

Join us for our NEW webinar! Analysis of Repair Data by Dr. Wayne Nelson

March 7, 2018 8:30-11:30 am Pacific time (California) 3 hours Cost \$300 per person, Group discounts available.

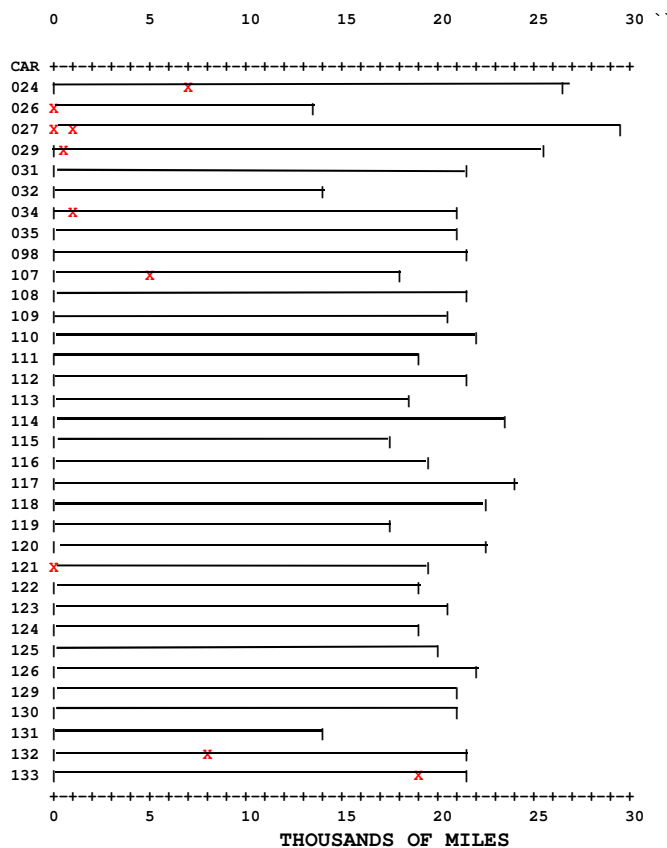
[Register here!](#) and pass this on to your co-workers!

Most reliability and survival data analyses deal with data with one event for each sample unit, end of life. However, in many applications, sample units can undergo repeated events, such as repairs of products, recurrences of tumors, consumer purchases on the Internet, remarriages, and reincarcerations. This course presents new analyses of such recurrent-events data that include costs, not just counts, of recurrences, which do not yet appear in most texts.

Participants need only a previous statistics course or two. The 3-hour course which costs \$300 per person covers:

INTRODUCTION TO RECURRENT EVENTS DATA AND APPLICATIONS

This introduction describes recurrent events data on a sample of units from a population and the information sought from such data. Such data are illustrated with three data sets: transmission repairs on cars, bladder tumor recurrences, and births of children to statisticians. The first two sets contain exactly observed event and censoring times; the third contains interval (grouped) data. Methods for graphically displaying and interpreting such data are given.



Display of automatic transmission data in production order.

This topic covers the population model for such recurrent-events data -- a simplified stochastic process model consisting of a cumulative history function for each population unit. These population functions are summarized with the population Mean Cumulative Function (MCF) for the "cost" or number of recurrences. The MCF yields most information sought in applications, for example, the number of transmission repairs on warranty and the repair rate as a function of population age, useful for planning maintenance. The model extends to continuous history functions, such as power output of an electric generating plant, and to left censored and interval data.

