CHAPTER 36

RELIABILITY PREDICTIONS

CONTENT

1. INTRODUCTION

Reliability prediction has been the subject of much discussion for many years. This chapter attempts to present a balanced view of the arguments such that the reader can decide on the applicability for a given application. The chapter will also emphasize appropriate use of the results and address the misunderstandings held by many engineers and engineering managers.

2. DEFINITIONS

2.1 Reliability

Reliability (as a performance measure) is the probability of being able to perform as required under given conditions for the time interval [1].

Reliability (of an item) is the ability to perform under given conditions for a given time interval [1].

2.2 Prediction

Computation process used to obtain the predicted value of a quantity [1].

The act of predicting (as by reasoning about the future) [2].

3. THE ISSUES

The true reliability characteristics of an item are never known until the item has been disposed off (see Serial 6), yet at various stages of the life cycle it is necessary to predict the reliability, so that decisions can be made (see Serial 7). There is not a common standard which identifies the appropriate method to be used; this results in subjective judgement being applied. This leads to conflict when the decisions are being reviewed by third parties.

4. BACKGROUND

There are various techniques available for predicting the reliability of an item, which can be split into the following categories:

a) Statistical models.

b) Parametric models.

c) Physical models.

The use of each of these can be considered to be a similar black box process, Figure 1.

Where a model is selected, some data is applied to it and some results are generated. In general the soundness of the process can be improved by having an extra stage where the results are compared to known values to ensure that the results are approximately correct. i.e. if this was a model to predict the life expectancy of civil servants and the answer was 150 years we might want to question the answer.

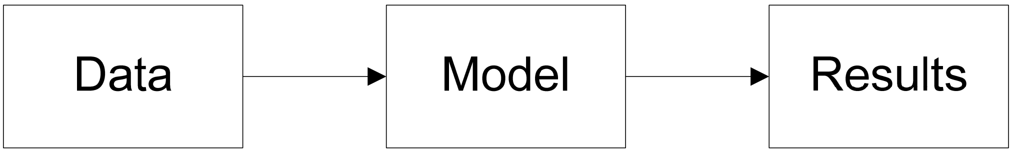

Figure 1 – Modelling Process

Additionally the competence of the people undertaking the prediction task and subsequent review will impact the effectiveness of the prediction; an individual with high competency cannot make up for a poor choice of model or data to use for the prediction (although should identify the weakness of activity), but a person with low competency is unlikely to develop a good prediction even if a good source of data and a reasonable model is selected.

5. OPTIONS

The following are considered as options to improve current reliability predictions best practice:

a) Continue as is; no recommendation on approach and leave Industry to do what it consider appropriate, this will mean the continuation of conflict and confusion.

b) Develop strict modelling guidance which means that everyone works to the same standard. On the surface this has the appearance of standardising the evidence presented to the MOD allowing a simple comparison to be made. This option is not practical for a number of reasons (see Serial 8)

c) Develop a standard approach to reporting modelling which allows the reader make judgements on the weight which should be placed on the prediction. A standard reporting framework is suggested at Serial 9.

6. WHY RELIABILITY IS NEVER KNOWN UNTIL THE END OF THE LIFE CYCLE

It is generally accepted that an item's reliability can be modelled by the bathtub curve, Figure 2.

Due to lack of knowledge it is never known if the reliability being seen is what will be seen in the future or will this change for instance:

a) A mechanical system which is a couple of years old, may in a few year time move in to the wear out phase and see increased failures.

b) A software system maybe suffering early life failures which will reduce as the bugs are cleared or as user training is improved.

Only at the end of life will all the failures have occurred and it will be possible to assess the true reliability (assuming that all required data is available).

