Failure Forecast For
The World's Most Unsafe Railroad

The world's most unsafe railroad is considered to be Houston's METRORail 7.5 mile long (12 KM) light-rail, commuter railroad, located in Houston, Texas.

Numerous accidents have occurred since the commuter railroad commenced operation in late 2003. Early studies of the accidents and corrective actions recommended are described in an executive summary or the full 58 page report by Texas A & M University's Texas Transportation Institute. Reasons for the accidents (failures) have a variety of causes (i.e., mixed failure modes) from people attempting suicide, running red lights in front of the train, automobiles turning in front of the train, drunks falling into the path of the train, and numerous other strange events that you would not predict. Many of these events clearly fit the category of MTBSE!

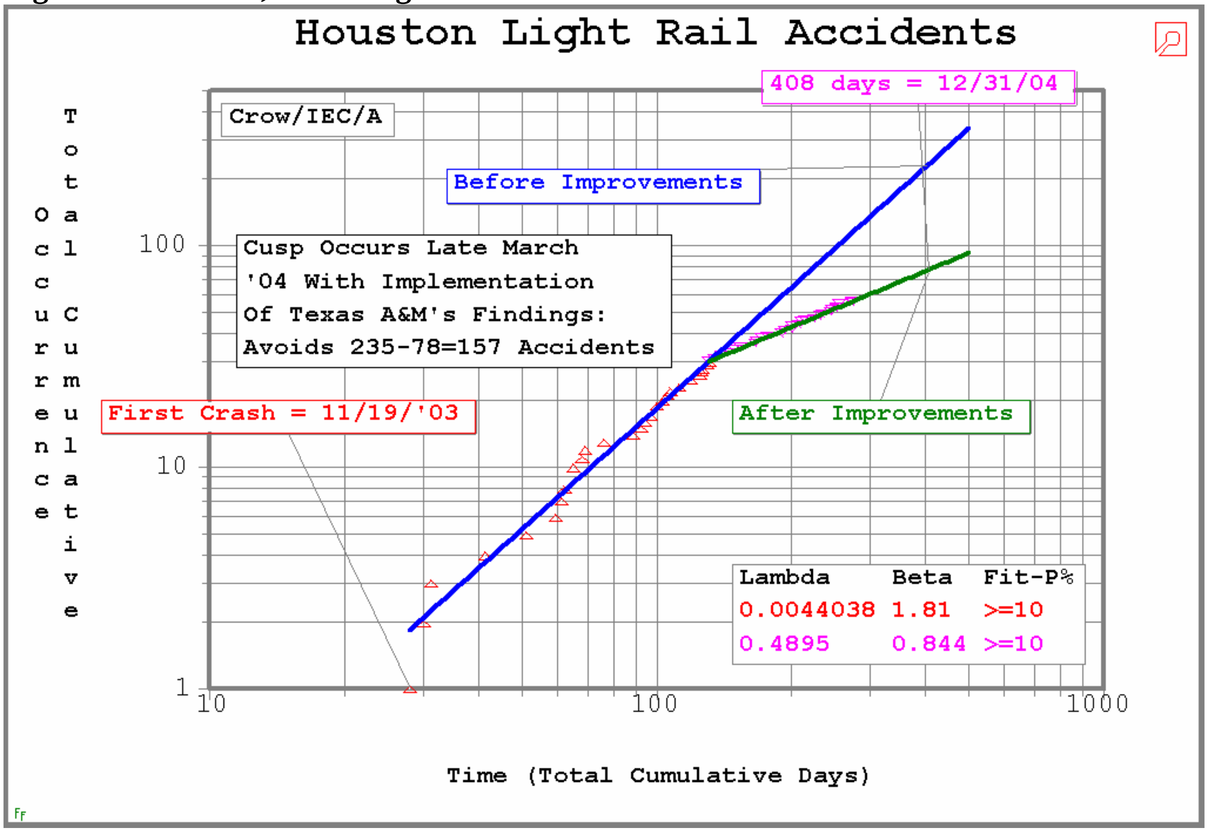
Light rail accidents are reported by the Houston Chronicle newspaper at http://www.chron.com/content/chronicle/special/04/lightrail/accidents/ltrail.html . A portion of the failure or accident information can be downloaded as an Excel spreadsheet by clicking here.

The question is:
How many accidents have been avoided in 2004 based on implementing improvements suggested by a Texas A&M traffic study which occurred mid year?