ESTIMATE OF THE MCF FOR EXACT DATA

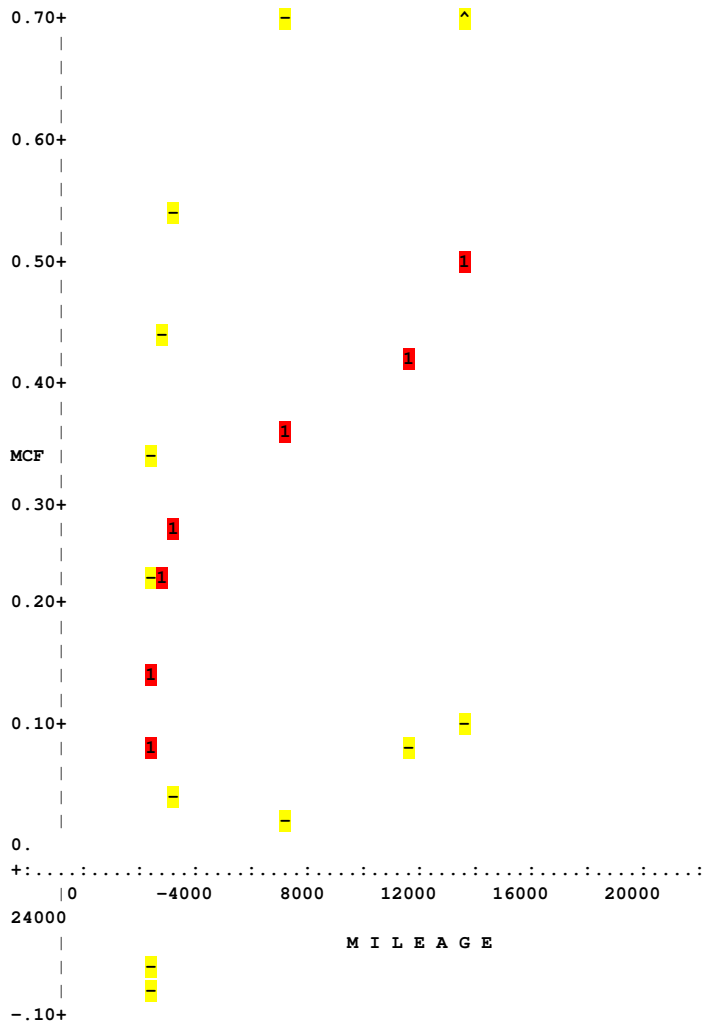
This topic provides a nonparametric estimate of the MCF, its plot, and its interpretation. It shows how to calculate and plot the MCF estimate for exact data (exact values of event and censoring times). The MCF estimate is illustrated with the transmission and bladder tumor data. The interpretation of the plot provides, among other information,

- the behavior of the recurrence rate (increasing or decreasing) as the population ages, important for product burn-in, overhaul, and retirement decisions,
- a prediction of the number or cost of recurrences for sample units in a future time period,
- an estimate of the average number or cost of recurrences up to a specified age, such as warranty age or at infinity,
- a comparison of data sets from different product designs, medical treatments, subpopulations, etc.,
- unexpected useful information, a great advantage of data plots.

This includes a survey of widely-used commercial statistical software that calculate and plot the MCF estimate; such calculations can be done with a spreadsheet. A technical section explains the underlying assumptions and properties of the MCF estimate and typical difficulties in applications.

CONFIDENCE LIMITS FOR THE MCF

This topic covers approximate confidence limits for the MCF for exact data. They are illustrated with the transmission and tumor data. This includes a survey widely-used commercial statistical software that calculate and plot the MCF estimate and its confidence limits. Technical details include the underlying assumptions and properties of the limits.



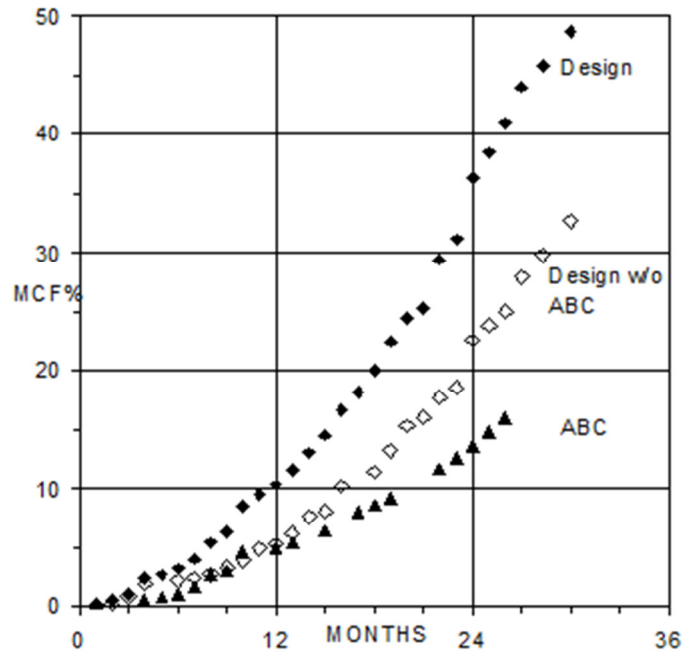
Manual transmission MCF and Nelson's 95% limits.

