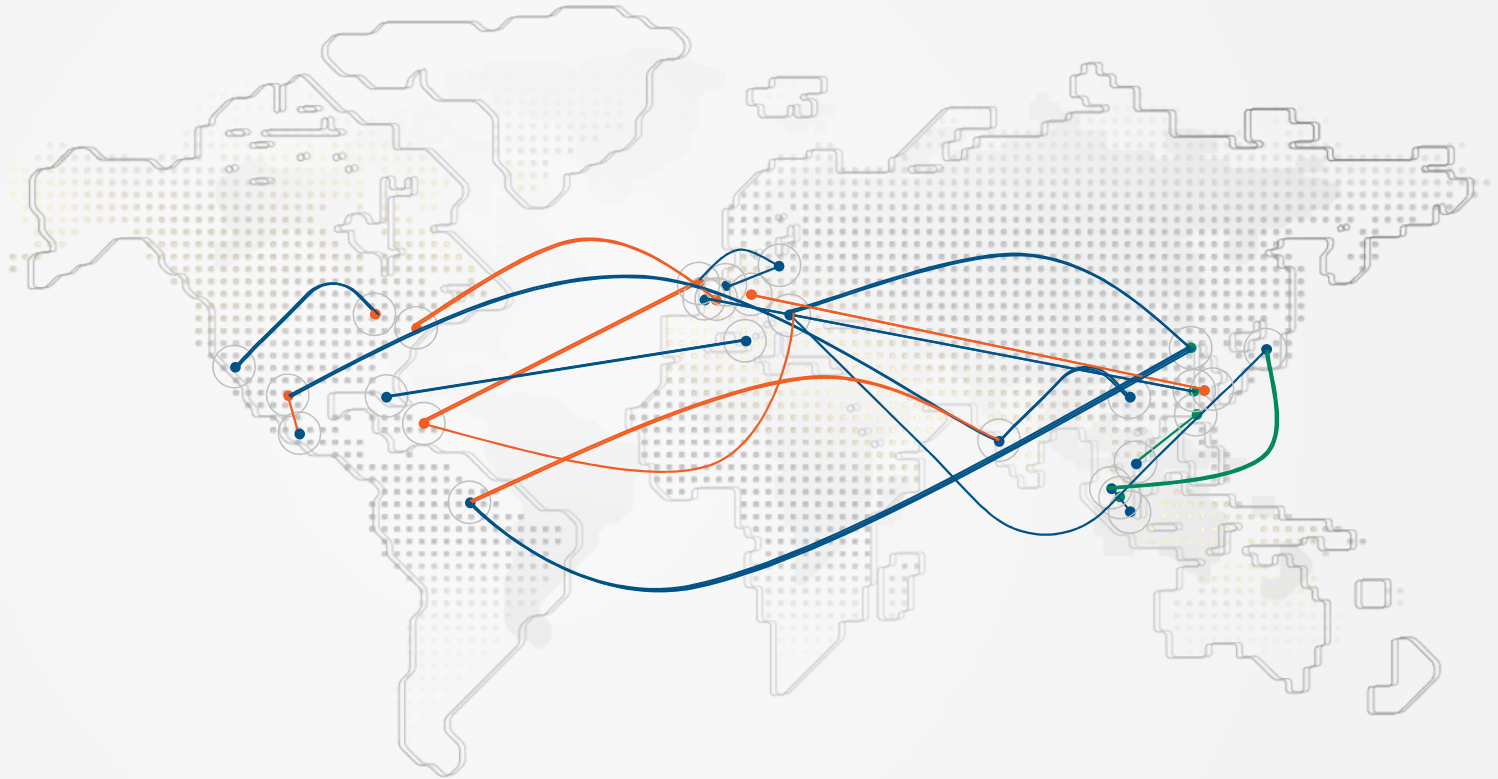


Physics of Failure: The Jabil approach, PoF in product design



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Jun 14, 2017

Physics of Failure

- What's the buzz about?



