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Reliability Growth Plot using MS Excel Guidebook

CONTENTS

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Reliability Growth Plotting Guide using MS Excel

Introduction

This guide shows you a way to use Microsoft Excel to plot repairable equipment failure history and identify if its reliability trends are unchanged, worsening or improving.

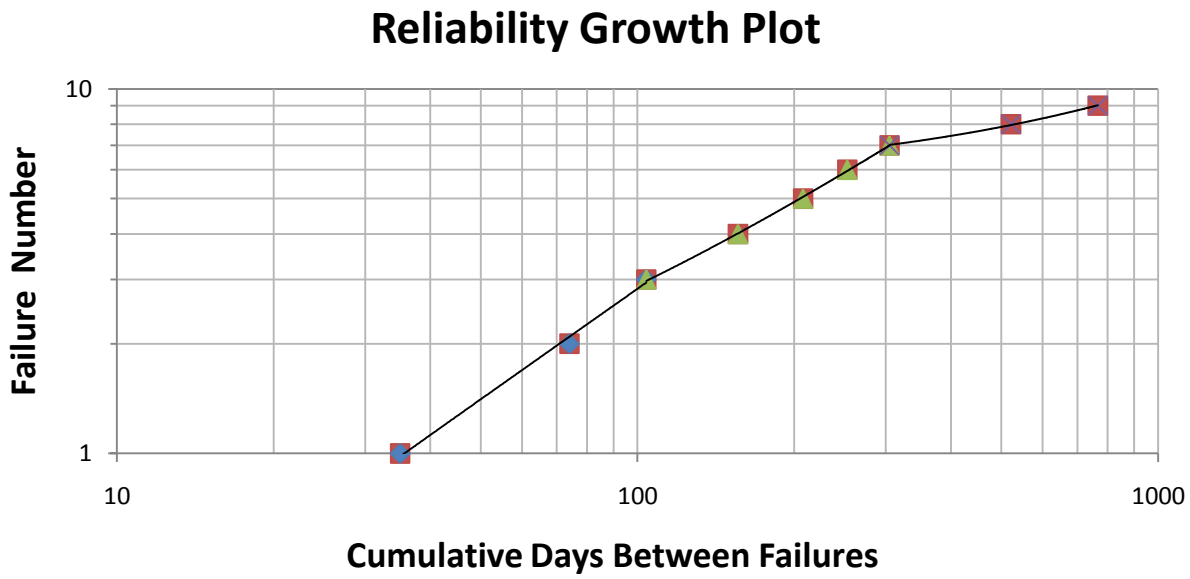

Figure 1 - Log-Log Plot of Equipment Reliability Growth

A way to see reliability growth is by plotting the observed number of cumulative failures against cumulative time on logarithmic paper Such a diagram is known as a Crow-AMSAA reliability growth plot, which is similar to the Duane Plot method, and applies for a piece of repairable equipment, a complete production process and even to an organisation. The development of log-log reliability growth plots can be traced back to the 1930's investigations of the learning curve for building airplanes[1]. It was developed into a graphical method in the 1960's by James Duane while working at General Electric for use in predicting improvements in mean-time-between-failures of new product developments. In the 1970's a mathematical derivation was developed by Larry Crow while in the employ of US Army Material Systems Analysis Activity (AMSAA). The measurement of reliability growth by Crow-AMSAA plot reflects changes in system reliability caused by changed efforts to affect reliability.

The method is now used in industry as a historic reliability key performance indicator as well as a means to predict the future impact of reliability improvement initiatives. The technique is purely empirical, but has been a very good approximation when applied to complete machines suffering multiple failure modes[2]. Crow-AMSAA plots are power laws and seem to imply a relationship between the failure of equipment and the risks it carries. Crow-AMSAA plots start by creating a table like Table 1, which in this case lists the failure dates for a repairable plant item and the cumulative days between failures. The data is used to create a computerised log-log plot, like that

[1] Comerford, Nigel., 'Crow/AMSAA Reliability Growth Plots and there use in Interpreting Meridian Energy Ltd's, Main Unit Failure Data', Areva T&D, New Zealand, 2005
[2] Sherwin, David,. Retired Professor of Maintenance and Reliability, 'Introduction to the Methods of Reliability Engineering with particular emphasis to Engineering Asset Management and Maintenance' presentation, 2007

in Figure 1, or in 1:1 scale on a sheet of log-log paper, like Figure 2, draw a graph of the cumulative days verses the cumulative failures.

