

NINETEENTH ANNUAL

**Bits**

TM

**Burn-in & Test Strategies Workshop**

**March 4 - 7, 2018**

**Hilton Phoenix / Mesa Hotel  
Mesa, Arizona**

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# Burn-In Concepts and Recent Developments

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**BiTS Workshop**  
**March 4 - 7, 2018**



## Content

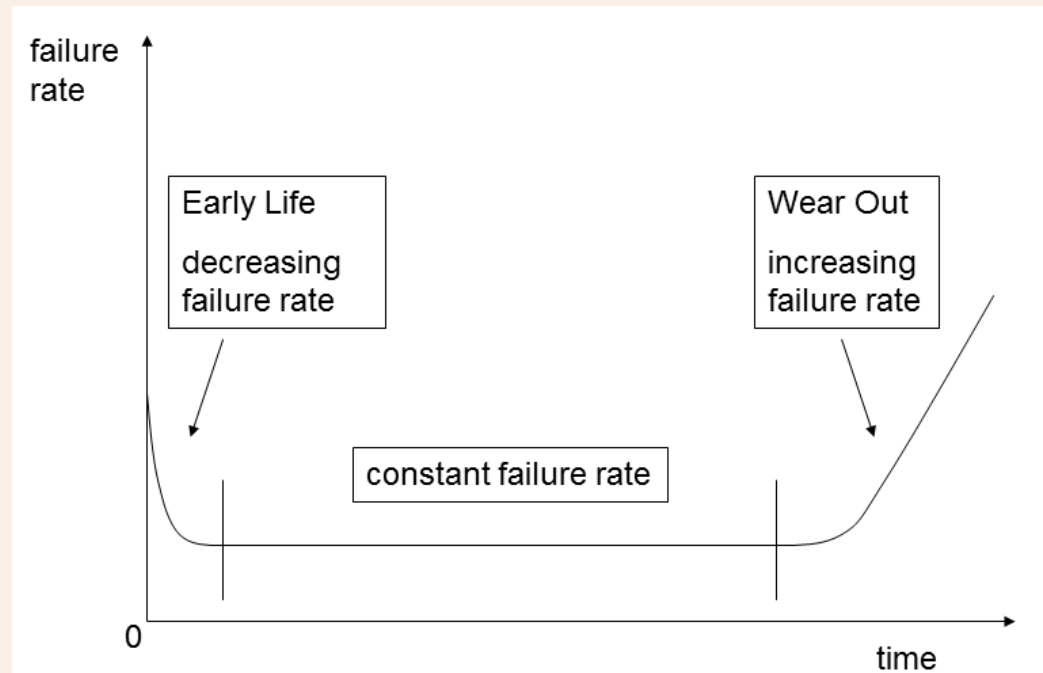
- Early failures
- BI-concepts
  - Productive BI
  - Qualification BI
- Quality dilemma
  - Sample size vs. quality level
  - Incorporate additional information
- Summary

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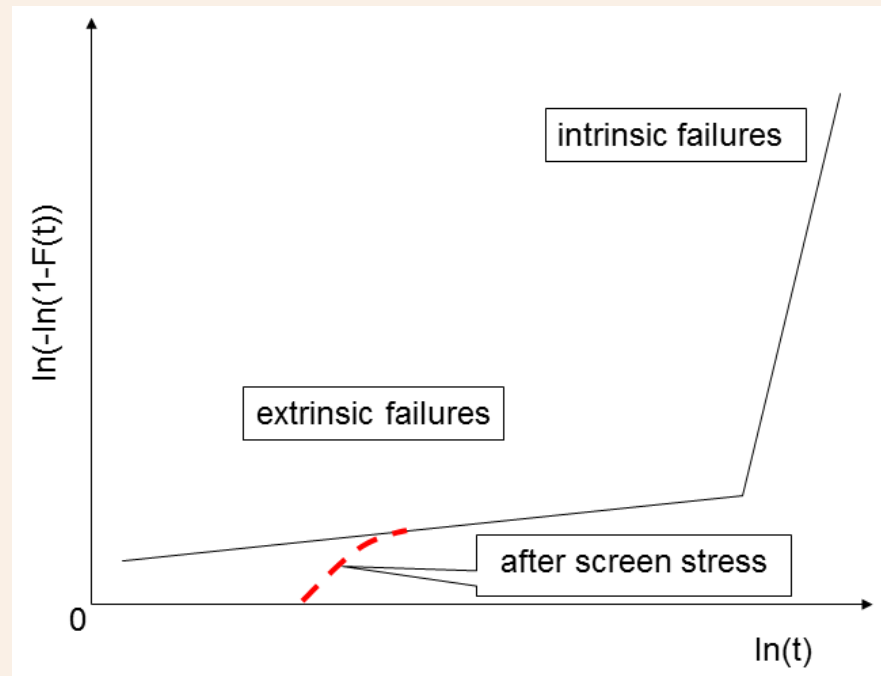
## Early failures