Physics of Failure

- Failure Effect – Mode – Mechanism – Initiator

Failure Effect (Function unavailable)

Failure mode (Fracture, wear, ...)

Failure Mechanism (Thermal cracking, Frictional corrosion, ...)

Failure Initiator (micro crack, pitting corrosion, contamination, corrosion, ...)

Physics of Failure

- Degradation: In most cases leading to gradual loss of the function of the component (in some cases end of life can be predicted)
- Overstress: In most cases leading to abrupt end of life of the component (life prediction has huge uncertainties or not possible)



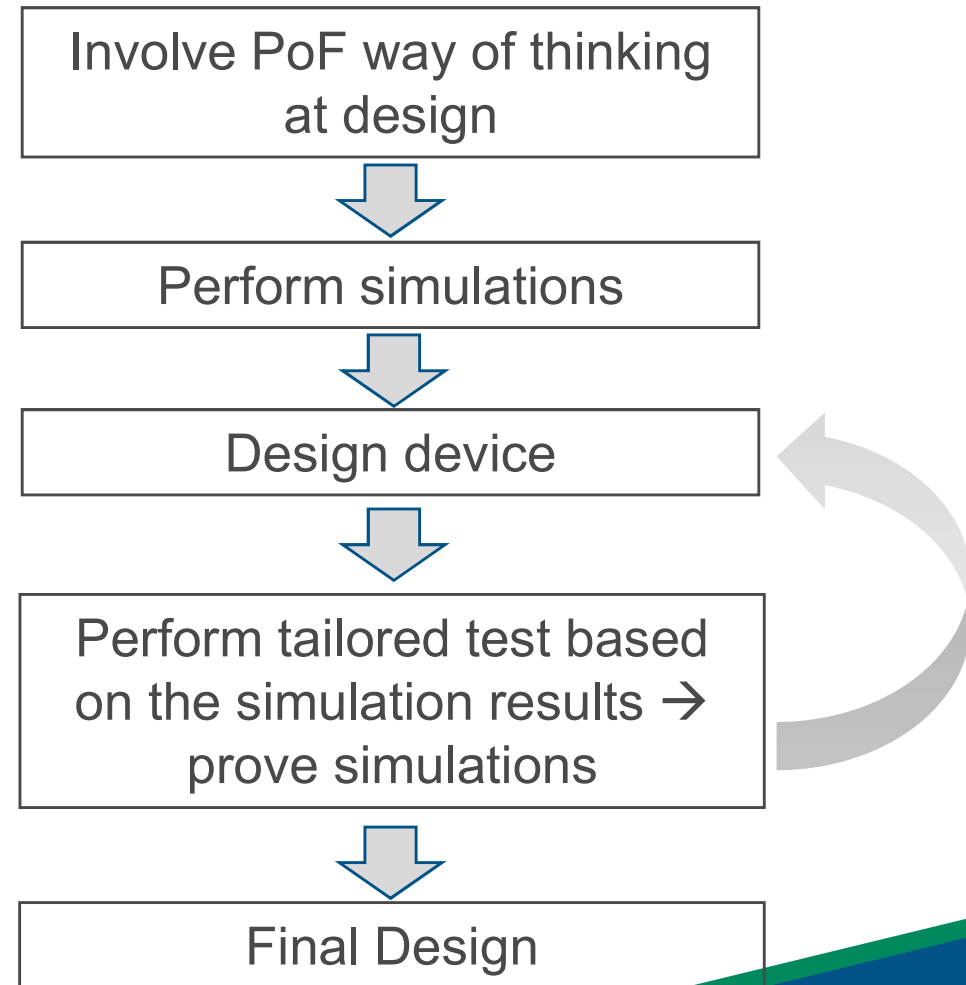
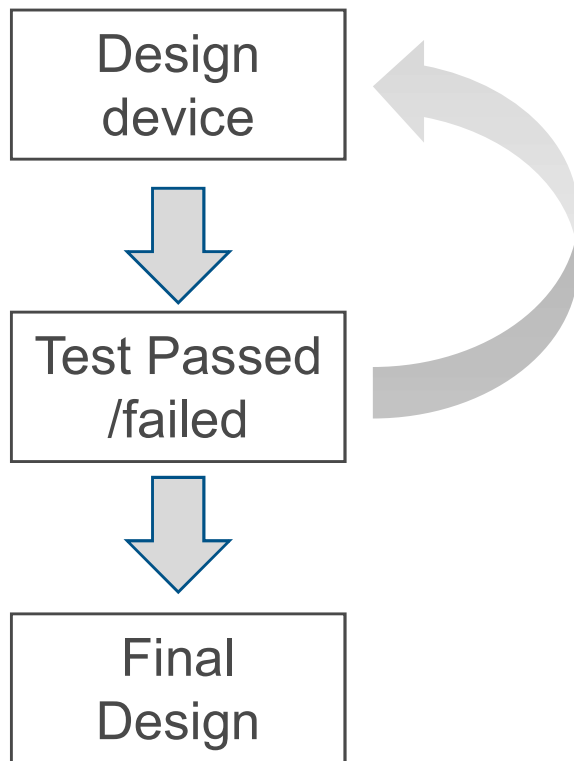
Reliability Knowledge

