ECE 510, Lecture 14
Defect Models of Yield and Reliability

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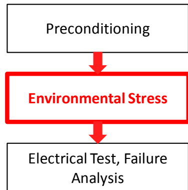
Outline

- Introduction
- Models of Yield
- Models of Defect Reliability
- Analysis and Synthesis of Lifetest and Burn In



Example Stress Flow

This Lecture

ELFR

Early life failure rate.
168 hrs
JESD22-A108

Assumptions

168 h is equivalent to early life requirement
SS computed from goal. eg. 3x611 = 1833

PC

Preconditioning.
JESD22-A113

(Lots x Units)

3 x 77

HTOL

High temperature operating life.
168 -1000 hrs
JESD22-A108

3 x 25

HTSL (Bake)

1000 hrs
JESD22-A103

3 x 25

TC

700 cycles
3 cycles/hr
233 hrs
JESD22-A104
Condition B or G
(C is too severe)

3 x 25

THB or HAST

1000 hrs (85/85)
JESD22-A101
96 hrs (130/85)
JESD22-A110

KMG Fitting of Multicensored Data

- Lifetest data was acquired on an SRAM Test Vehicle as follows

	T (C)	V
BI Condition	135	4.6
Use Condition	85	3.3

Acceleration Model Parameters

Q	0.3	eV
C	2.6	/V

Lifetest Data at BI Condition

Hours	6	24	48	168	500	1000	2000
Fails	8	3	1	1	0	1	0
SS	2460	2451	2448	2445	936	698	461

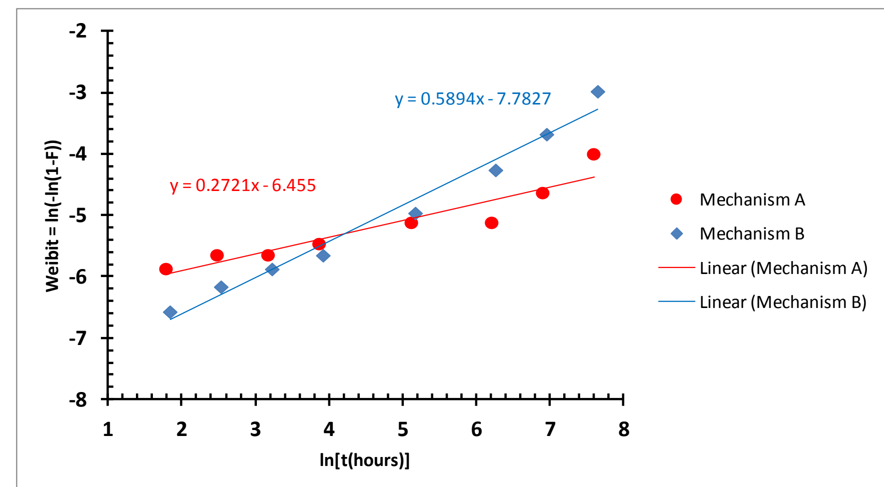
- This is multicensored data because units were removed at various readouts due to
  - Invalidated failures.
  - Units removed at 168 h to go into other stresses.
- We'll demonstrate the Kaplan-Meier-Greenwood method of extracting a model, including confidence limits.
  - Other methods such as MLE could be used too.
- Model will be scaled to product, and compared with product data.
- Watch carefully, a similar homework problem will be assigned!

Homework 14.1

- A product undergoing life test produces the following data

Hours	6	12	24	48	168	500	1000	2000
Fails Mechanism A	4	1	0	1	1	0	1	1
Fails Mechanism B	2	1	1	1	2	3	3	3
SS	1423	1417	1415	1414	573	420	268	117

