Forecast Of The Next Space Shuttle Failure

The world's most complicated flying system with humans aboard is the space shuttle. It is expected to resume flights sometime between May 12 and June 3, 2005 to complete the international space station.

Articles appear lamenting the aging space shuttle fleet. This suggests future space shuttle failures are imminent. Using the actual failure data and reliability growth plots, when is the next space shuttle failure forecast?

Data for space shuttle launches/landings is summarized in an Excel spreadsheet. For success, the number of launches must equal the number of landings. Figure 1 summarizes the data on a Crow-AMSAA reliability growth plot along with a forecast of when the next failure is expected.

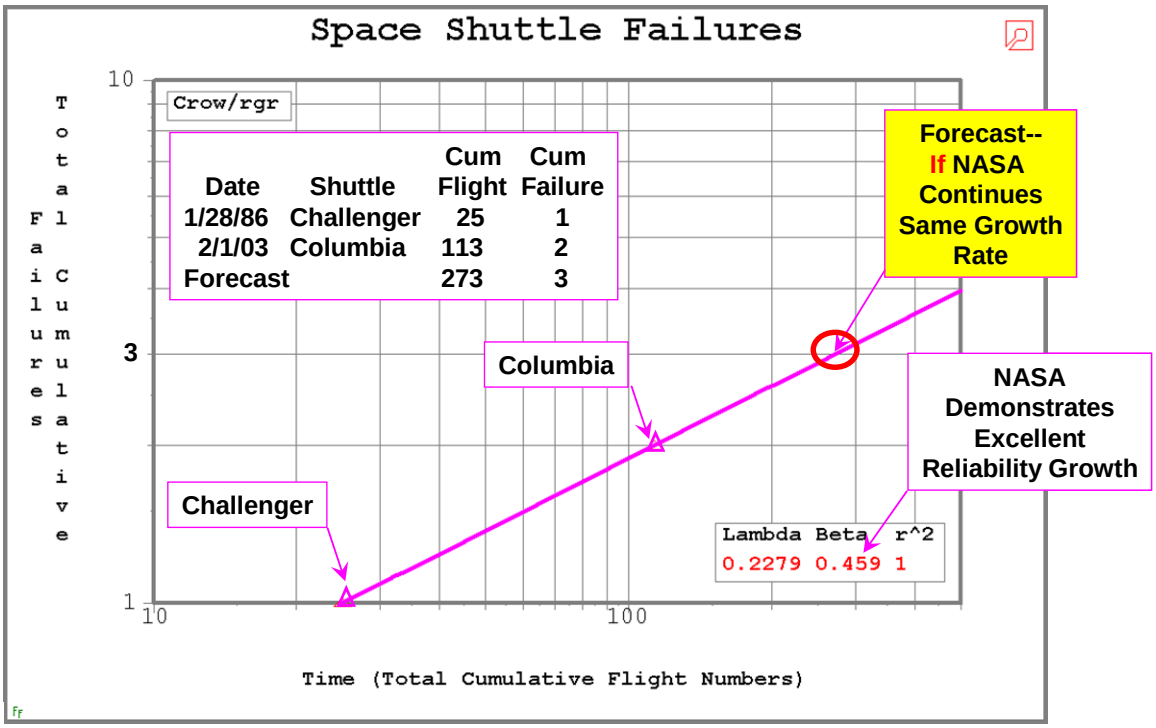

Figure 1: Crow-AMSAA Forecast Of Next Space Shuttle Loss

Figure 1 shows NASA has demonstrated excellent reliability growth. Reliability growth is indicated with the beta value substantially less than 1.

On Crow-AMSAA plots, when:

beta < 1, reliability is improving and failures come more slowly,

beta ~ 1, the system is not improving and not deteriorating, and
beta > 1, reliability is deteriorating and failures are coming more quickly.
The anguish over aging space craft is not demonstrated by the facts if NASA continues their excellent improvements!

