has is a hammer, everything looks like a nail. Maintenance technicians rely on the knowledge they possess – right or wrong – and the tools they have at their disposal – good or bad – to perform the work with which they are tasked. It is the job of reliability professionals to properly educate their technicians and give them the right tools to be successful.

One method to ensure their success and prevent inducing infant mortality when installing new components is utilizing precision practices. Some examples include:

- Precision alignment – shaft and sheave;
- Torque specifications and tools;
- Quantitative job plans;
- Standards;
- Training.

In the reliability arena, a familiar concept is the P-F curve, where P is the point where the defect occurs and F is the point of failure. If improper methods are employed during installation, point P might begin the moment power is supplied to the asset after repairs. By using precision alignment and installation techniques, you can utilize another curve: the I-P-F curve, where I represents installation. The concept behind this curve is to extend the line from I to P as far as possible utilizing precision techniques. There are many precision installation techniques, but for the sake of this article, the focus will be specifically on precision shaft alignment.

An article in the April 1999 "Maintenance Technology" magazine[2] gives a very thorough reporting of results from a study performed by the University of Tennessee Reliability and Maintainability Center, where researchers performed experiments to determine the effects of misalignment on bearing life. In summary, one of the

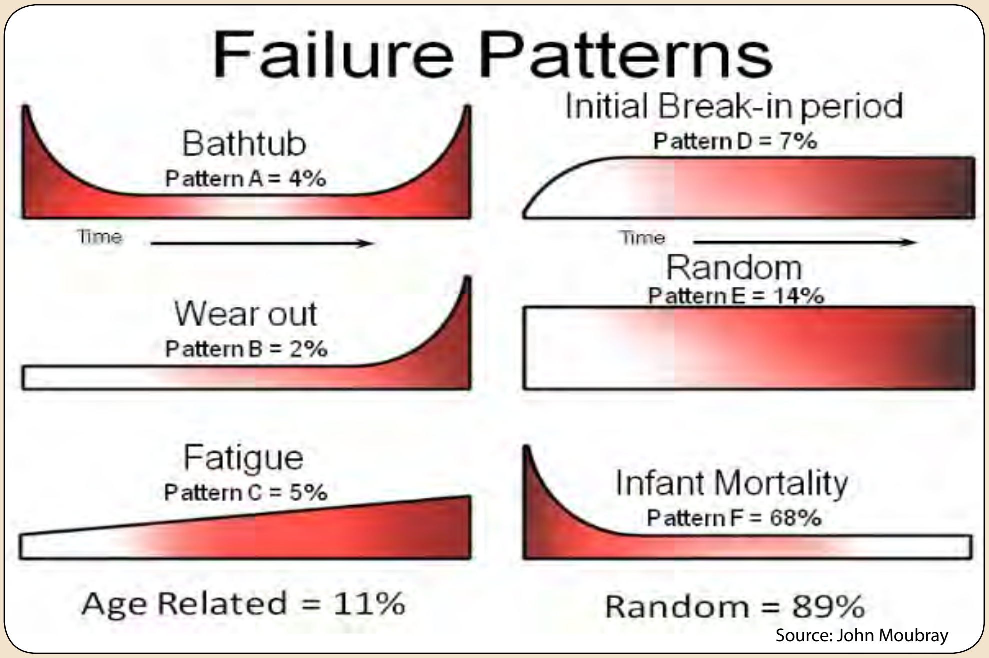


Figure 1: Failure patterns

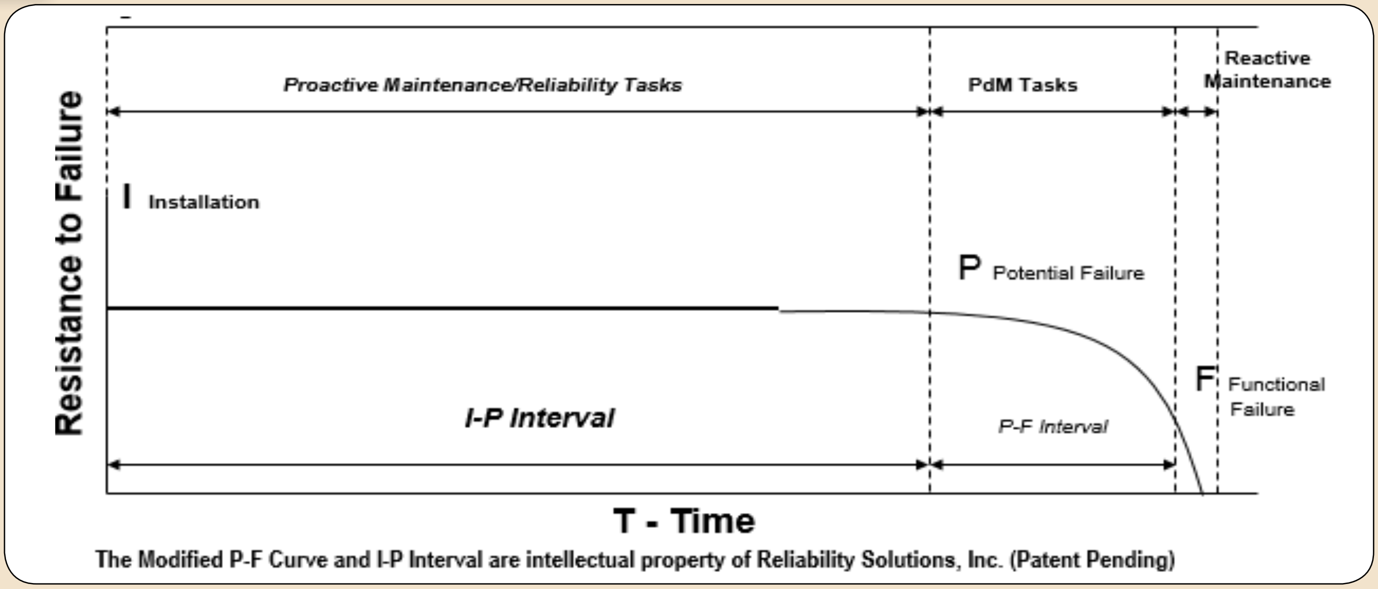


Figure 2: I-P-F curve

study's conclusions was that as little as 1-3 mils (.001"-.003") can reduce bearing life by 10 percent due to increased load on the drive end bearing, depending on the type of coupling used to connect driver to driven component. Also, with some types of couplings, as little as 5 mils (.005") can cut bearing life by as much as 50 percent. Think about it, you can reduce inboard bearing life by *half* with improper installation techniques.

In addition to being detrimental to bearing life, misalignment has been shown to increase energy consumption as much as nine percent[3] and reduce lubricant film thickness by as much as 75 percent in journal bearings.[4]

