Statistical Bulletin
Reliability & Variation Research

DETROIT RESEARCH INSTITUTE
P.O. BOX 36504 • GROSSE POINTE, MICHIGAN 48236 • (313) 886-7976

LEONARD G. JOHNSON
EDITOR

WANG H. YEE
DIRECTOR

Volume 11
Bulletin 2

May , 1981

THE FIVE RULES FOR AN EFFECTIVE RELIABILITY PROGRAM

In engineering and industrial circles we are constantly dealing with SAMPLES. How large should test samples be ? How much field data must be collected in order to judge a product ? These are everyday DECISION PROBLEMS. We must face them. We can't run away and hide from them. What is seriously needed here ? Answer - ----- A grasp of the mathematical concept of EVIDENCE . How is Evidence related to Confidence ? What is the proper confidence level to test to when we are seeking Evidence of a product's reliability ?

These are nagging questions which must be answered. To answer them, we obey the FIVE RULES OF SYSTEM RELIABILITY.

RULE # 1 : To build adequate reliability , you must count the cost of failures , as well as the profits of success .

RULE # 2 : Make no assumptions about sample sizes until you have collected EVIDENCE.

RULE # 3 : To economize in testing , use past experience, as well as new data .

RULE # 4 : Whatever sample size you must use, know the width of your confidence band for that sample size.

RULE # 5 : Be aware of possible aberations in statistical investigations which may be caused by mixtures or system peculiarities .

Faithful Obedience to these rules and a good knowledge of the concepts of ENTROPY and EVIDENCE will enable you to make WISE DECISIONS about the adequacy and reliability of your consumer product .

Let us now discuss these five rules , one by one. Look at Rule #1 again . What does it say ? It says that in order to build adequate reliability you must count the COST OF FAILURE as well as the PROFITS OF SUCCESS .

WHY SUCH A RULE ?

The reason is very fundamental , and it is simply this ---------- A high cost of failure compared to profits from success means that your probability of failing to meet a goal must be made small enough, so that high costs from failures are so rare that your profitability is not damaged. In other words, you must have a confidence level high enough to make your reliability goal realizable with a profitability which is not destroyed by costly failures. So, the costliness of failure to meet a goal when compared to your profits from a reliable product will determine what Confidence Level you will need in your testing program. Your SAMPLE SIZE must then be large enough to yield sufficient EVIDENCE , as dictated by such a confidence level.

Next comes Rule #2, which says that you are to make no assumptions about SAMPLE SIZES until you have collected EVIDENCE .

Why such a rule ?

Because until you know that you have Sufficient Evidence to give Enough Confidence to rule out failures which could wipe out profits, you cannot say that your Sample Size is adequate. This is why , in most cases, Nobody can tell you in Advance What Sample Size You Should Test. It's a matter of testing and observing in a sequential fashion -------- A Wait and See Type of Situation , Where Testing is Done Sequentially, together with Statistical Analysis FOR CONFIDENCE at each step of the sequence.

WHAT ABOUT RULE # 3 ?

It simply amounts to a realization that he who doesn't learn to use past experience will end up paying a higher price for his decision procedures, since he will duplicate the cost of past knowledge by treating it as non-existent, and then proceeding to design a larger testing program than what would be needed if he combines past knowledge with a smaller present sample on a similar design.

NEXT COMES RULE # 4.

It is just telling you Not to Kid Yourself or Anybody Else about the adequacy of a sample, and that the way to avoid such misunderstandings is to clearly state what errors or deviations are possible with decisions based on a particular sample size. In other words, LET EVERYBODY ON THE DECISION TEAM SEE THE SIZE OF THE CONFIDENCE BAND !

FINALLY , WE COME TO RULE #5.

It is a warning about the possibility of peculiar behaviors of Weibull plots or other statistical tools when populations are Not Homogeneous. Such situations occur when a product is made in different plants or used in different climates , seasons, or geographical areas. Or, an item you use might come from different suppliers. Furthermore, a system of items in series cannot be expected to maintain a fixed Weibull slope throughout its lifetime.

So, Rule #5 is simply a warning to beware of oversimplifying a real life situation , in which mixtures and a multiplicty of failure modes are the rule rather than the exception.

Among the many problems facing us in Product Reliability , the following stand out :

I THE SAMPLE SIZE PUZZLE

II THE SAMPLE SIZE ANSWER

III PRODUCT COMPLIANCE - A MODERN NECESSITY

IV THE FIELD DATA DILEMMA

For each of these problems, as we shall show in future Bulletins , the real answer is directly tied in with faithful obedience to the five rules we have just discussed.