REDUCED INSPECTION USING PROBABILISTIC ANALYSIS

ISPMNA5, Tokyo, October 7 – 9, 2024

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October 9, 2024

UA5

Agenda

01 **Background / Extant Position**

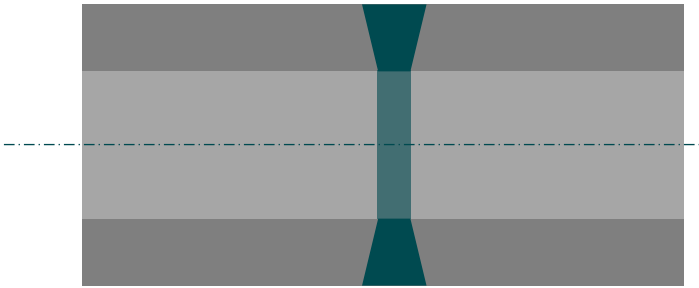
02 **Method**

03 **Improved Position**

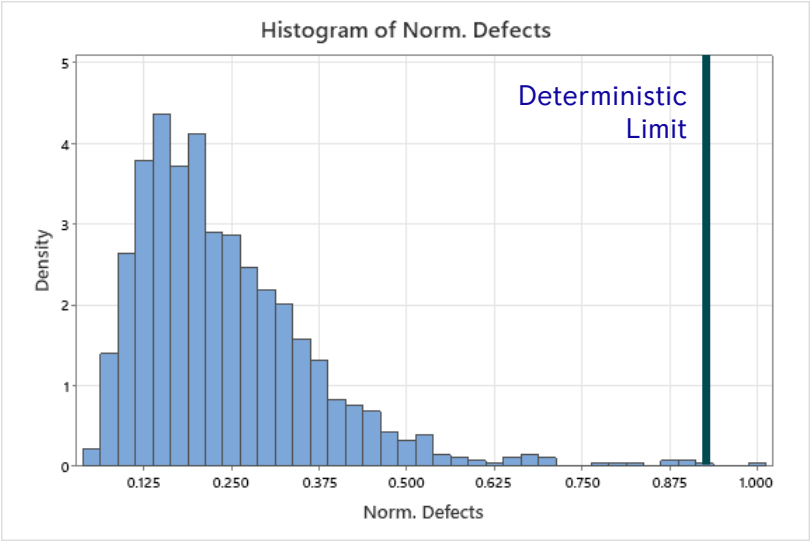
01

Background / Extant Position

Extant Position

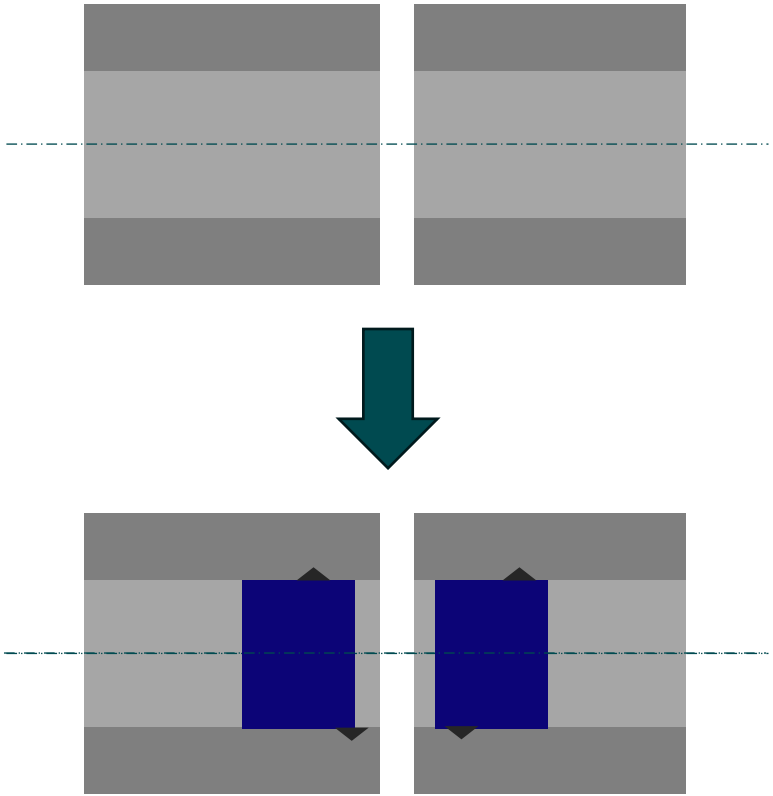


- Pressure retaining pipe sections butt welded
- Internal surface defects contribute to structural failure and reduce thermal hydraulics performance
- 100% inspection conducted