Crow-AMSAA (C-A) plots are one successful method for clearly presenting failure data. C-A plots are tools frequently used by reliability engineers when dealing with mixed failure mode data. Data plotted on log-log paper often presents itself as straight lines. You can search this website by clicking here for other examples of C-A plots including the theory which drives the method. The task of reliability engineers and traffic engineers is to make improvements to reduce the failure trend lines and thus make a cusp appear on the C-A plots to signify progress.

Using the Houston Chronicle failure data I have built a Crow-AMSAA plot. It shows a clear cusp, following the improvements, for the world's most unsafe railroad in Houston, Texas. See the C-A plot in Figure 1. The red triangular data points show the early accidents prior to implementing improvements. The magenta inverted triangular data points show a reduction in accidents after the improvement program. The cusp is clear. Improvements have occurred. Fewer accidents are occurring.

Figure 1: Houston, Texas Light Rail Line Accidents



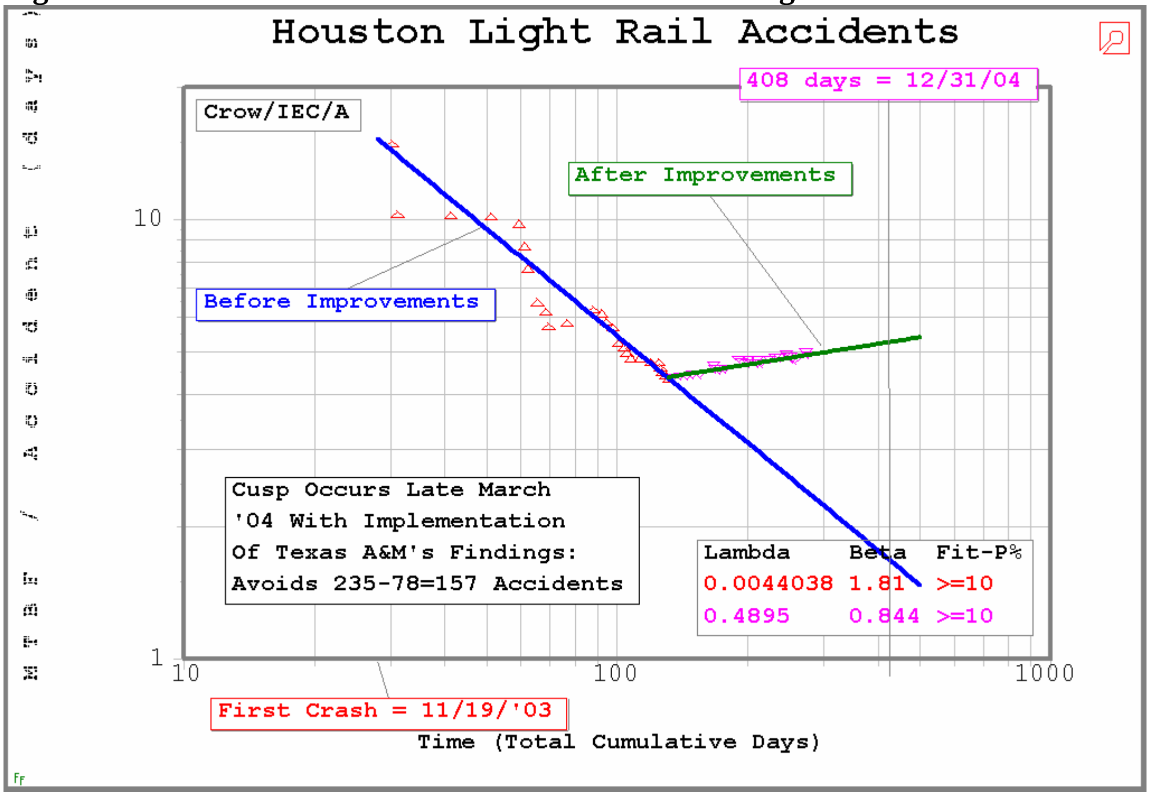
Extrapolating the **no-improvement** trend line to the end of 2004 suggests 235 failures would have been expected by December 31, 2004 which is 408 cumulative days. Extrapolating the **improvement** trend line in a similar manner shows 78 accidents are expected by the end of 2004. Improvements have occurred. Expect an accident reduction of 235-78 = 157 accidents by the end of 2004. ***C-A plots are "show me, don't tell me" about improvements.*** The actual accident failure count at the end of 2004 was **67** accidents versus the **78** accidents predicted in August 2004—see Figure 3.

