

## Use of statistics in maintenance

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Statistics is a collection of powerful tools that can be used to describe and model the world. Statistics is a very complex field. We will use the very simplest concepts in this article to aid us in understanding how to take effective action on maintenance problems.

The simplest idea is the mean (shown as X with a line over it). For our purposes the mean is the same as the average. To calculate the mean add up all of the readings (the data) and simply divide by the number of readings. It is valuable to evaluate a number of readings or measurements and compare them over time (called a trend chart). The mean can be used to determine maintenance function effectiveness in a wide variety of ways as in:



<b>Possible ways to measure maintenance effectiveness using the mean</b>	Mean hours to respond (average response) to an emergency	2.5 hours
	Mean backlog weeks per person	4.7 weeks
	Mean hours between stoppages on the giant press	4790 pieces
	Mean hours to repair when the giant press does break	12 hours

Related to the Mean is the standard deviation (SD). The SD measures the variability of the measurements. For example the mean of the three readings (1, 10, 250) is 87. The mean of a second group of three readings (79, 89, 93) is also 87. As you can see the mean doesn't express a sense of the variability of the readings. The SD of the first distribution is 115 while the SD of the second is only 5.9.

In any of the statistical measurements, the SD is increasingly important, as the variability of the readings gets larger. If the backlog by craft or skill set has a mean of 4.7 weeks per person but it also has an SD of 5 weeks then we must look deeper into the number. If the SD were only 1 day then the mean would be all we would need.

How to calculate the standard deviation (SD)

1. Calculate the mean =  $\bar{X}$
2. Subtract each reading from the mean:  $D$  (Difference) =  $\bar{X}$  - Reading
3. Multiply each difference by itself:  $D = (\text{Difference})^2$
4. Add the squared Difference for each reading and divide by the number of readings  
Variance =  $\text{Sum}(D) / \# \text{ readings}$   
(Readings-1 is the weighted and just # of readings is not weighted)
4. Take the Square root of the Variance:  $SD = \text{SQRT}(\text{Variance})$

The great thing is that many advanced calculators have statistical function keys that do the math for you.

**What is the Normal Curve (bell shaped curve) and what aspects are important to us.** The normal distribution curve can help us identify the 'bad actors' in our buildings, equipment and fleet, among our mechanics and of the parts used.

The readings in the curve can be maintenance hours per ton of steel, MTTR (mean time to repair), MTBF (mean time between failures), or any numerical measure. In the real world, when you plot readings from any measure that is a normal distribution, your data will only approximate the normal curve. Usually a greater number of readings will smooth the curve and make it more bell shaped.

You can divide a normal distribution into partitions that are extremely useful to help you analyze a problem. The size of the partition is called one standard deviation (SD). The useful property of the SD is that 68.27% of your readings will be within 1 SD of X. (That is  $X \pm SD$ ) and 95.45% of your readings will be within 2 SD of X. ( $X \pm 2SD$ ).

#### **How can the mathematics of the normal curve help manage our assets?**

The challenge of maintenance management is to know where to allocate your resources. In terms of the bell shaped curve the 'bad actors' group we are referring to is the one more than 1 SD on the weak side of the mean. Our job as maintenance managers is to identify and manage the 'bad actors.'

This group represents 15.9% of the whole population and most of the problems. If we manage the weak 15.9% we will be managing the whole group. Also bringing them up to average results in the greatest impact per unit of work.

**No other group of units will give you as good a return on your time and money investment then those 1 SD or more below the mean.**

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