- Any defects detected measured
- Compared against deterministic limit
  - Accept, rework or concession based on bespoke assessment
  - Historically 99.9%+ of measured features accepted against deterministic limit
- Further downstream manufacturing processes conducted but not accounted for



Manufacturing Route

- Inserts added prior to welding
  - Opportunities to scratch internal surfaces



Manufacturing Route

- Inserts added prior to welding
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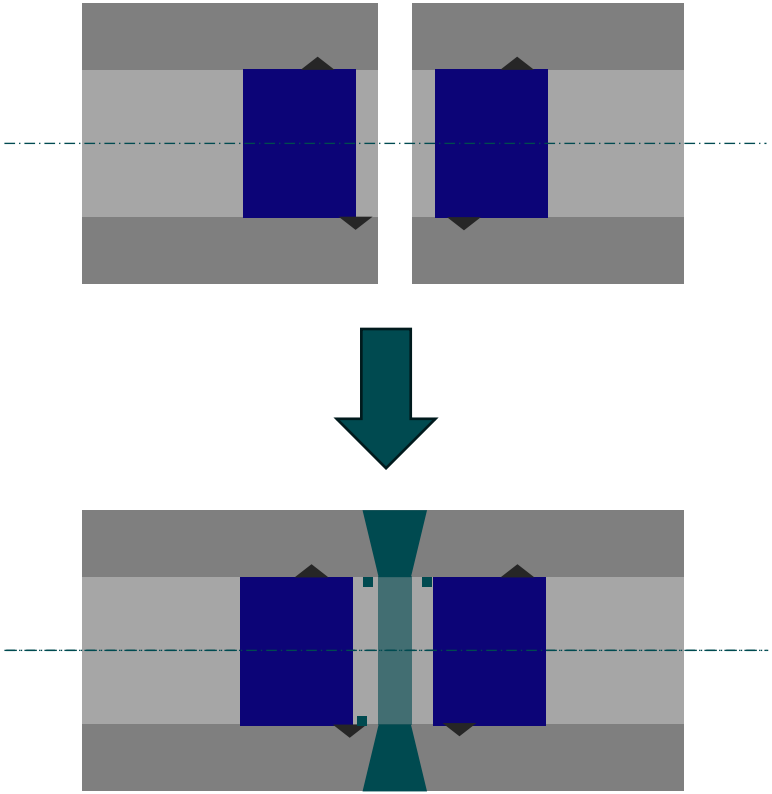
- Spatter during autogenous welding