Failure No	Failure Date	Cumulative Time in Days	Comments
0	January 25th		New equipment installed
1	March 1st	35	
2	April 9th	75	
3	May 9th	105	New material selected
4	June 30th	155	
5	August 21st	205	
6	October 5th	245	
7	November 26th	295	Precision Maintenance introduced
8	July 1st	495	
9	March 26th	745	

Table 1 – Reliability Growth Cumulative Days

Example on Pre-printed 1:1 Graph Paper

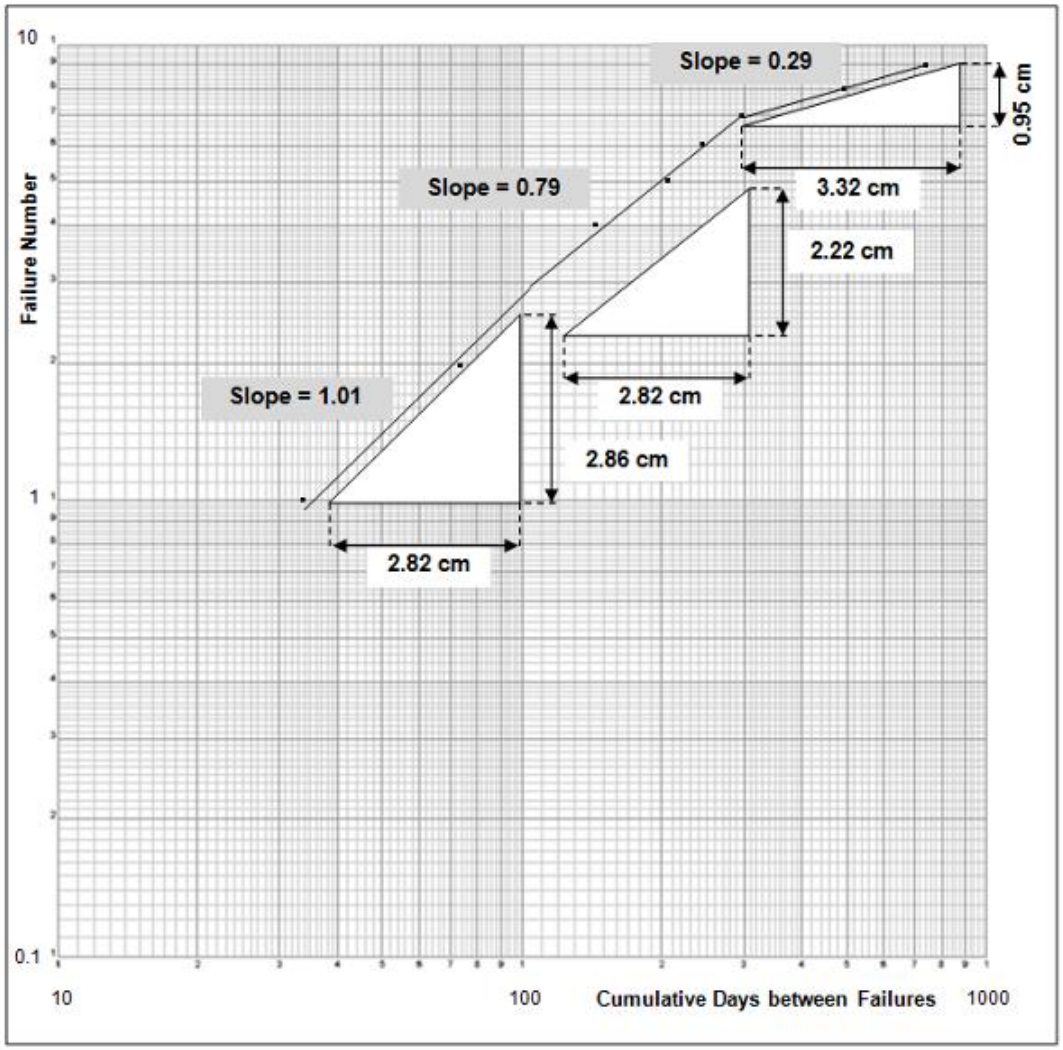

Figure 2 – 1:1 Scale Log-Log Paper Plot of Equipment Reliability

Notice the triangles drawn on Figure 2 have the same slope as the lines. Because the graphical log-log plot is 1:1 (must be a 1:1 scale), you can measure the X and Y lengths with a ruler and calculate the slopes. The slopes tell a lot about what is happening with the equipment. The slope is called

the Beta Value - 'β' (not to be confused with the beta used in Weibull Analysis; the two have very different meanings). The Beta is a reliability trend indicator.

