ASQ CRE Prep course

Lesson V. B. 1.

Accelerated Life Tests


The Best Test

Cautions about ALT

- **Masked failure mechanisms**
- **New failure mechanisms**
- **Different models at different stresses**

- **Respect constraints**
  - Time, expenses, sample size, accuracy
- **Use use conditions**
  - Environment, frequency, loading
- **Minimize assumptions**
  - Statistical, modeling, variability
- **Focus on failure mechanisms**
  - Stress, damage, measurement

Guiding Principles

With no constraints

- **Build products and deploy, measure time to failure for every unit.**
  - **Real time**
  - **Real stresses**
  - **Real variability**
  - **“Customer” defines failure**

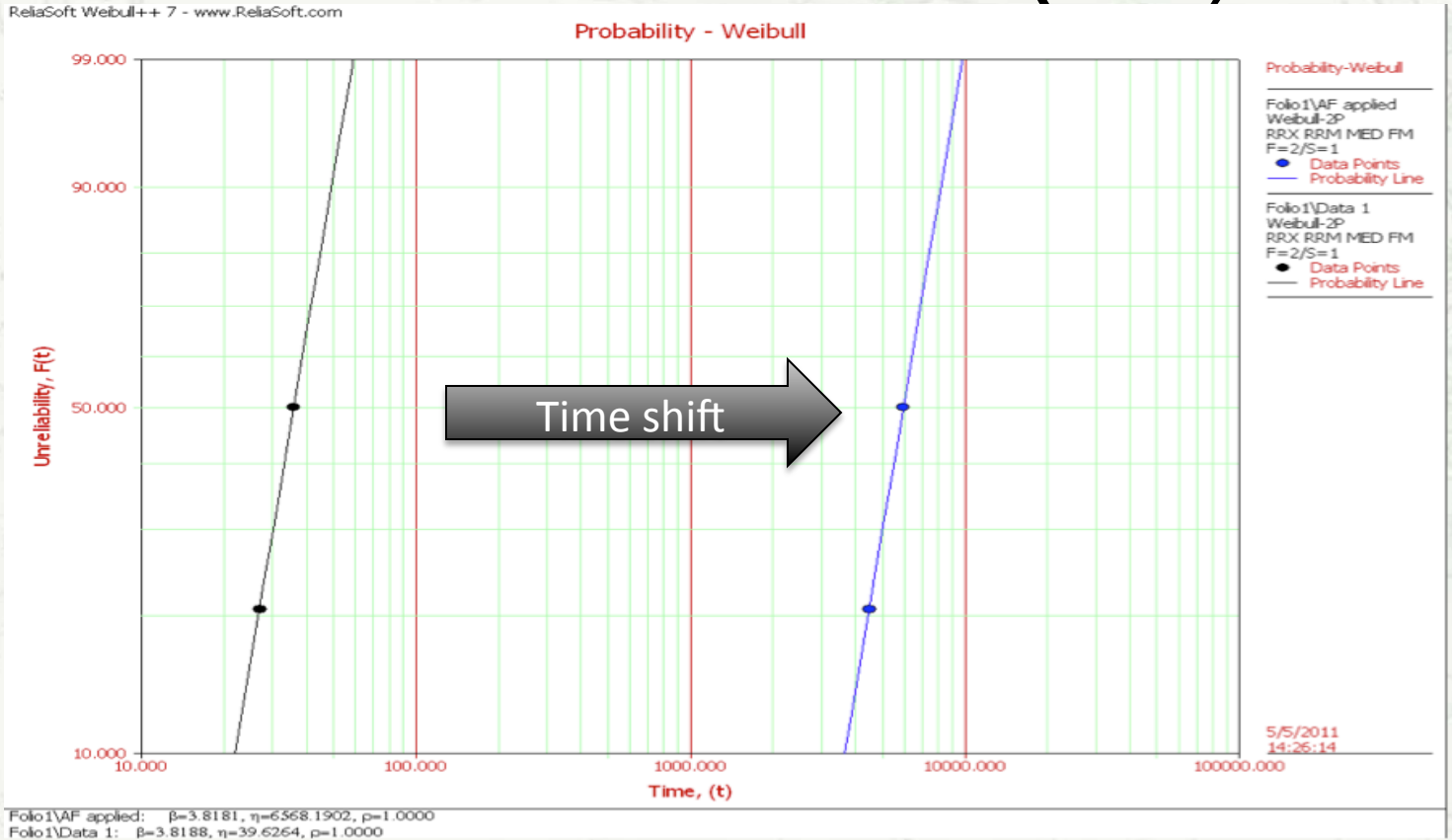
No Constraints

- **Benefits**
  - **Perfect results**
  - **No assumptions**
- **Problems**
  - **Takes time**
  - **No Sales, or**
  - **Customer risk**