- Experience
- Self study
- Inhouse training
- External training
- Seminars
- Workgroups
- Partners



Physics of Failure

- Traditional Way of work VS PoF



Physics of Failure – tools / methods (1/2)

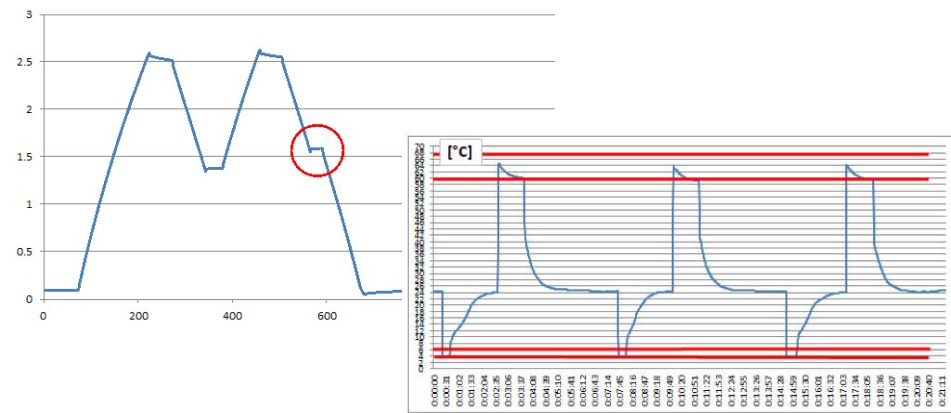
Accelerated Testing	Failure Analysis	Finite Element Method (FEM)
Block Diagram Development	Reliability Demonstration Testing	Root Cause Analysis
Design for Manufacturing/Assembly (DFM/A)	Failure Modes and Effects Analysis (FMEA)	Mission Profile Generation (Product Usage Profile)
Design of Experiments (DoE)	Reliability Growth Testing (Modeling)	Failure Reporting & Corrective Action System (FRACAS)
Real World Usage Profiles	Pareto Analysis	Statistical Process Control (SPC)

Physics of Failure – tools / methods (2/2)

Design Review	Reliability Modeling and Prediction	Variation Simulation Modeling (VSM)
Regression Analysis/Prediction Modeling	Fault Tolerance Analysis (Markov Modeling)	Weibull Analysis
Environmental Stress Screening	Risk Assessment	Gage Repeatability and Reproducibility
Reliability Benchmarking	Fault Tree Analysis (FTA)	Probabilistic Design - Stress & Strength Interference