Figure 2 clearly makes reliability visible with a plot of the mean time between failures (MTBF). When MTBF increases with time (time is measured in flight numbers), reliability is improving. When MTBF neither increases or decreases, then reliability does not improve or deteriorate. When MTBF declines with time, then reliability deteriorates.

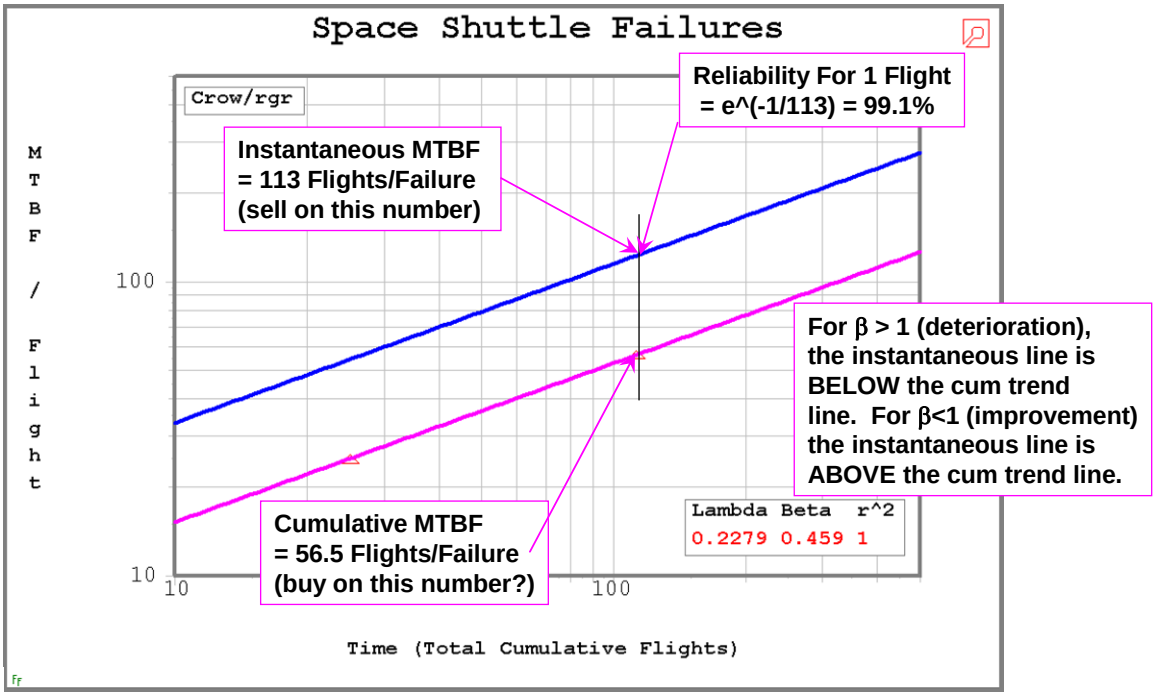

Figure 2: MTBF Trend Line and Instantaneous MTBF Trend Line

The MTBF trend line shows the overall history. The instantaneous trend line shows the MTBF at each instant. The instantaneous trend line is above the overall history trend line when beta < 1. However, when beta>1, the instantaneous trend line lies below the overall history trend line.

Figure 3 shows the overall reliability of the space shuttle and the instantaneous reliability. Of course the risk for failure is the complement of the reliability.