Time Compression

- **Use product more often**
  - **Increase use cycles per day**
  - **Maintain other stresses at use levels**
  - **Measurement system detects specific failure**
- **Assumes specific action leads to failure**
  - **Wear, fatigue, accumulation**
  - **Must understand or assume failure mechanism**

Acceleration Factor (AF)



Time Compression

- **Benefits**
  - Less time
  - May use a sample
  - Simple extrapolation
- **Problems**
  - Not suitable for time dependent failure mechanisms
  - Nor, 24/7 loaded products

Stress to Life Relationship

Stress to Life Relationship

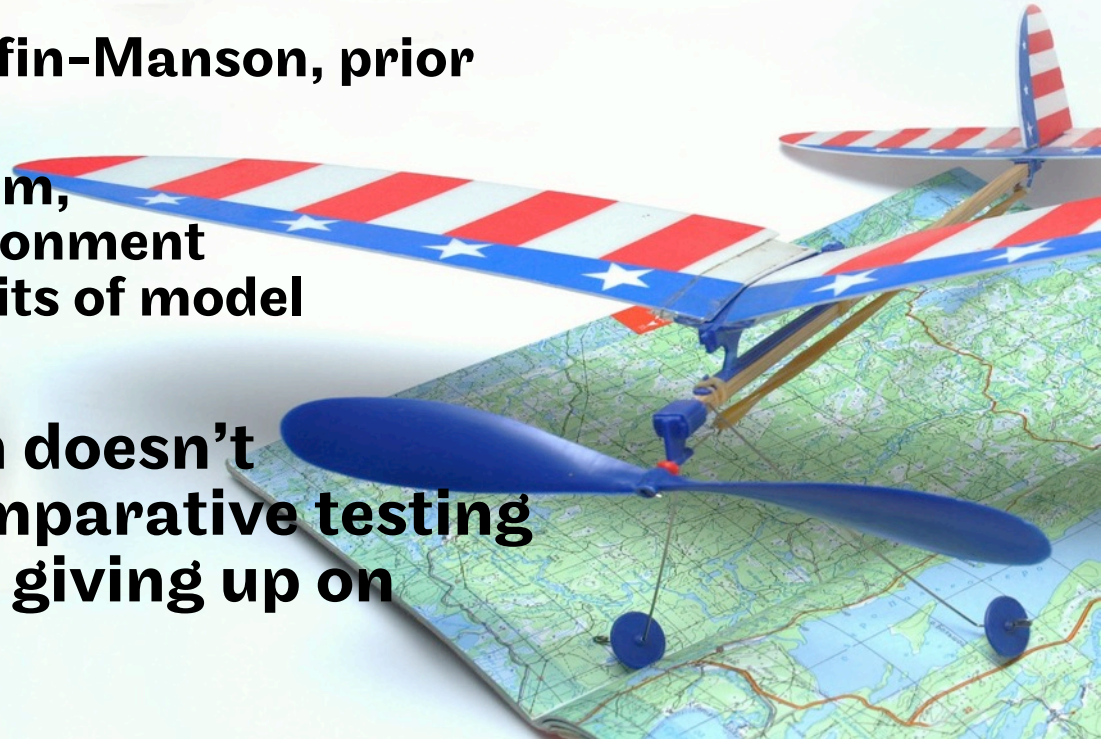
- **Benefits**
  - Creates AF model
  - Product of use specific

- **Problems**
  - 1 or 2 stresses or failure mechanisms
  - Logistically challenging

Acceleration Model

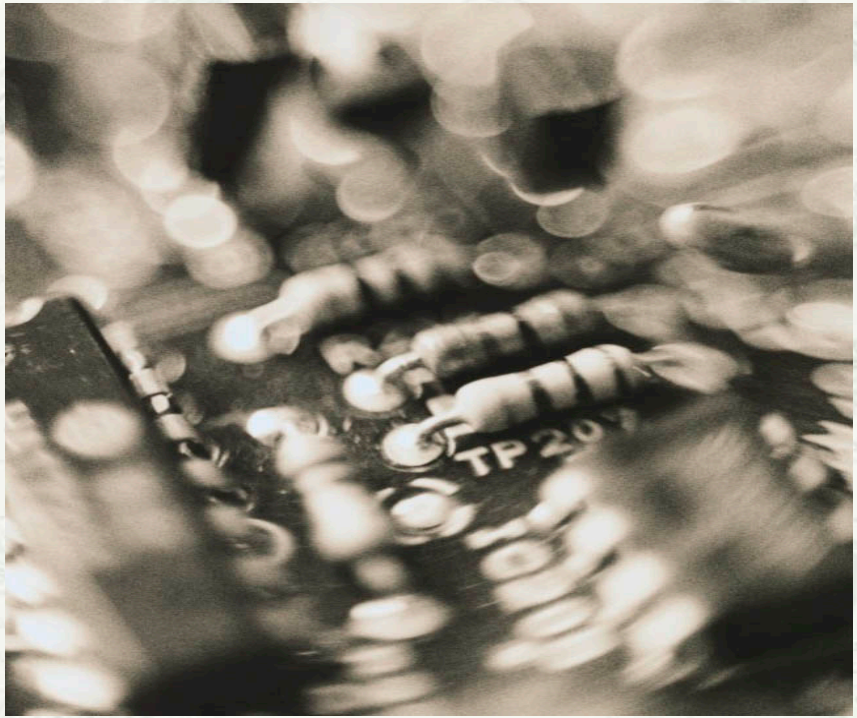
- **A model exists describing the stress to life relationship**
  - **Arrhenius, Peck, Coffin-Manson, prior work**
  - **The failure mechanism, use profile, and environment within applicable limits of model**