- Beta < 1, Reliability Improving
- Beta ~ 1, Reliability Static
- Beta > 1, Reliability Deteriorating

In Figure 2, you can see that the beta for the early failures was indicating a steady reliability trend. After the material change, the reliability was better. And with the introduction of precision maintenance, the reliability trend improved massively.

Software for Crow-AMSAA investigation and reliability improvement analysis is commercially available and provides useful management indicators when sufficient data points are available. A simple Crow-AMSAA plot, as in Figure 3, can be developed using MS Excel.

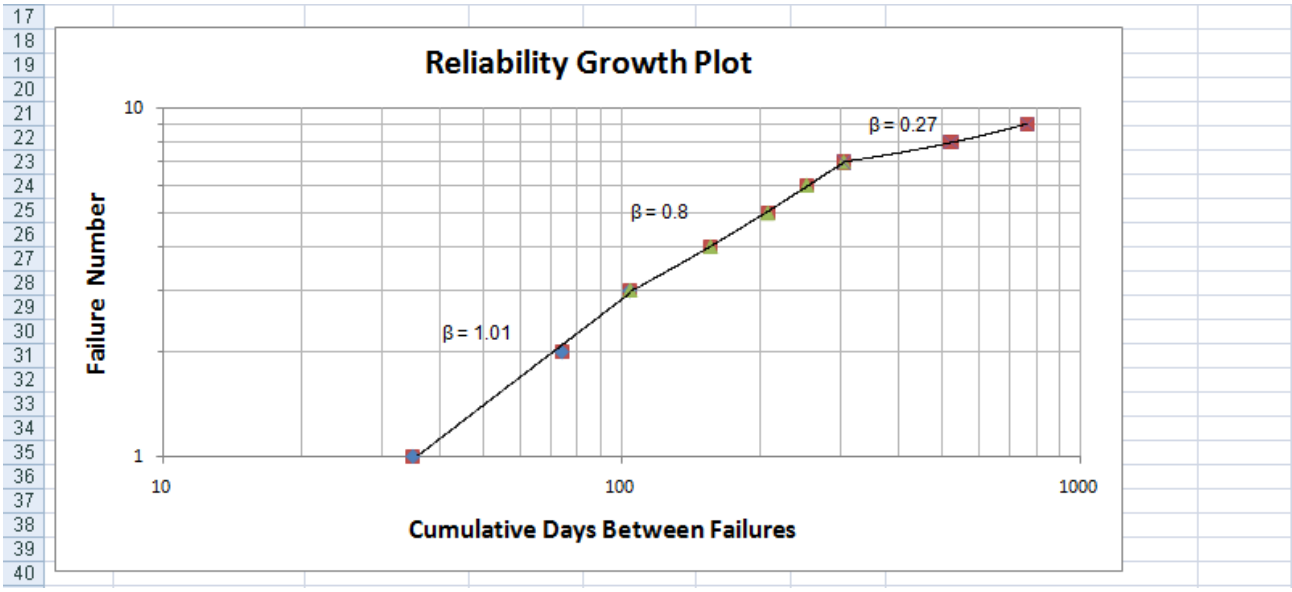

Figure 3 – Excel Log-Log Plot of Equipment Reliability

The historic failure data is entered into a spreadsheet table with X-axis data to the left of the Y-axis data. (Excel plots left-hand column data as the X-axis in the horizontal and the right-hand column on the Y-axis. You can change the axes later by swapping X and Y data using the 'Select data…' function and changing the choice for the series on each axis.)

Creating the Graph in MS Excel

	A	B	C	D	E	F	G
1				X Axis	Y Axis		
2		**Failure Date**	**Days In-Between Failures**	**Cumulative Days**	**Failure No**	**Comments**	
3		25-January-2006	0	0	0	New equipment installed	
4		01-March-2006	35	35	1		
5		09-April-2006	39	74	2		
6		09-May-2006	30	104	3	New material selected	
7		30-June-2006	52	156	4		
8		21-August-2006	52	208	5		
9		05-October-2006	45	253	6		
10		26-November-2006	52	305	7	Precision Maintenance introduced	
11		01-July-2007	217	522	8		
12		01-March-2008	244	766	9		
13							
14							