Reliability Engineering Services
HALT & Classical Techniques
"Reliability Integration"

OPS A LA CARTE®

Misuses of MTBF

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Overview

- How does your organization talk about reliability?
- How do your customers talk about reliability?
- Is there a disconnect?

Overview

- MTBF – calculation
- MTBF – a very poor four letter acronym
- History of Use
- MTBF is often Misleading

Examples of misuse of MTBF

- **"MTBF is when 50% fail"**
- **"MTBF is the failure free period"**

MTBF Calculation

$$MTBF = \frac{\#\,hours}{\#\ failures}$$

$$MTBF = 1/\lambda$$

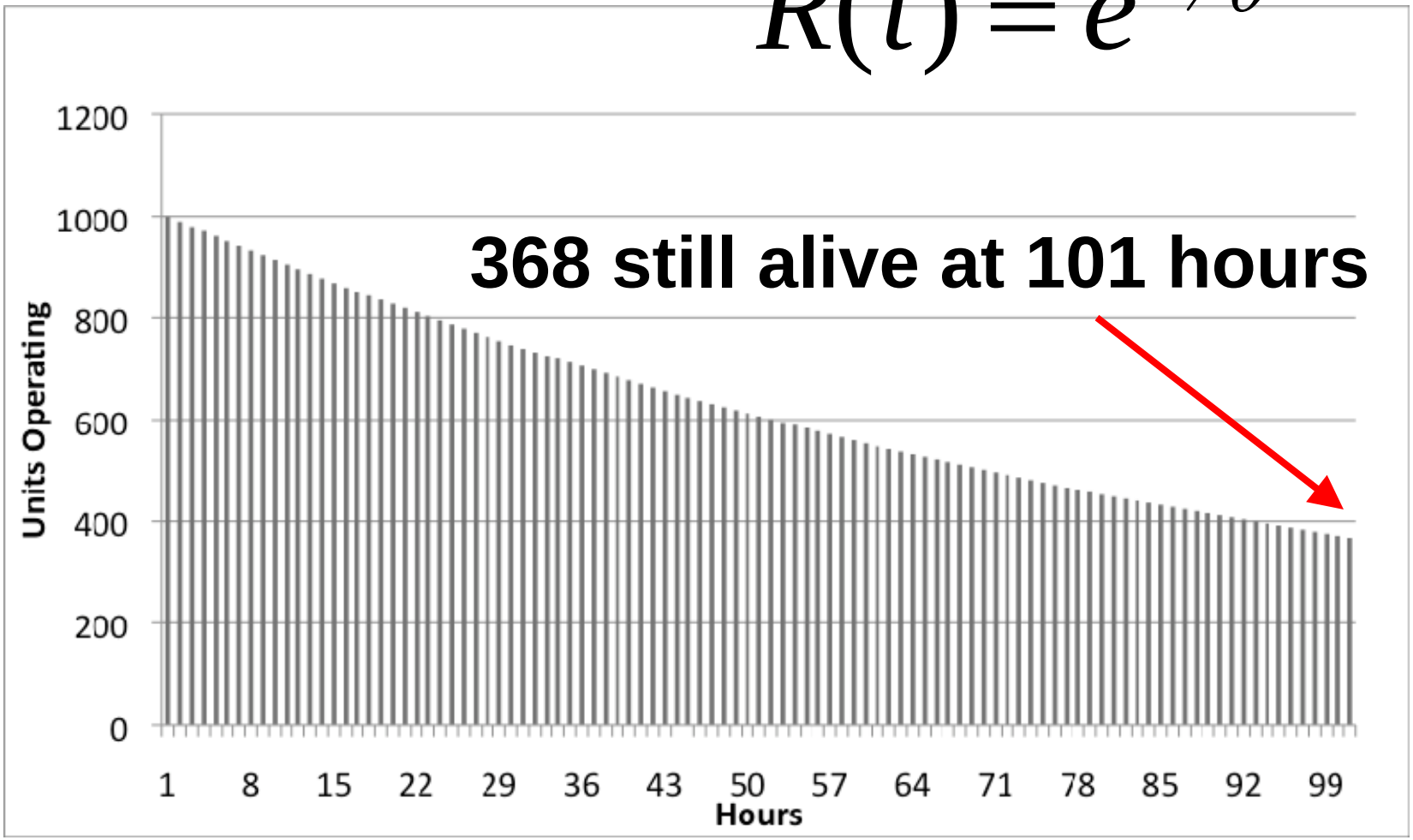
Mean (M)