Physics of Failure

- Jabil way of work:
 - Understand the product
 - Identify the key features
 - Identify the user profile(s)
 - Identify the key failure physics
 - Derive test program
 - Setup tests
 - Perform tests
 - Analyze results
 - Report and Advise



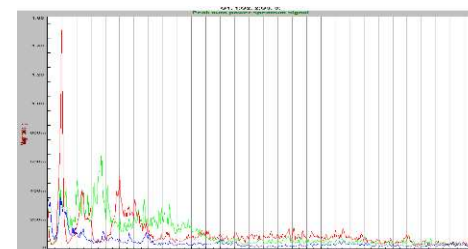
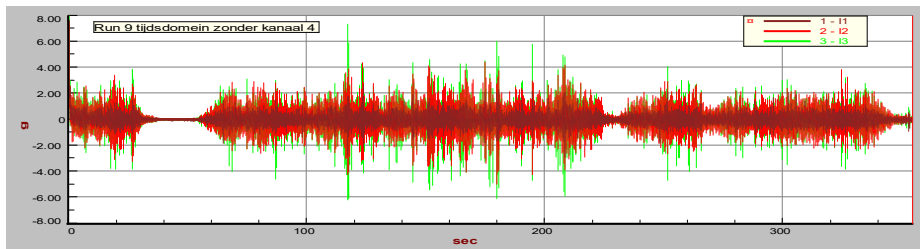
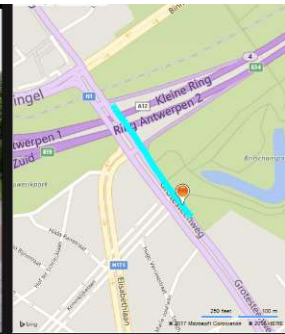
Jabil customer applications

- Automotive and transport
 - Adaptive head-light (LED/Laser)
 - LED Backlight
 - Car tracking devices
 - Car entertainment
 - Power electronics
 - Wireless charging
 - Connectivity
 - head-up displays
- (Smart) Metering
 - Tracking
 - Connectivity (IOT)
- Home appliance and entertainment
 - Connectivity (IOT)
 - Second source components compatibility



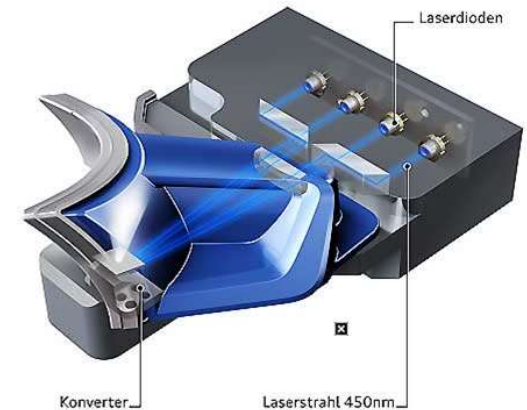
Automotive and transport - Verification user profile

- Study standards on mission profiles
- Make a test run on real life automotive environment with accelerometers to record the real life mission profile (shock and vibration)



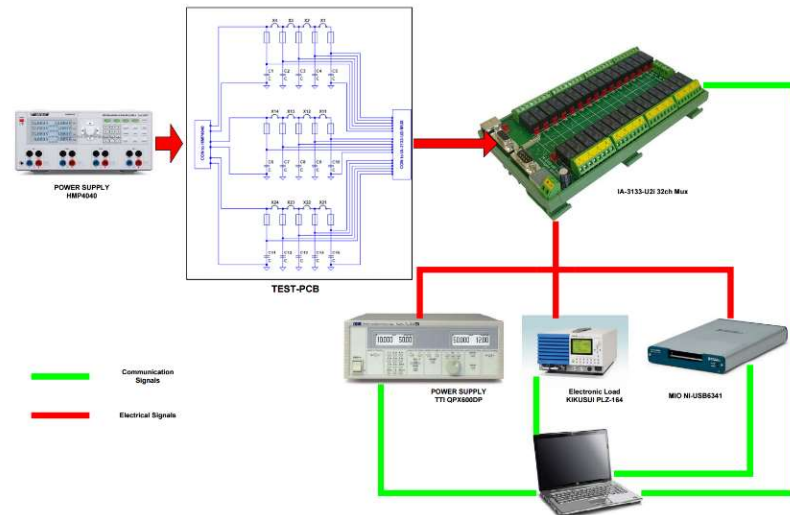
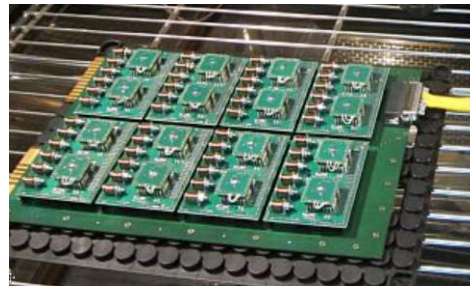
Automotive: Adaptive head-light