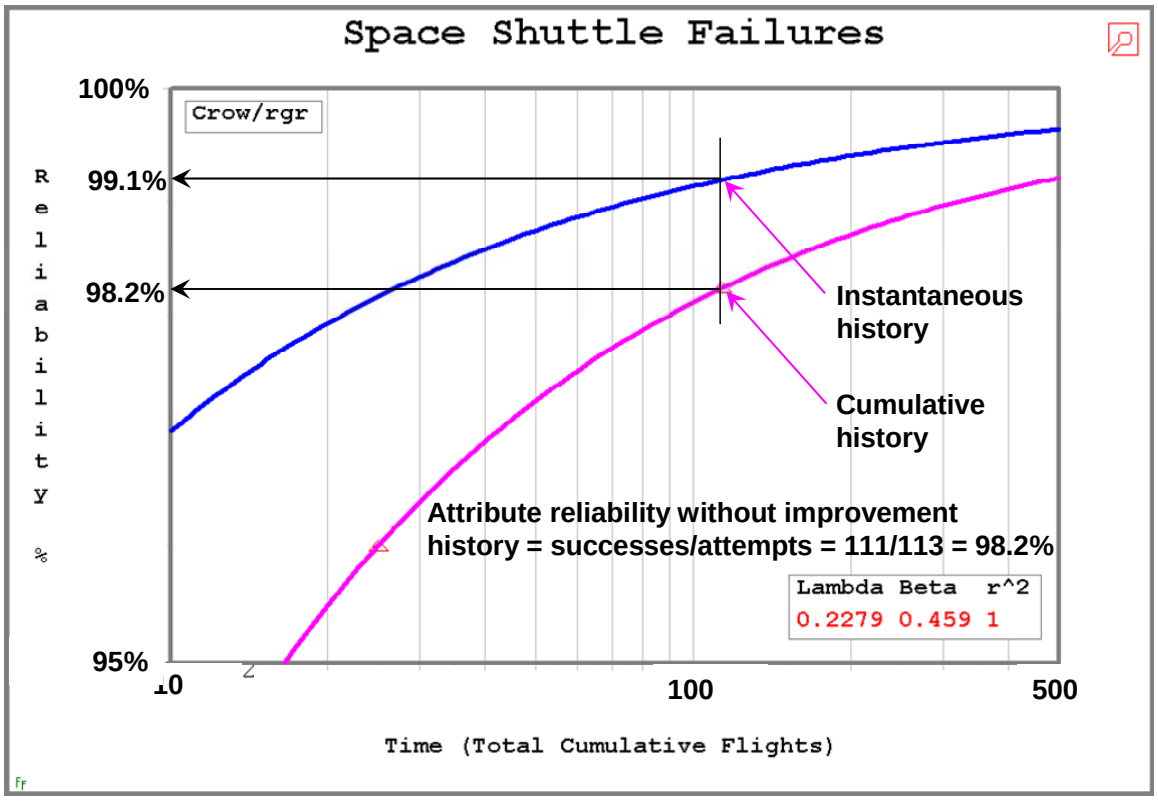

Figure 3: Space Shuttle Reliability

For the Columbia space shuttle on flight number 113, the risk for failure was 1-0.991 = 0.9% probability for failure. The amount of money at risk for a space shuttle flight 113 was:
$risk=pof*$consequence = 0.009*US$4,000,000,000=US$36,000,000 of exposure. This is based on the consequence as the sum of capital cost = US$2 billion plus the retrival, analysis, and human cost =US$2billion. Clearly no private enterprise company will insure each space flight!

The forecast of the next failure at flight number 273 carries an error of approximately ±10% so the next failure could be as short as flight number 246 or as long as flight number 300. If you were insuring the space shuttle, I'd suggest you let your competitor win the bid for insurance on flights within the range of 246 to 300 while you make competitive bids either side of the range to get the business.

Can failures occur before that flight number 273? Of course!—particularly if we have shorter MTBSE! The evidence for MTBSE would display as a tilting the trend line in Figure 1 upward. You can also argue the loss of Challenger and Columbia were the direct result of management MTBSE. Of course management decisions looked good before the crash, but after the crash you can see the undesirable management decisions expresses as MTBSE.

The graphs are made using WinSMITH Visual software. You can download a no cost demonstration version of the software and a ZIP copy of the authentic files for import into the demo software. The demo software will randomize your data slightly if you manually input the data, however, by use of the unzipped files, the data will be handled with fidelity.

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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

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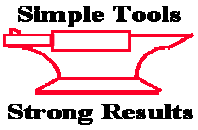

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