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THE USE OF LOG-LOG PLOTTING IN FIELD FAILURE ANALYSIS

INTRODUCTION

In dealing with field failure data we encounter several types of difficulties which need to be overcome. These are

(1) The same system or machine in the field can fail several times. Thus, repair or renewal must be accounted for.

(2) The good machines or systems, which do not fail, must be taken into consideration in our analysis.

(3) Redesign credits must be established and properly taken account of when we evaluate improvements.

Because of the above mentioned difficulties, and because of the way in which field failure data are usually collected, it is often impossible to construct a Weibull plot , simply because we do not have a good way of estimating the median rank of a particular first failure. Weibull plots are supposed to represent first failure distributions, while field data provide added information (about repeated failures) which should be used in order to get a more accurate product evaluation.

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THE LOG-LOG PROCEDURE FOR GETTING WEIBULL PARAMETERS

The secret of getting more accurate estimates of Weibull parameters from field data is outlined in the following steps :

I : At specific time intervals keep a running record of how many machines in the field have accumulated different specific numbers of hours , and always update these figures. For example , such a record on a particular date (August 1) might be as follows :

TABLE I

TABULATED RECORD OF NO. OF MACHINES WITH SPECIFIC HOURS OF OPERATION

	SERVICE HOURS (AT LEAST)						
	500 hrs.	1000 hrs.	1500 hrs.	2000 hrs.	2500 hrs.	3000 hrs.	
DATE (Aug. 1)	71	47	36	32	19	9	No. of Machines

II : Alongside of the tabulated record of service hours given in (I) above, We also keep a record of how many failures have occurred among machines with at least so many hours , as follows :

TABLE II

TABULATED RECORD OF FAILURE CASES VS. SERVICE HOURS ON MACHINES IN THE FIELD

	SERVICE HOURS (WITHIN)					
	500 hrs.	1000 hrs.	1500 hrs.	2000 hrs.	2500 hrs.	3000 hrs.
Failures Reported (Aug. 1)	12	23	32	44	37	22

III : Divide the FAILURE TOTALS in TABLE II by the MACHINE TOTALS in TABLE I for each cumulative total hours of service to form TABLE III (for FAILURES PER MACHINE) as follows :

TABLE III

(FAILURES PER MACHINE AT DIFFERENT HOURS)

HOURS OF SERVICE

	500 hrs.	1000 hrs.	1500 hrs.	2000 hrs.	2500 hrs.	3000 hrs.
FAILURES PER MACHINE	. 169	. 489	. 889	1. 375	1. 947	2. 444

IV : Plot HOURS OF SERVICE AS ABSCISSA and FAILURES PER MACHINE as ORDINATE on LOG-LOG paper . The data from TABLE III yield us the log-log plot shown in FIGURE 1 .