- Adaptive head-light with object tracking:
 - Main light source: blue power lasers
 - DMD (digital mirror device):
 - Adaptive beam shaping
 - Individual objects can be tracked & dimmed
 - Logo/symbol projection (optional)
- Risk analysis & FMEA - Summary of top risks:
 - Phosphor layer: aging, humidity, temperature, overload, shock & vibration
 - DMD chip: temperature, shock & vibration
 - LED/laser on PCB: mechanical stress factors due to temperature



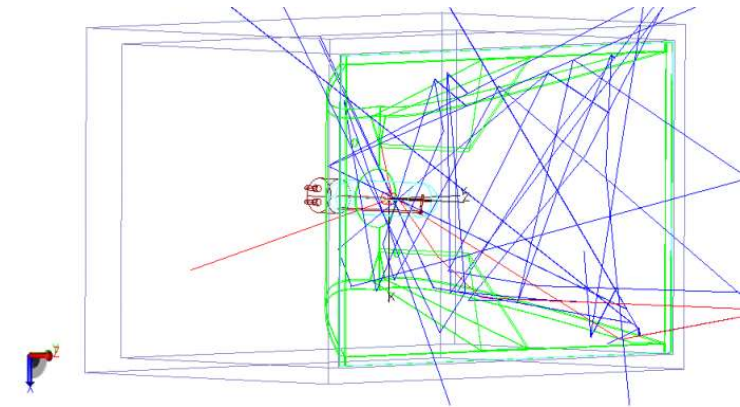
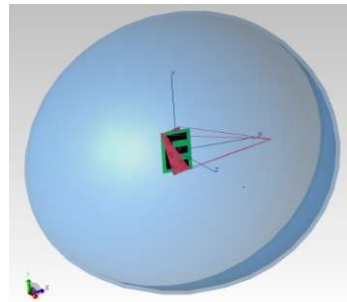
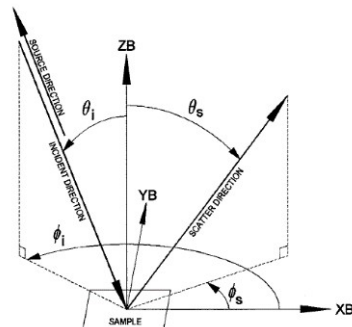
Component Investigations

- Capacitors
- Super capacitors
- Varistors
- Sensors



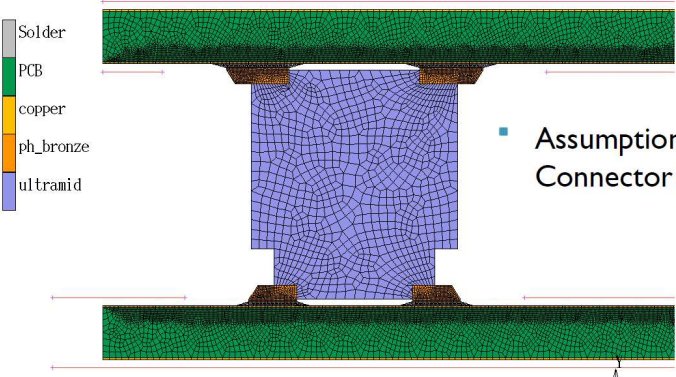
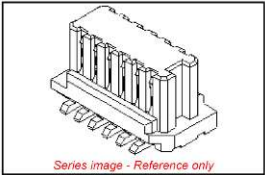
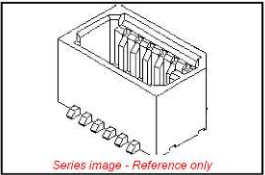
Virtual testing – Readability of displays in certain light conditions