A C-A plot in Figure 1 visually shows improvements have occurred to reduce accidents. Furthermore the simple graphic allows quantification of how much of an improvement has really occurred during a time interval to justify the improvement programs. The line slopes of the C-A plots are helpful in determining how much improvement/deterioration has really occurred. Line slope statistic, beta, is a key clue:

1) When **beta>1** (as occurred before the improvement program) failures are coming more quickly,
2) When **beta ~1** failures are not improving or deteriorating, and
3) When **beta<1** (as illustrated after implementing Texas A&M's improvements) it tells failures [accidents] are coming more slowly.

If failures are coming more slowly, then the mean time between failures should be growing. See the evidence for this improvement in Figure 2.

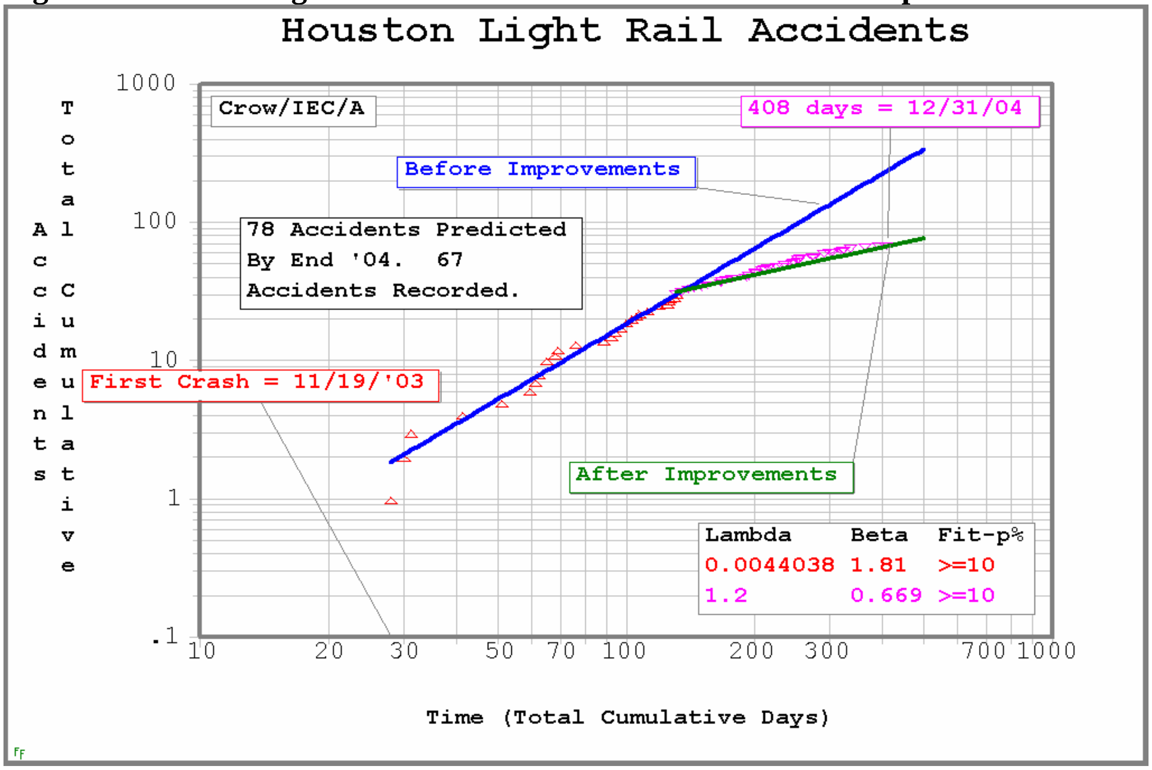
Figure 2: Mean Time Between Accidents For Houston Light Rail



The graphical evidence is clear. Powerful improvements are underway to reduce failures and grow the mean time between failures as shown in Figure 2.

Figure 3 shows the year end results for 2004. Compare to Figure 1's forecast. Note the fewer failures and also note the smaller beta = 0.699 which says further improvements are being made to reduce accidents.

Figure 3: Houston Light Rail Accidents End Of Year 2004—An Update



These C-A plots were made using WinSMITH Visual software.

Thanks to Ken Young of Mohr Engineering Division of Stress Engineering Services, Inc. for pointing out the data for this Problem Of The Month. Thanks to Loyd Hamilton of Lyondell-Citgo Refining LP for accident statistics updates. The update statistics were taken directly from the Chronicle website hyperlink listed above.

Return to the list of problems by **clicking here**.

Refer to the caveats on the **Problem Of The Month Page** about the limitations of the solution above. Maybe you have a better idea on how to solve the problem. Maybe you find where I've screwed-up the solution and you can point out my errors as you check my calculations. E-mail your comments, criticism, and corrections to: Paul Barringer by **clicking here**. Return to the top of this problem.

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