Besides aligning the shafts, a critical step in installation is detection and elimination of soft foot. Soft foot causes machine frame distortion and results in an uneven air gap between the rotor and stator in a motor and can result in additional increases in power consumption of up to 17.4 percent.[3]

In fact, many machine failures and defects can be eliminated up front by correctly installing and aligning shaft and belt-driven equipment by, among other things:

- Making sure the foundation is properly sized for the weight and operating conditions of the asset.
- Ensuring the baseplate is properly bolted or grouted to the foundation; both should be flat and level.
- Centering equipment horizontally on the baseplate, with equal amounts of shims placed under each foot. Installing jack bolts is also recommended to facilitate horizontal movement of the machines.
- Tightening all anchor bolts to the proper torque.
- Requiring precision alignment of the machines to proper tolerances prior to releasing the asset to operations.
- Selecting the right length and material belt and its pitch angle, then correctly installing the belts and sheaves.
- Correcting all three types of misalignment – vertical angularity, horizontal angularity and axial offset – as part of the precision alignment process.

Armed with this knowledge, how can you, in good conscience, *not* provide your people with the right tools for, and training in, proper installation techniques, such as precision shaft alignment? When you think about it, very few people set out on a path to do poor work. Most maintenance technicians are no different than doctors, lawyers, or engineers in that they want to be the best at what they do. They each have a deep sense of pride in their work and skills and most will readily accept tools, training and techniques to make their jobs easier.

In conclusion, one more observation: Precision maintenance, in and of itself, is not the golden ticket to world-class reliability, but used properly, it is a powerful weapon in your arsenal in the battle against unplanned downtime. It allows your technicians to be more productive and proactive, thanks to a reduction in rework and urgent repair work. Best of all, it allows you to apply the Hippocratic oath and "do no harm."

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