- **If failure mechanism doesn't change, may use comparative testing in absence of model, giving up on accuracy of result.**



Acceleration Model

- **Benefits**
  - **Single stress to apply**
  - **Fewer samples**
- **Problems**
  - **Assumptions multiplying**
  - **May miss new failure mechanism**



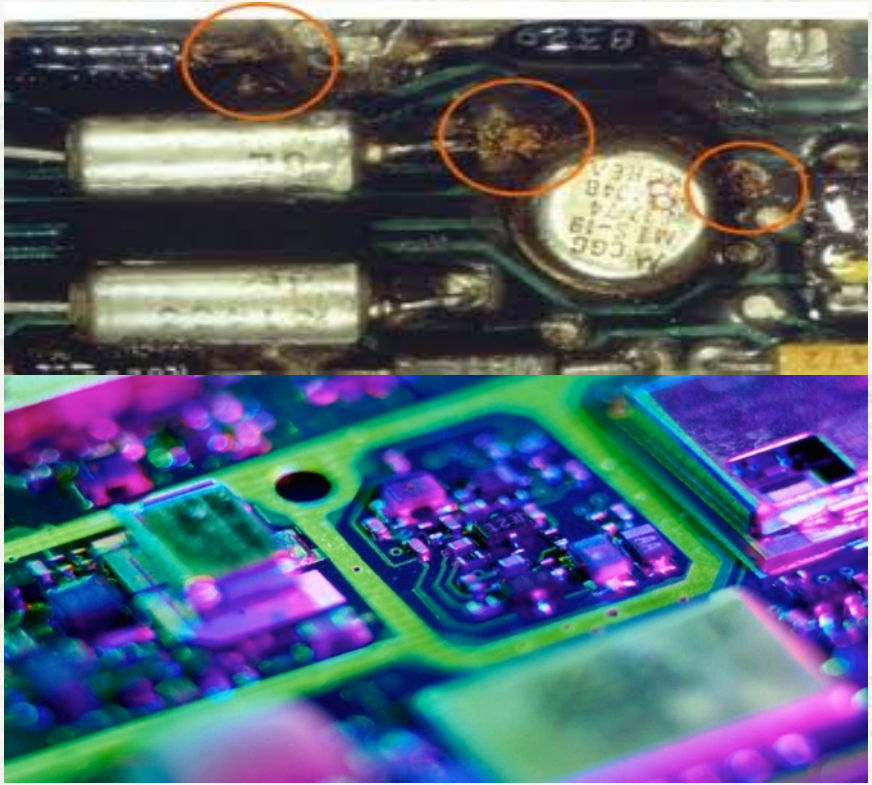
ALT w/ AF model

- **Peck's Relationship**

$$AF = \left(\frac{RH_u}{RH_t}\right)^{-3.0} \exp\left[\frac{E_a}{k}\left(\frac{1}{T_u} - \frac{1}{T_t}\right)\right]$$

- **Norris-Landzberg**

$$AF = \left(\frac{\Delta T_t}{\Delta T_u}\right)^{1.9} \left(\frac{f_u}{f_t}\right)^{1/3} \exp\left[1414\left(\frac{1}{T_u} - \frac{1}{T_t}\right)\right]$$



Step Stress

- **Variation of acceleration model ALT, with samples experiencing step increases in stress**
  - **Quicker than acceleration model method**
  - **May require more samples**
  - **Requires careful control of stress and failure detection**
  - **Best with accumulated damage failure mechanisms**

Degradation

- **Useful when performance decays over time in a measurable way**
  - **Often used with an acceleration model**
  - **Failure is defined by threshold value**
  - **Non destructive measurements permit repeated measures on samples**

Focus on the Failure Mechanisms?

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Lesson V. B. Bonus

A Few Models