- Development of a method to qualify the legibility and readability of icons and characters
 - opaque and transparent head-up displays
- Simulation method to assess the visual performance of a display regarding legibility and readability based on basic optical characteristics of the display
 - approach based on computer simulations.

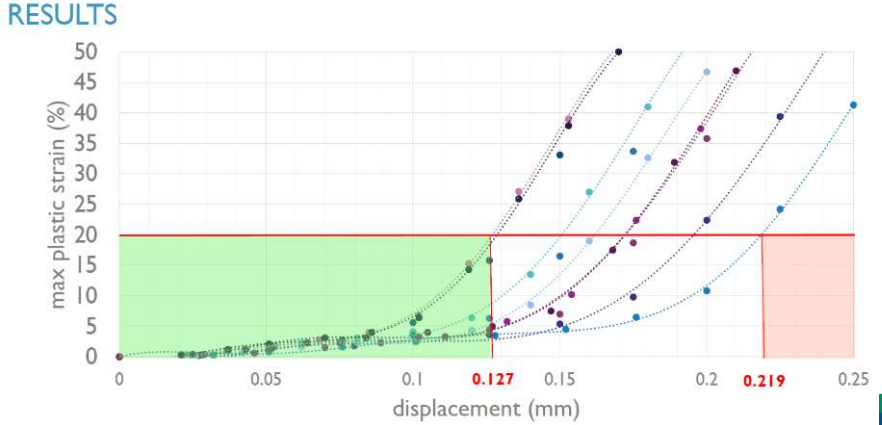


Virtual testing – Board to Board connector

- Make a 2D Parametric model to find the maximum displacement possible

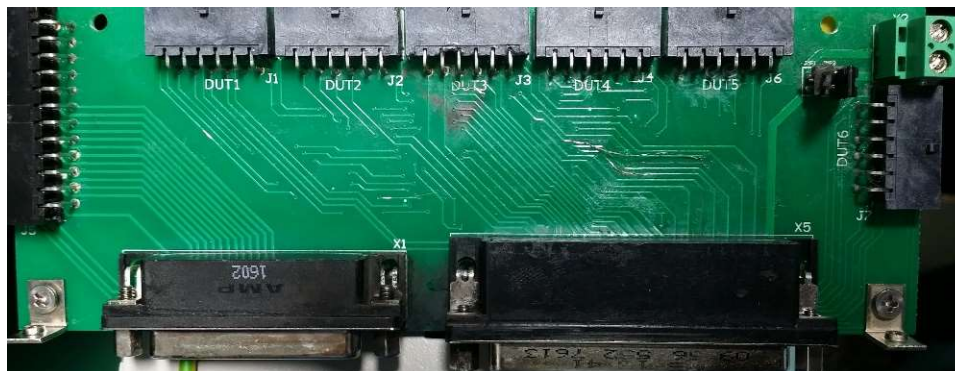
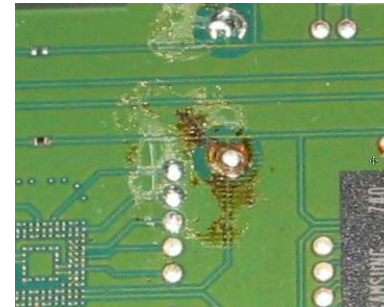