- Bathtub curve



## Early failures

- Overstress at oxides
  - Extrinsic failures follow Weibull-distribution with  $\beta < 1$
  - Overstress screens out extrinsics
  - Modelled by a conditional Weibull distribution
    - for small  $t$ : exponential distribution
    - constant FIT-rate



## Early failures

- Weed out early failures
  - Defect density reduction
  - Optical inspection
  - Stress test
  - Postprocessing
    - Part average testing (univariate, multivariate)
    - Statistical bin analysis
    - Nearest neighbor yield
    - ...



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## Productive Burn-In

### 100 % Burn-In

- Integrated part of the production flow
- Overstress during Burn-In
- BI-Time reduction, but no BI-release

### Conditional Burn-In

- Burn-In is triggered by certain criteria
  - Yield loss at 100 % BI
  - Failure limits for certain tests
  - If BI is triggered: flow like 100 % BI

## Qualification Burn-In

### BI-Study

- Random sample from production
- BI is performed under very controlled conditions; every failure is investigated
- Inference from random sample to remaining production volume

### BI-Monitoring

- Production monitoring
- Random samples are taken continuously from production (e.g. from each lot) and put to BI
- BI-monitoring: flow like BI-study

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## Bi-sampling – sample size vs. quality

### Quality dilemma

- Quality targets are continuously lowered
  - 0.1 %, 1 ppm, << 1 ppm
  - 0 defects
- Sampling resolution on attributive data:

Testplan	p @ 90 % CL
0 / 10,000	230 ppm
0 / 100,000	23 ppm
0 / 2,300,000	1 ppm

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## Incorporate additional information

- Countermeasure Model
  - After a failure, a countermeasure is introduced.
  - The efficiency of the countermeasure is estimated with experts and quality department.
  - This information can be added to the random sample. It results in a lower  $p$ .
- Model equation:
  - $\alpha$  = efficiency of countermeasure
  - $1 - CL = \alpha \cdot B(0, n, p) + (1 - \alpha) \cdot B(1, n, p)$

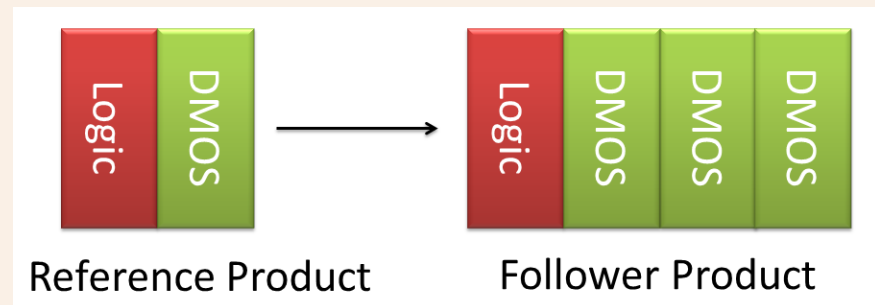
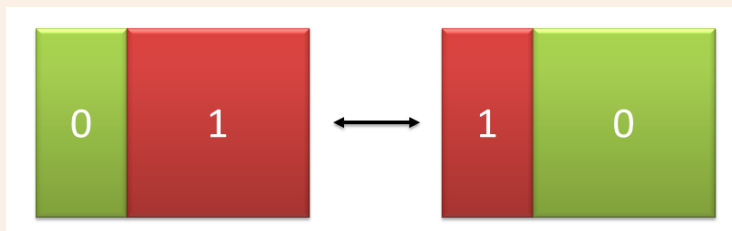
## Incorporate additional information