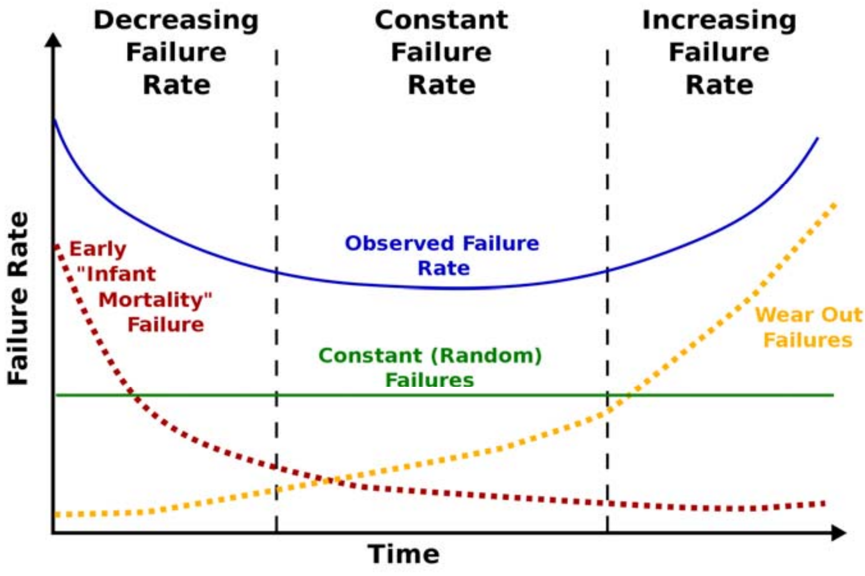

Figure 2 – The Reliability Bathtub Curve

7. RELIABILITY PREDICTIONS ARE REQUIRED TO MAKE DECISIONS

The reliability of an item requires to be predicted to enable a number of decisions to be made. These including:

a) System Engineering:

- Selection of one item over another;
- Selection of one supplier over another.

b) Supportability Engineering:

- Selection of appropriate maintenance;
- Selection of support infrastructure;
- Identification of tools and support equipment;
- Identifying the requirement for technical documents;
- Identifying training needs.

c) Logistics:

- Identifying range of spares;
- Identifying the scale of spares;
- Identifying when spares are required;
- Identifying turnover of spares.

d) Safety:

- That the reliability supports the safety needs.

e) Costing forecasting:

- Identifying the finance required to overcome unreliability;
- Identifying the through life cost of support.

f) Programme & Risk Management:

- Identifying the programme challenges of achieving the desired reliability levels.

8. THE PROBLEM WITH DEVELOPING A STANDARD MODEL FOR RELIABILITY

A standard model for reliability is a challenge as:

a) Different situations call for different approaches; can we define them all.

b) Different approaches can be applied to the same thing; do we wish to say one is always better.

c) Even for the same approach there are different tools, which may implement the approach differently.

d) There is always the user skill to consider.

e) The choice of data will always impact on the results even the same data type can have impact.

f) The level of granularity in the model will impact the results.

9. STANDARD PREDICTION REPORT

An unsophisticated forecaster uses statistics as a drunken man uses lamp-posts - for support rather than for illumination. Andrew Lang

In addition to the actual predictions and details of how the predictions were derived, the report should include:

a) Competence: Modeller's to include qualifications and training experience, more weight being given to a person with relevant;

- External recognition/qualifications;
- Training and development;
- Board knowledge (rather than a dedicate handle turner);
- Experience of similar systems/environments.

Reviewer's, as Modeller's.

b) Data: The source of data [3], order of preference being:

- Past test or field data based on similar equipment;
- Engineering analyses, failure mechanism modelling, and/or accelerated life testing;
- Subject matter expertise based on known reliability levels for comparable equipment and technologies;
- Handbooks.

Why this source of data is considered appropriate, the preference being for the data being appropriate rather than available.

Any areas of concern with respect to the data.

c) Model: Why the model is considered appropriate.

d) Tool: Why the tool has been selected.

e) Result Calibration: The preference being for evidence that the prediction reflects the real world.

10. RECOMMENDATIONS

A standard prediction reporting methodology is developed in accordance with Serial 9, once developed MOD will update its internal guidance so that project teams expect this type of evidence and has the ability to assess it

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REFERENCES

1 IEC 60050-191: International Electrotechnical Vocabulary – Part 191: Dependability

2 http://www.thefreedictionary.com/prediction

3 DOD Guide For Achieving Reliability, Availability, And Maintainability – section *4.5.2.13* *https://acc.dau.mil/adl/en-US/378067/file/51155/RAM_Guide_080305.pdf*