LOG-LOG PLOT

FAILURES PER MACHINE VS. HOURS OF SERVICE

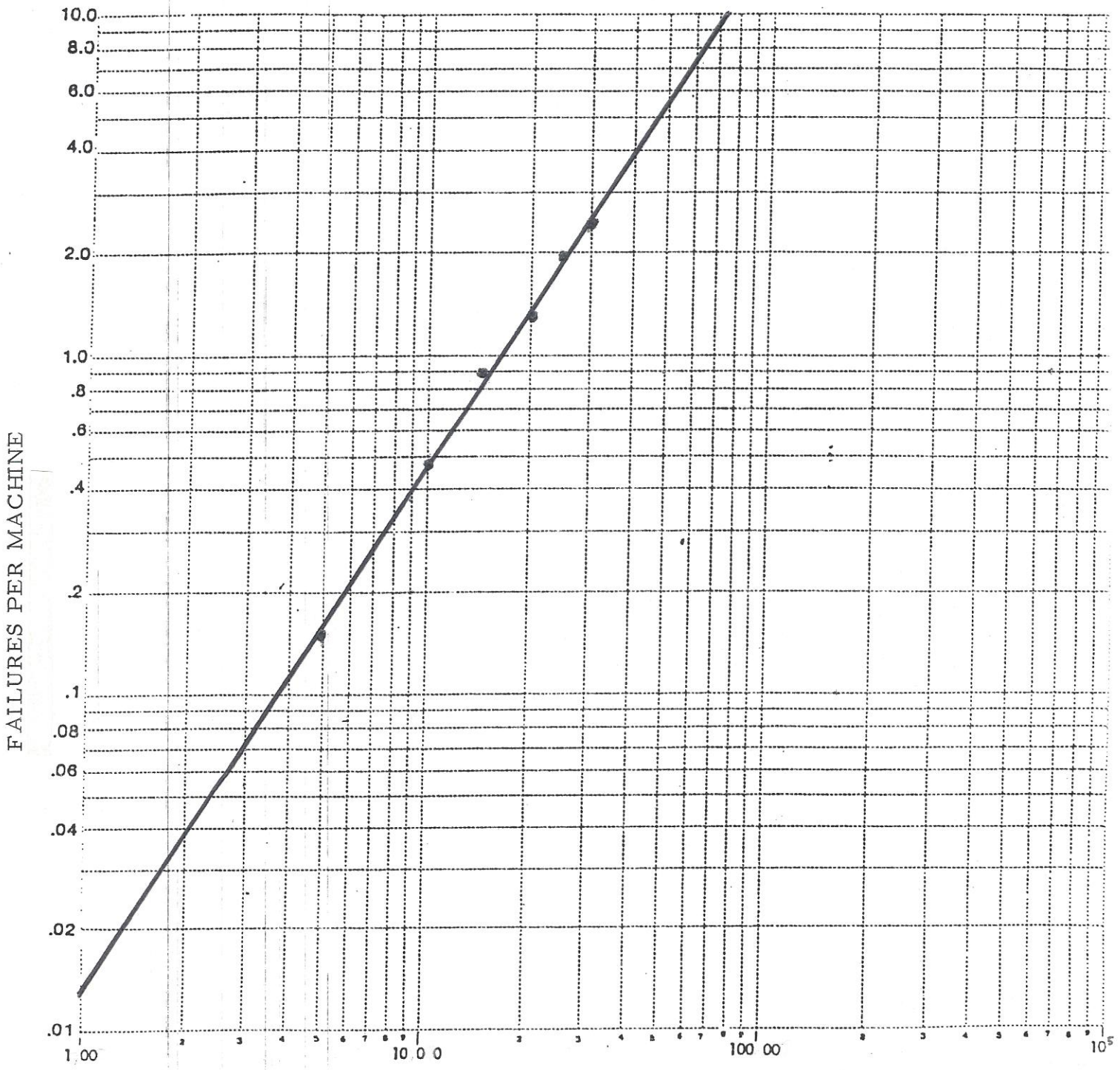

FIGURE 1

Leonard G. Johnson / Henry L. Pouch

CONCLUSIONS FROM THE LOG-LOG PLOT OF FAILURES PER MACHINE VS. HOURS OF SERVICE

CONCLUSION # 1 : The WEIBULL SLOPE of the distribution of FIRST FAILURES is the SLOPE OF THE LOG-LOG PLOT. In this case , the LOG-LOG plot has a slope of 1.5 . Hence , the WEIBULL SLOPE of the distribution of FIRST FAILURES on this machine population is $b = 1.5$.

CONCLUSION # 2 : The CHARACTERISTIC LIFE of the distribution of FIRST FAILURES is the ABSCISSA corresponding to an ORDINATE of 1 FAILURE PER MACHINE on the LOG-LOG plot of FIGURE 1. By examining the LOG-LOG plot of FIGURE 1 , we see that 1 FAILURE PER MACHINE occurs at 1650 hours. Hence, for the population of machines in the example, we conclude that the distribution of first failures has a CHARACTERISTIC LIFE $\theta = 1650$ hours .

NOTE : The analytical technique of handling REDESIGN CREDITS in modifying a LOG-LOG plot will be discussed in detail in the next issue of the STATISTICAL BULLETIN .