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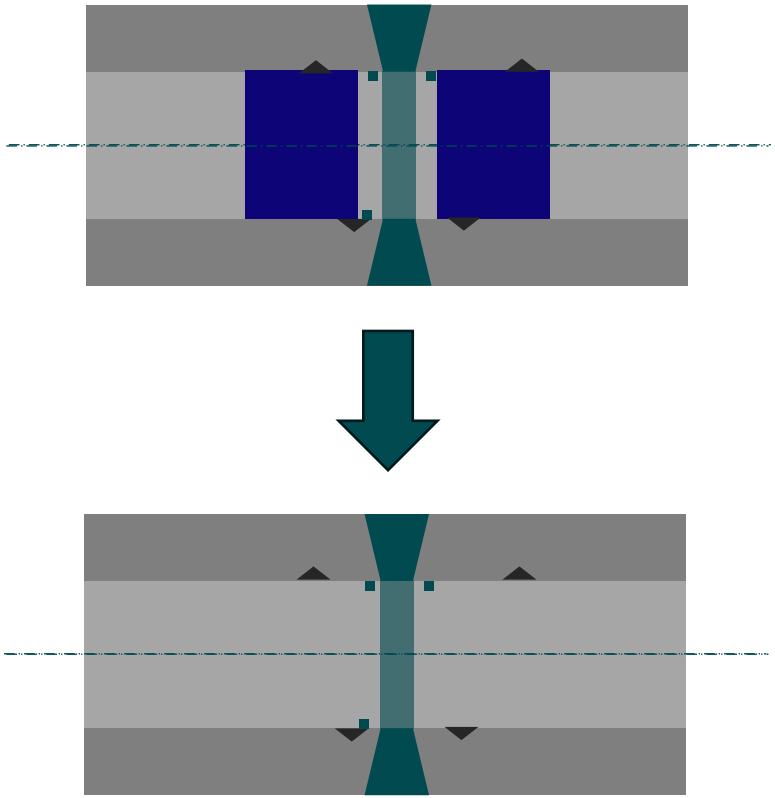
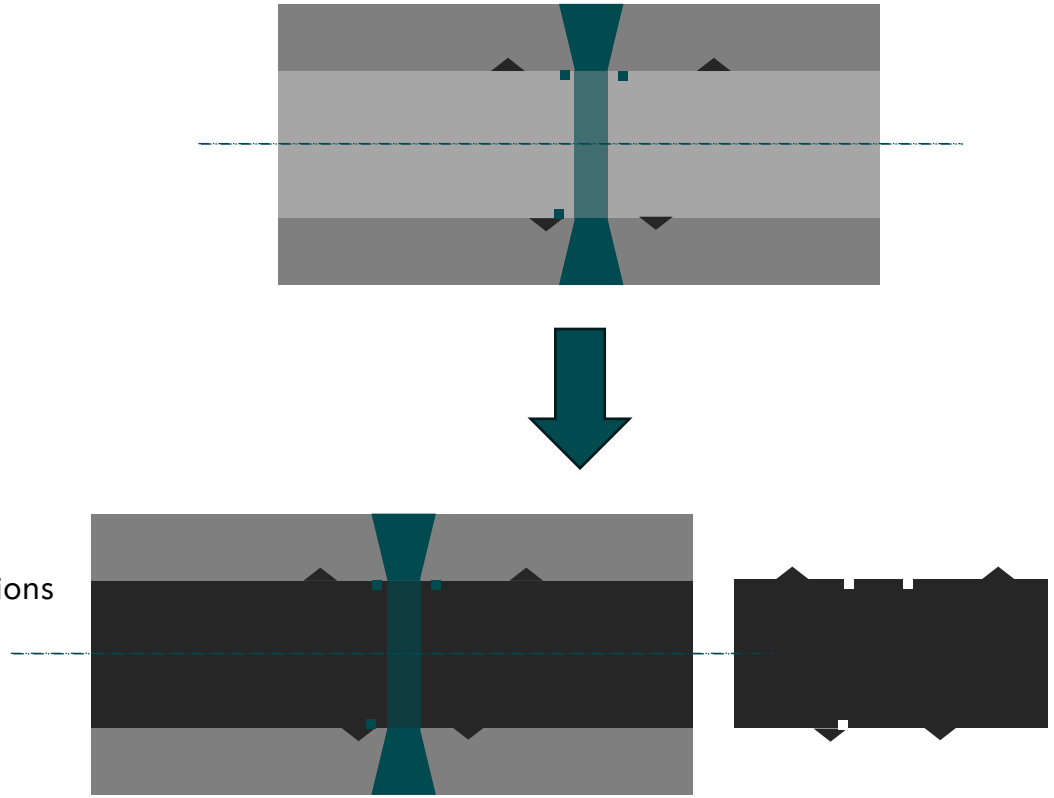