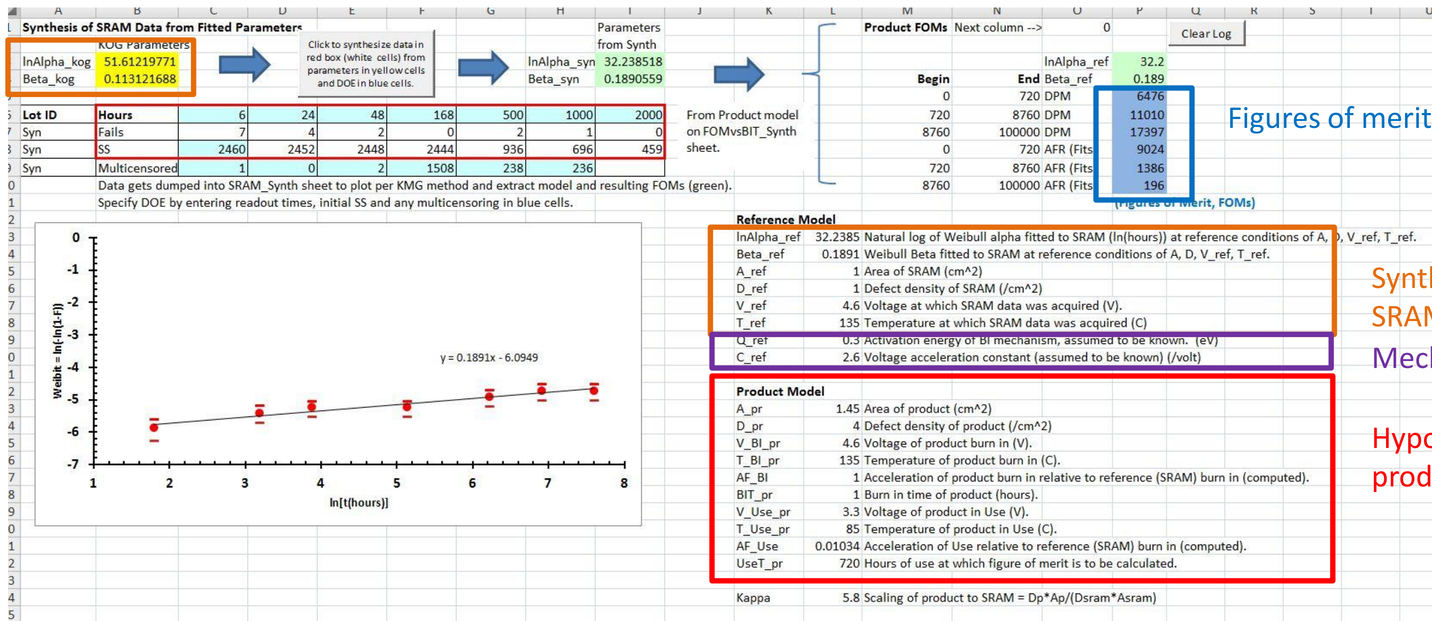
- Mechanisms A and B are mutually censoring because failure by one precludes failure by the other.
- There is also censoring by removals.
- This is an example of multicensored data which may be analyzed by the Kaplan-Meier method.
  - No need to do the "Greenwood" extension giving confidence limits.
- Extract a Weibull model for each mechanism, give α and β and superimpose a plot of the model over a plot of the data..



