The Fallacy of MTBUR & MTBF as Reliability Metrics

Thomas Carroll

NetJets, Inc

October 25, 2005

Traditional Measurement

- Mean Time Between Unscheduled Removals (**MTBUR**)

- Mean Time Between Failures (**MTBF**)

Great for measuring **rates** of removals or failures, but do they actually indicate reliability?

How Are They Calculated?

MTBUR =

$$\frac{\text{Number of flight hours x units installed per aircraft}}{\text{Number of unscheduled removals during that period}}$$

MTBF =

$$\frac{\text{Number of flight hours x units installed per aircraft}}{\text{Number of shop confirmed failures during that period}}$$

What Should a Reliability Measure Do?

- Identify reliability issues
  - Premature failures
  - “End of Life” failures
  - Rogue components
  - Shop workscope shortcomings
  - Scheduled maintenance program problems

What Does MTBUR NOT Tell Us?

- Reliability issues
  - Premature failures
  - “End of Life” failures
  - Rogue components
  - Shop workscope shortcomings
  - Scheduled maintenance program problems

MTBUR is Extremely Misleading

Assumption:

MTBUR indicates the average (mean) time a component spends in service

- So it is often used to set maintenance program intervals
  - If the MTBUR is 30,000 hours, the program is set for 28,000 hours

Fact:

MTBUR has **nothing** to do with the amount of time a component spends in service

MTBUR Example

- An operator puts 20 aircraft in service January 1
- For a particular component, there are 2 installed on each aircraft, which equates to an in-service population of 40 components
- By December 31, each aircraft has operated 3000 flight hours
- The total component operating hours = 120,000 hours (40 components x 3000 flight hours)
- If 4 components were replaced, the MTBUR would be 30,000 hours (120,000 hours / 4 removals)

How Can it Be?

How can the MTBUR be 30,000 hours, when the most any component operated during that year was 3000 hours?

➔ Because MTBUR is the ***rate*** of replacement

For every 30,000 hours of combined component operational hours, 1 unit was replaced

MTBUR has **nothing** to do with how long each component is in service

MTBUR Disregards Time in Service

(100,000 hours) x (2 units per aircraft)

$$\frac{\text{Number of flight hours x units installed per aircraft}}{\text{Number of unscheduled removals during that period}}$$

(10 unscheduled removals)

These 10 could be:

- ⇨ 10 different serial numbers removed once each with very high time in service
- ⇨ 2 different serial numbers removed 5 times each with extremely short time in service

Using MTBUR, there is no distinction in performance

MTBF is All That - And Worse

- Same inconsistencies and inadequacies as MTBUR calculation
- Confirmation of failure is determined by shop technician trying to correlate subcomponent failure to the reported system failure
- Many times shop technicians aren't proficient with the system operation

The Challenge

- How can reliability be measured without using MTBUR or MTBF?
  - View each Component and End Item individually
    - They all have a stories to tell
  - Don't cut their lives into pieces
    - Life is continuous, with a beginning and an end
  - Look at all the individuals at the same time
    - See the removed and the installed simultaneously
    - Compare the "good" to the "bad"
- How can it be done?
  - Mapping each individual as a unique life

Mapping the Individuals

- Gather all the factors related to the data
  - Hardware specifics
    - Component serial numbers
    - Component part numbers
    - Reasons for removal
    - End Item ID numbers
  - Stream of time
    - Compile the data in a continuous flow from birth to death
- Arrange the data in a visual display
  - By Component Part Number or End Item population

It Takes New Analysis Techniques

- Visual assessments of problems
  - Batch
  - Seasonal
  - Maintenance programs
  - Rogue serial numbers
  - End of Life
- Multi-layered assessments
  - Overhauls
  - Operational impacts
  - Modification accomplishments
  - Other related system issues

Bottom Line

- With innovative reliability measurement and analysis techniques, less manpower will be spent on sifting data and chasing “ghosts”
  - Problems will be quickly identified and quantified
  - The course toward solutions will be easily charted

- Reliability measurement will no longer be a liability, generating more questions with minimal results
  - It will be a tool to improve the performance of systems and components, as a valuable **asset**

The Fallacy of MTBUR & MTBF as Reliability Metrics

Thomas Carroll

NetJets, Inc

October 25, 2005