Manufacturing Route

- Inserts added prior to welding
  - Opportunities to scratch internal surfaces
- Spatter during autogenous welding
- Inserts removed
- Polymer replicant used to find defects
  - Inserted into pipe
  - Removed using bespoke tooling
  - Visual inspected for defects
  - All detected defects laser scanned for dimensions
  - Method can result in damage
    - Tooling required to remove polymer
  - Human factors influence on detection



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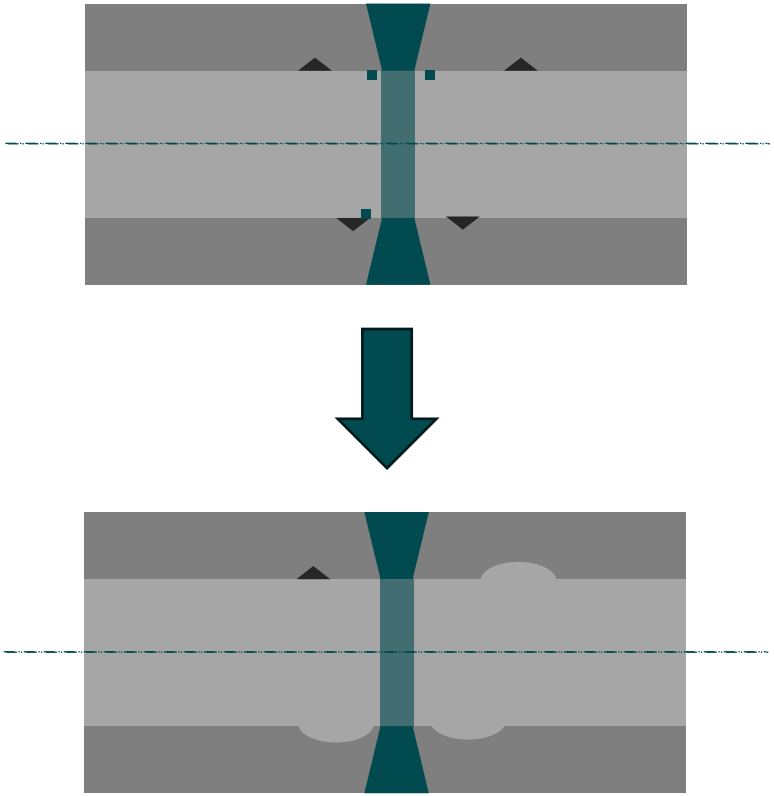
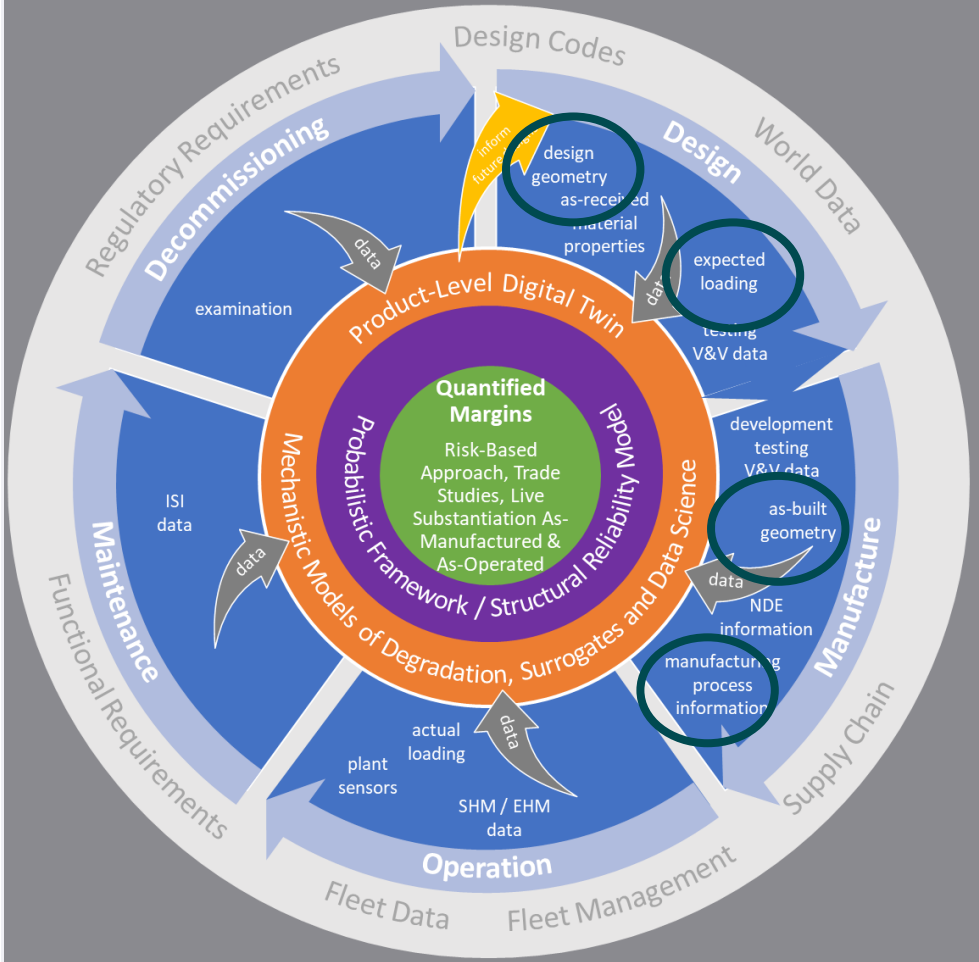
- Reworks conducted as required
  - Reinspection conducted post repair



