# Decision Making & Forecasting using the data available to Utilities – Pitfalls, Challenges, and Case Studies of ways forward

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## *ABSTRACT*

*Asset Management is increasingly discussed and employed for managing cable systems. Many utilities have limited data that is not amenable to traditional analysis/modelling approaches. The authors propose a number of methods that can be adapted to utilize the types of field data that utilities generally either have available or can be gathered together relatively quickly. These data may then be augmented with diagnostic results and age estimates to provide a basis for planning decisions.*

## *KEYWORDS*

Asset Management, Cable Diagnostics, Ageing, Weibull Analysis, Crow-AMSAA, Failure Prediction

## INTRODUCTION

The interest in Asset Management for Cable Systems continues to grow. There are many goals, but the most common are to a) wisely use the resources allocated to Operations and Maintenance and b) predict how these resources will need to grow with time as the system continues to age at a rate which is likely to be modified by the remedial actions.

Perhaps the key challenge is to develop the baseline models which realistically estimate the future under the "status quo" operation. In principle, this should be straightforward as all that is required for such estimates are the installation and failure records for the cable system. However, it is the acquisition of these simplest of data that has always been the challenge for people working in this area; as it is often reported that the data are limited, incomplete, and/or inconsistent. As a consequence simple "rules of thumb" (linear approximations of failure rates) / heuristics (age based conditioning) are often used in the base case models; with all the inherent in accuracies in these approaches. Clearly the heuristic approach poses a major hurdle for Asset Management programs which aim to develop a consistent and transferable approach to estimating the value of various intervention strategies. The uncertainty inherent in the base case makes it difficult to determine the optimal strategy either in terms of effectiveness or efficient use of limited resources. Furthermore, the magnitude or direction (smaller / larger) of the base case uncertainty is not known.

Cable System Diagnostics show great promise in guiding Asset Management programs [1-6] that require immediate feedback. However, they have not thus far provided assistance in the arena of predictions. Recent evolutions in the technology have led to the use of Data Driven Health Indices which provide a robust snap shot of current condition and indications of ageing dynamics via Age Lines. Unfortunately, diagnostics are not completely perfect for this application as they are not retroactive, require investment in data collection / collation, and are inherently "sampling-based" as it is not possible to test every circuit.

Historical utility data has always been attractive because they are available now, all encompassing (not sample based), segregated (age / type etc.) and completely historical thereby including all the transients / changes that have occurred on the system. Its use has been limited due to the concerns of data fidelity, changing data management systems, and dispersed storage. However, there have been some recent developments by which the data may be "cleaned" and "re assembled" in a practical and expedient manner. As a consequence much more of this type of analysis may be undertaken.

Thus there are attractions and drawbacks with both of the approaches available to utilities. This paper discusses these issues further and provides illustrations via Case Studies; thereby describing:

- Newly developed algorithms for Diagnostic Data that provide pre conditioning for use in Asset Management Analyses,
- Architecture of utility service data and why this makes "classical" analysis difficult,
- Data fidelity issues that compound the challenges of the architecture,
- Distribution fitting solutions for discrete devices (Parametric Modelling with assumed Failure Sequence),
- Trend evaluation and prediction for lumped failure per year data (Crow AMSAA),
- Modelling using pre-treated utility data (Parametric Modelling with Population Reconstruction)
- Indications of how they might be included in "value" case studies
- Dielectric Loss tests establishing system health with prognosis of future service performance under different remediation strategies
- Service Failure Data estimating Survival Curves for different cable system technologies and vintages, thereby providing guidance on the optimal intervention strategies

## CLASSIC RELIABILITY ANALYSES

Classic reliability analyses [7] use failure data from the field to fit probability distributions. These distributions allow the engineer to do a number of useful things

1. Consider the whole population, the survivors together with the failures,
2. Obtain a figure print of the failure mode – this is generally the gradient of the curve, and