Synthesis Demonstration

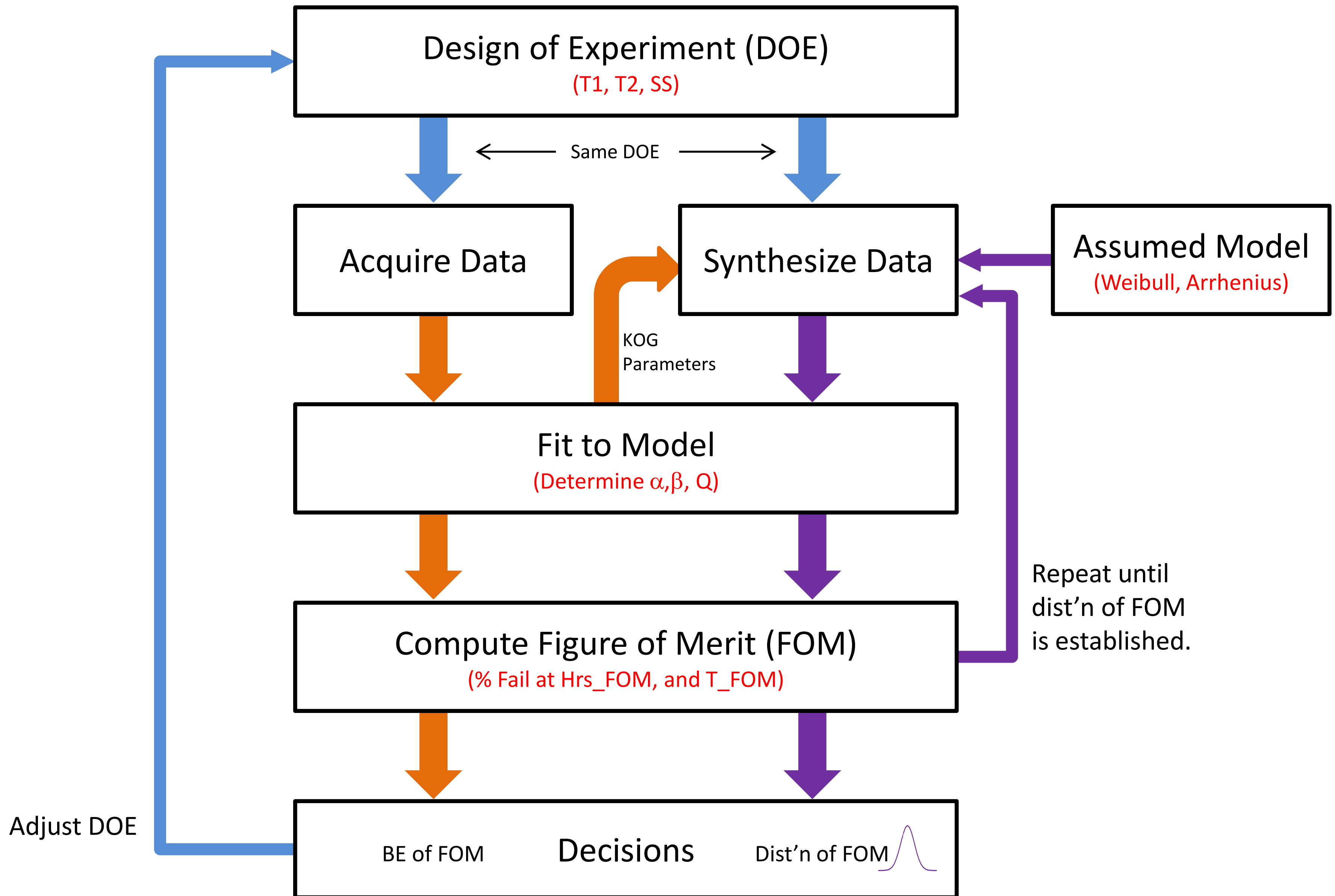
- When a model has been extracted from the SRAM data it may be used to calculate figures of merit (FOMs) for products different from the SRAM.
- Reliability FOMs include predicted DPM and failure rates for 0-30 days, 30 days to 1 year, and 1 year to 10 years.
- The extracted model may be used to re-do the experiment by simulation many times to quantify the variability of its predictions.
- The output of the tool may be examined using a tool provided: Multi Plotter Rev. 3.xlsb

Fitted to SRAM.



Hypothetical product

Estimation of FOM CLs by Synthesis



In-Class Exercise

- Simulation for product from SRAM model.
- Demonstrations.
  - Plot distributions and correlations of FOMs. Get UCL.
  - Effect of DOE on FOM dist's – vary SS.
  - Effect of Beta on failure rate.
    - Make Beta_kog <, =, > 1
  - Plot of FOMs vs BIT.
  - Effect of Q,C on BIT.
  - Effect of product defect density.
  - lnAlpha vs Beta variation. (Correlated?)
- Key messages.
  - Relationship between DOE and decision-making.
  - Use model to determine DOE.
  - Low accel'n = long BIT.
  - Beta < 1: Burn In improves reliability.
  - Beta > 1: Burn In hurts reliability.