02

Method

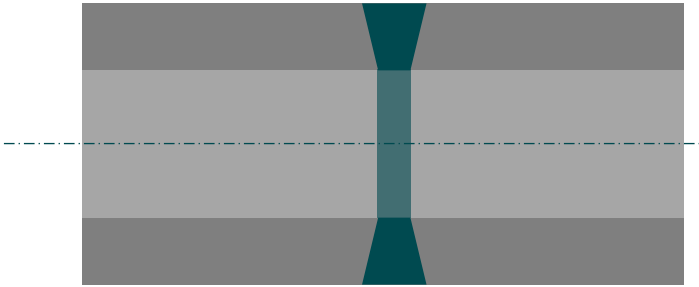
Data-Centric Engineering



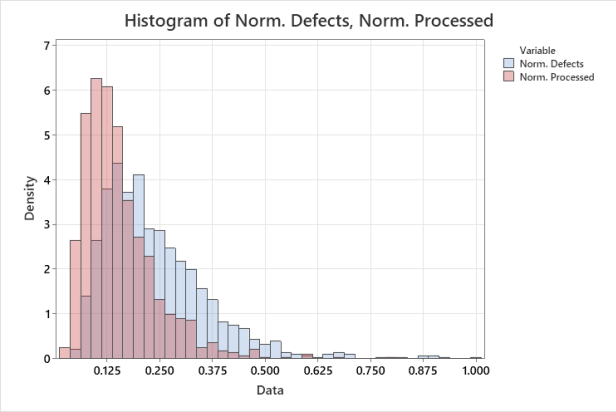
- **Holistic use of lifecycle data from raw material and manufacture through to operation, maintenance and decommissioning**
- **Product and fleet digital twins of degradation mechanisms**
- **Uncertainty quantification and probabilistics**
- **Integrated physics-based multiscale models**
- **Surrogate and reduced order approaches**