ANALYSIS OF DATA WITH A MIX OF EVENTS

Many applications involve more than one type of event. This topic deals with data with a mix of events; for example, a product may fail from a number of causes and a birth may be a boy or girl. Usually one seeks to estimate the MCF

- for all events combined,
- separately for a particular event (say, a particular failure mode),
- for certain combinations of events (say, all types of failures on a particular subsystem),
- for the population when certain events are eliminated (say, through a product redesign that eliminates failure modes).

These estimates are illustrated with data on subway car motors and naval turbines.



Subway Car Motor MCF with and without Failure Modes A, B, and C.

ESTIMATE OF THE MCF FOR INTERVAL DATA

This topic provides an estimate of the MCF for interval data, where event and censoring times are grouped into intervals. The estimate is illustrated with the childbirth data, which includes a comparison of the MCFs of men and women and data on refrigerator defrost controls to predict the demand for replacement controls.

COMPARISON OF SAMPLES

This topic provides confidence limits and a plot to compare two sample MCFs. This is illustrated with the transmission and tumor data sets. This includes a survey of commercial statistical software that calculate and make the plot. A technical section explains the underlying assumptions and properties of the comparison.

SURVEY OF FURTHER METHODS

This surveys parametric methods for analysis of recurrence data, which fit a mathematical function f or the MCF to the data. Topics include

- the Poisson and nonhomogeneous Poisson models, data analyses, and software,
- reliability growth models, data analyses, and software,
- renewal models and data analyses,
- models and data analyses for a single observed unit, rather than a sample of units,
- Poisson models with covariates, data analyses, and software,
- Cox regression model for recurrent events with covariates, data analyses, and software.

COURSE MATERIALS. Course participants will receive detailed written materials on all topics covered in the webinar. Those who wish to delve deeper into recurrent events data analysis will find Dr. Nelson's book most useful: ***Recurrent Events Data Analysis for Product Repairs, Disease Recurrences, and Other Applications***, by Wayne B. Nelson, ASA-SIAM

Series on Statistics and Applied Probability, SIAM (Philadelphia, PA, www.siam.org/books/sa10/, 800-447-7436 orders), Copyright 2003, xi+154 pp., ISBN 0-89871-522-9.

INSTRUCTOR Dr. Wayne Nelson is a leading expert on reliability and accelerated test data analysis, and he has made significant contributions to recurrence data analysis. Formerly with General Electric Research & Development for 24 years, he now privately consults on and teaches engineering applications of Statistics for many companies, professional societies, and universities. For his contributions to reliability data analysis and accelerated testing, he was elected a Fellow of the Amer. Statistical Assoc. (ASA), the Inst. of Electrical and Electronics Engineers (IEEE), and the Amer. Soc. for Quality (ASQ). He also authored two popular Wiley books ACCELERATED TESTING and APPLIED LIFE DATA ANALYSIS. Among his 130+ publications, he received the Brumbaugh, Wilcoxon, and Youden Prizes of ASQ and 9 outstanding presentation awards from ASA. ASQ awarded him the 2003 Shewhart Medal and 2010 Shainin Medal for his technical leadership. In 2005, the IEEE Reliability Soc. conferred on him its most prestigious Lifetime Achievement Award for his many outstanding contributions to reliability and accelerated test data analysis and reliability education. Contact him at WNconsult@aol.com