- **The "Mean" in MTBF**
- **What does it mean to you?**

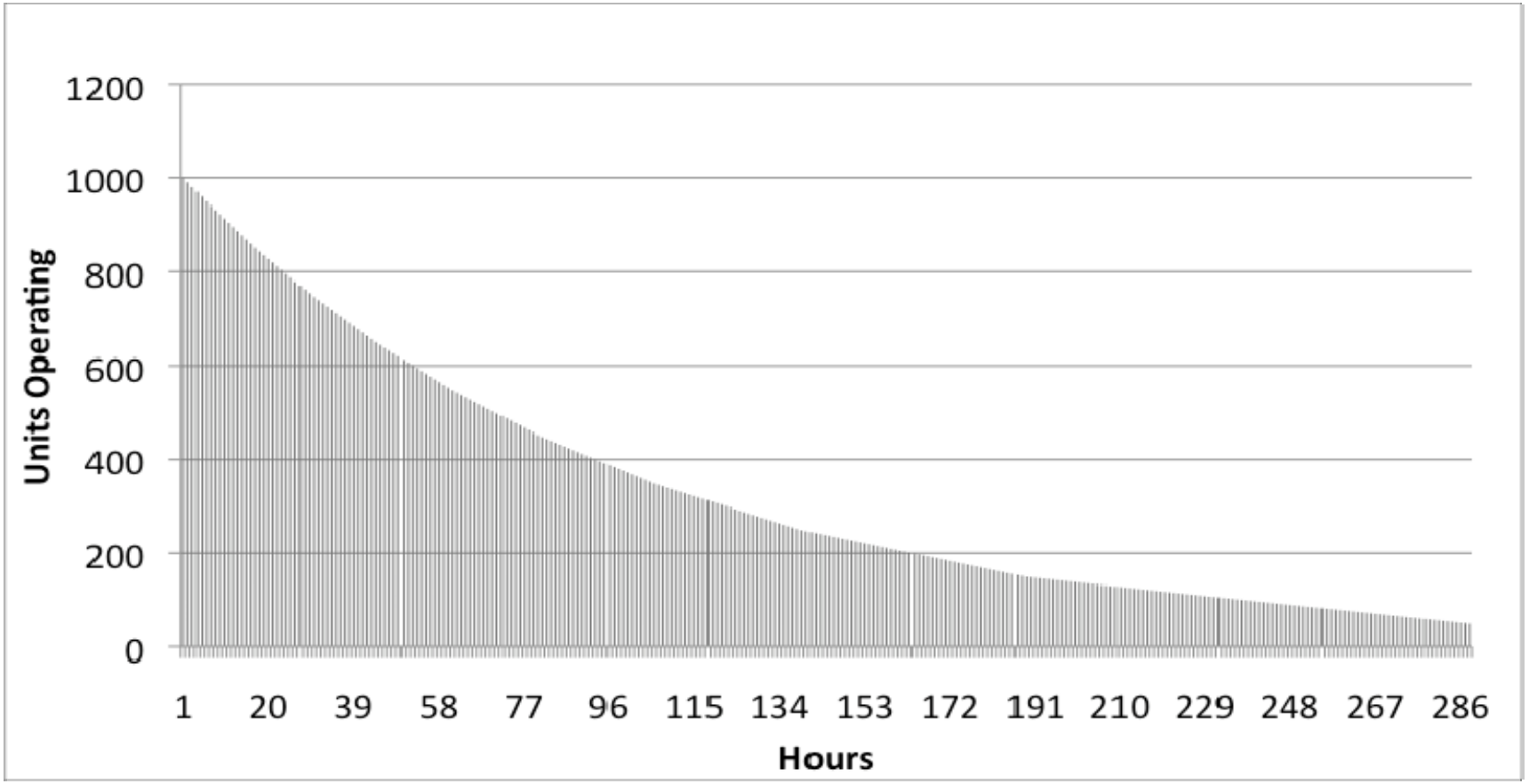
  (No pun intended!)
- **Average?**

Start 1000 units, MTBF = 100

$$R(t) = e^{-t/\theta}$$



Note the exponential decay



Other Issues

- **Time – just because it is hours…**
- **Between – not the duration of the failure free period!**
- **Failure – start with the customer definition and get agreement on the definition of relevant and non-relevant failures**

