Decision Making & Forecasting using “Real” Utility Data – Pitfalls, Challenges, and a Way Forward

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Outline

• Introduction
• Service Performance Data - What’s the issue?
• Prediction
• Data Re-Construction – Filling in the Gaps
  – Example
• Conclusions
Introduction

• Interest in Asset Management for Cable Systems continues to grow.

• The goals are to
  1. Wisely use the resources allocated to Operations and Maintenance
  2. Predict how these resources will need to grow with time as the system continues to age
  3. Estimate when the threshold is reached

• Key challenge is: develop baseline models which realistically estimate future under “status quo” operation.
A Typical Annual Performance History

[Graph showing the trend of failures in service and total SAIDI from 2002 to 2012.]
What are the roadblocks to use

• Completeness of the data – annual versus vintage
• Accuracy of the data
  – Everything is a cable failure
  – Forgetting to go back to correct entries
• Dispersal of the data (stored in different places)
• Changes
  – Recording systems
  – Categories
Base Case Prediction is Possible

![Graph showing failure rates for cable, joint, elbow, and termination over experience years: 2002, 2010, and 2015. The graph indicates that model fit predictions are possible for these failure rates.](image-url)
Predictions for TXU FIS from Jicable 2007

![Graph showing estimated cumulative experience vs. number of failures for different materials: HMWPE, Classic XLPE, and Additive WTR XLPE.](image-url)
Effectiveness of Scenarios

• This style of Base Case shows:
  – What happens in near future in “do nothing” case
  – Indicates if more or Less resources are required
  – Shows if the resources are effective

• This style of Base Case does not help to
  – Understand what vintage contributes
  – Understand the impact of targeted resources

• For this analysis we need to know where the Failures In Service (FIS) came from

• A Big Job – 17000 FIS records
A Big Job

• What we are trying to do is estimate what has happened to the components installed in 1970, 1980 etc
• Then we can estimate curves for all vintages
  – Predict into the future
  – Model effect of different scenarios

• A big job for 17000
• Not such a big job for
  – Records going forward today
  – Records from recent past (say 2 years)
Re Construction Approach

• Select a recent period of FIS – say 3 to 4 yrs
• Add age data using rules / approximations
  – Age of ancillary equipment
  – Construction date of neighbourhood
  – Returned Samples
  – Line Crew Interviews
• Develop Weibull Curve
• Sanity check against “bathtub”
• Use installation records to appropriately scale
• Input heuristic utility knowledge
Process

- Segregate: EPR, HMWPE, XLPE, WTRXLPE, PILC
- Est. Installed Base (Purchase (data) – Removal (heuristic))
- Estimated age at FIS, Confirm device (if possible)
Installed Base and Failures In Service

[Graph showing cable age vs. number of sections and age at fail vs. number of sections]
Utility Heuristic Knowledge

• All failures are repaired - No Replacement
• Good performance in early years
• Purchase records are reliable
• Few Hybrid/mixed circuits
Age Segregated Failures

![Graph showing age segregated failures with different age classes and percent age at RS (yrs)].
Estimated Combined Survival Curve
Failure In Service Prognosis

![Graph showing cumulative number of failures in next 20 years vs current cable age in years. The x-axis represents the current cable age in years, ranging from 0 to 50, and the y-axis represents the cumulative number of failures in the next 20 years, ranging from 0 to 50. The graph shows a distribution of failures with a peak around the 30-year mark.]
Multi-Year Prediction (Synthesized Data)

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<th>Year</th>
<th>Actual Annual Failures</th>
<th>Model I Estimates</th>
<th>Model II Estimates</th>
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Model I – Full Vintage Data
Model II – Annual Data only

Variable
- Actual Annual Failures
- Model I Estimates
- Model II Estimates

Year
Annual Failures [#]
Replacement Rates

- More complete information gives less “fuzzy” estimates
- Perceived efficiency is lower without vintage data

![Graph showing Failure Reduction vs. Replacement Components]
Conclusions

• Many issues to consider at start:
  – Oldest portions of system that remain may be the “best” versions of those technologies
  – Vintage data is rarely available for analysis
  – Can start to improve record keeping at any time

• Commonly available utility data offers limited help for predicting system performance

• Able to combine heuristic knowledge and available service performance data to make reasonable estimates going forward.