- Assumption: Male and Female Connector have a rigid connection



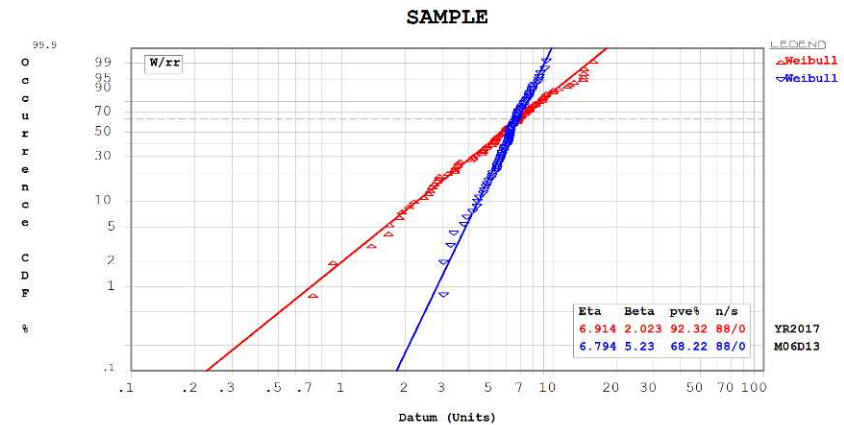
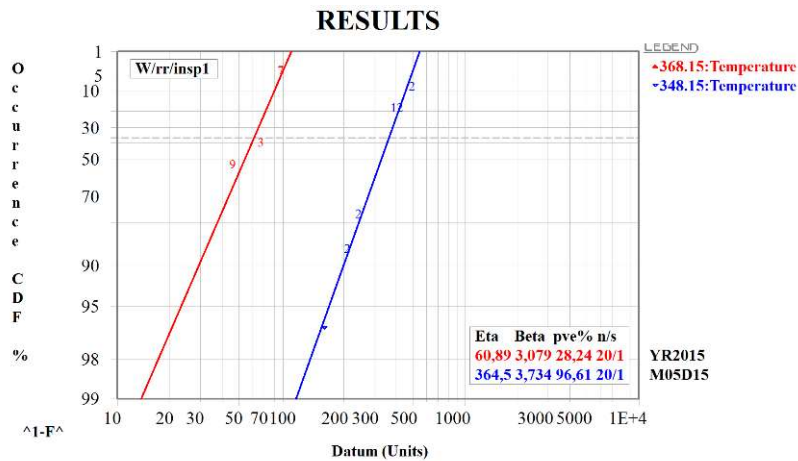
Connections and connectors

- Shear forces
 - Find possible design margins
 - Compare connection
- Accelerated testing and aging effects
 - Corrosion
 - Electromigration



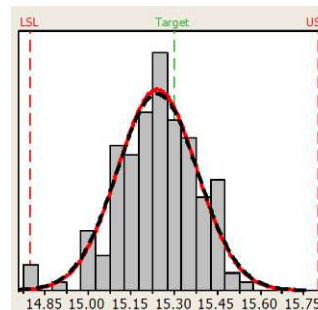
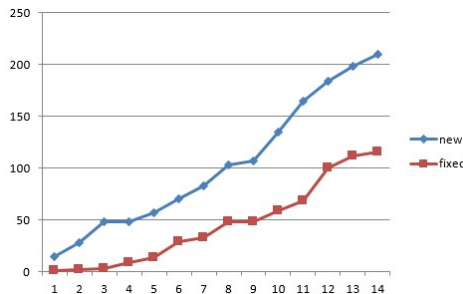
Pitfalls

- Create none relevant failures
 - Overstressing
 - Changing material properties
- Don't mix failure mechanisms
 - Can create wrong conclusions



Recommendations

- Use field and test data and compare with specifications from customers and suppliers
- Component level investigations on alternative components: what is the risk of using them?
- Define model and work out a simulation to have results at an earlier phase in the project
- Embed “Physics of Failure” in product design process



Questions

Questions?