History of Use

- **Remember Slide Rule Mechanical Adding Machines**

History of Use

- **Parts Count Predictions based on adding failure rates of components**

$$R(t) = e^{-\lambda_1 t} \bullet e^{-\lambda_2 t} \bullet \cdots \bullet e^{-\lambda_n t}$$

$$R(t) = e^{-(\lambda_1 + \lambda_2 + \ldots + \lambda_n)t}$$

Use Reliability

- **R(t) is the probability that a random unit drawn from the population will still be operating by t hours**
- **R(t) is the fraction of all units in the population that will survive by t hours**

Complete Reliability Specification

- **Function – what the product does**
- **Duration – time, t**
- **Probability – R(t)**
- **Environment – where and how product used**
- **Consider the duty cycle of the product when specifying the calculation**

Other Measures

- What is the cost of a field failure?
- Warranty $ per unit shipped
- Returns/field failure $ per unit shipped
- What else could you use?

Actually…

- **MTBF is or should be used for repairable systems**
- **MTTF should be used for non-repairable systems**
- **MTTF is calculated the same as MTBF when we assume**
  - negligible repair time
  - Interarrival times as from an independent sample of nonrepairable parts
  - Expontential distribution for lifetime of parts

Impact

- **Understanding the aspects of MTBF has a significant impact on:**
  - Managing warranty costs
  - Life Cycle Cost Calculations
    - Comparison of alternative systems
    - Customer operating cost predictions and guarantees
  - Customer Satisfaction

www.nomtbf.com

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Author's Biographical Sketch – Fred Schenkelberg

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- Fred Schenkelberg is a Senior Reliability Engineering Consultant at Ops A La Carte. He is currently working with clients using reliability assessments as a starting point to develop and execute detailed reliability plans and programs. Also, he exercises his reliability engineering and statistical knowledge to design and conduct accelerated life tests.
- Fred joined HP in February 1996 in Vancouver, WA. He joined ESTC, Palo Alto, CA., in January 1998 and co-founded the HP Product Reliability Team. He was responsible for the community building, consulting and training aspects of the Product Reliability Program. He was also responsible for research and development on selected product reliability management topics.
- Prior to joining ESTC, he worked as a design for manufacturing engineer on DeskJet printers. Before HP he worked with Raychem Corporation in various positions, including research and development of accelerated life testing of polymer based heating cables.
- He has a Bachelors of Science in Physics from the United States Military Academy and a Masters of Science in Statistics from Stanford University. Fred is an active member of the RAMS Management Committee and currently the IEEE Reliability Society Santa Clara Valley Chapter Vice President.

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- Art Degenholtz is a is a Senior Reliability Engineering Consultant at Ops A La Carte. Prior to joining Ops A La Carte Art was a consultant at Curtiss-Wright Controls in the areas of Reliability, Maintainability and Safety. Art also consults in the area of certification of organizations to ISO9001:2000 and AS9100B requirements.
- Prior to his work at Curtiss-Wright Controls Art was the Product Support Manager at Allied Signal Test Systems Division in Teterboro NJ and was responsible for reliability, maintainability and safety of automated test equipment. Additional responsibilities included: reliability planning and allocations, field reliability data, failure modes effects and criticality analysis and reliability testing.
- Art is a licensed Professional Engineer (New York State) and a Registered Patent Agent, registered to practice in the U.S. Patent and Trademark Office.
- Art has a BME degree from The City College and an MS in ME degree from Columbia University.
- Art is a member of the SAE G-11 Reliability, Maintainability, Supportability and Logistics committee.

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Ops A La Carte LLC

- Ops A La Carte is a Professional Reliability Engineering firm focused on providing **confidence in reliability** throughout the product life cycle.
- We offer a flexible method of engagement from **end-to-end reliability solutions** to solving specific problems to providing individual targeted reliability services.
- We do this through reliability assessment, consultation, testing, and training.
- We have our own Reliability Lab called **HALT and HASS Labs** where we have successfully helped customers improve the reliability on over 500 different products.
- www.opsalacarte.com