- Countermeasure Model
  - Example:
    - $\alpha = 80 \%$ ,
    - $p_{target} = 100 \text{ ppm @ } 90 \% \text{ CL} \rightarrow 0 / 23,000 \text{ pcs.}$
    - $1 / 23,000 \text{ pcs} = 169 \text{ ppm @ } 90 \% \text{ CL}$
    - Model equation:
      - $1 - 0.9 = 0.1 = 0.8 \cdot B(0, n, p) + (0.2) \cdot B(1, n, p)$
    - Numerical solution:
      - $p$ : 119 ppm @ 90 % CL
      - $n$ :  $23,000 + 4,394 = 29,394 \text{ pcs.}$
    - Use for calculation: R-package *GenBinomApps*



## Incorporate additional information

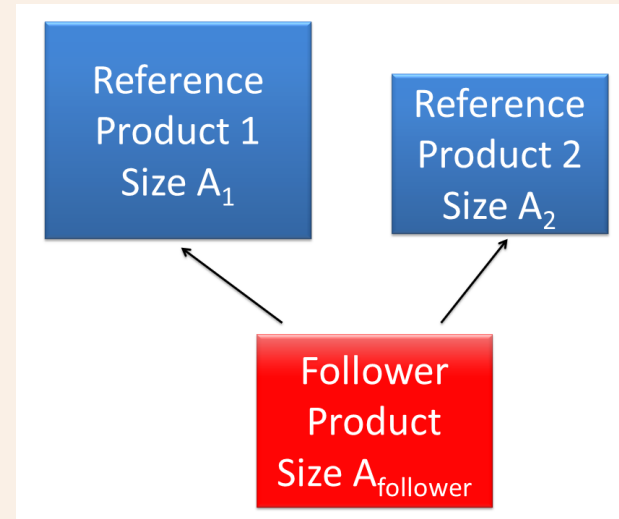
- Separate Area Scaling



- BI-Study: 1/100k  $\rightarrow$  39 ppm @ 90 % CL
- Follower product:
  - Classical area scaling: 78 ppm @ 90 % CL
  - Separate area scaling: 65 ppm @ 90 % CL

## Incorporate additional information

- Multiple Reference Products



- Reference product 1: 10 mm<sup>2</sup>, 1 / 75 k → 51,9 ppm @ 90 % CL
- Reference product 1: 5 mm<sup>2</sup>, 1 / 69 k → 56.4 ppm @ 90 % CL
  - → Follower product: 4 mm<sup>2</sup>, 19.4 ppm @ 90 % CL

## Incorporate additional information

- Synergy Model

- Subsets were already burnt in other studies

- Example:

- Product with new metal block, 1 failure in Si.

- 1 / 23,000 pcs = 169 ppm @ 90 % CL

- Technologies with same Si: 0 / 69,000 pcs.

- Synergy model:

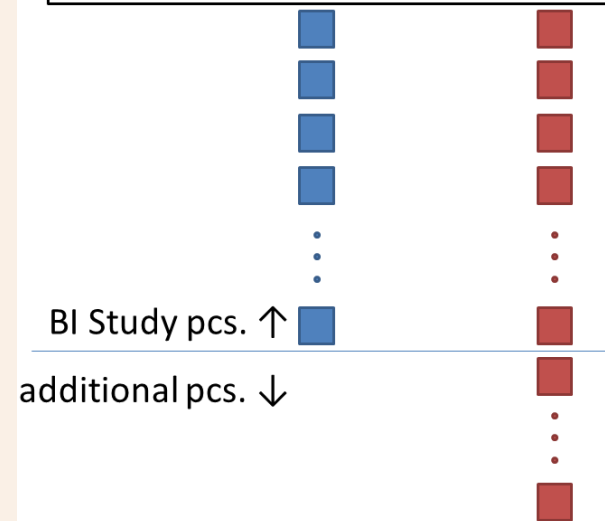
- → 130 ppm @ 90 % CL

- Burn 23,000 + 8,177 = 31,177 to reach

$p_{target} = 100 \text{ ppm @ } 90 \% \text{ CL.}$

- Use for calculation : R-package *AdvBinomApps*

Product = Subset 1 + Subset 2



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## Summary

- 100% BI is a method to screen out (nearly) all early failures.
- BI sampling can be used to proof a certain early life failure level.
- In case of sampling plans with acceptance numbers  $> 0$ :
  - Additional information can be added to the random sample.
  - This can further reduce the estimated ppm-level.

## References

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