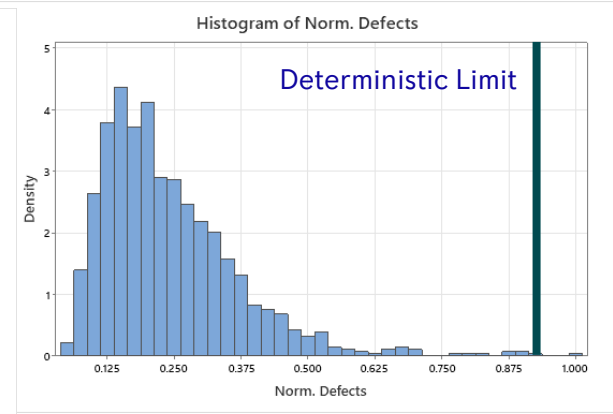
V&V Validation and Verification
NDE Non Destructive Examination
SHM Structural Health Monitoring
EHM Equipment Health Monitoring
ISI In-Service Inspection

Data Centric Engineering Approach

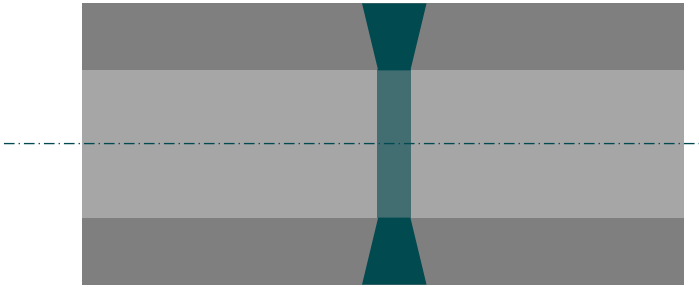


- Statistical view on defect generation
  - Review of manufacturing processes
    - Trial Data
    - Downstream processing
  - Similar products





Data Centric Engineering Approach



- Statistical view on defect generation
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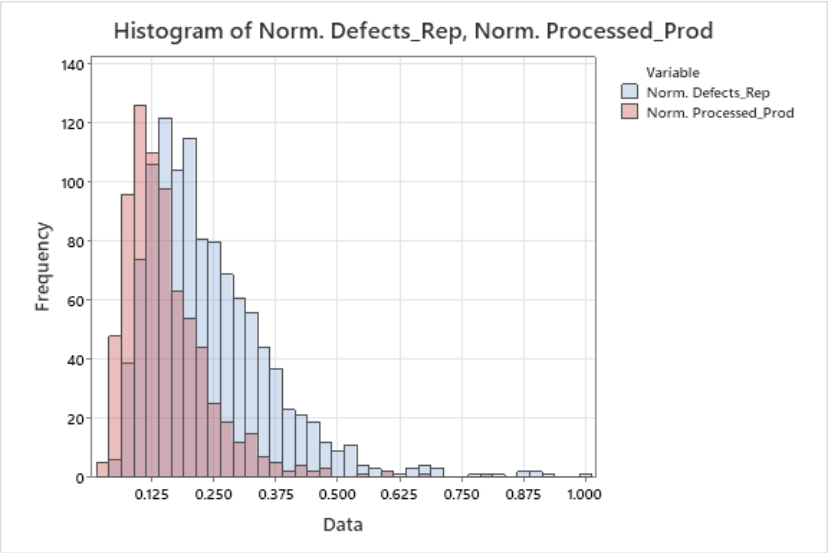
  - Similar products
- Review of current measurement capability
  - Likelihood of false positives
  - Reliability of missing defects

Inspector ID	Defect ID				
	A	B	C	D	E
1	✓	×	×	✓	✓
2	✓	✓	×	✓	✓
3	×	✓	×	✓	×



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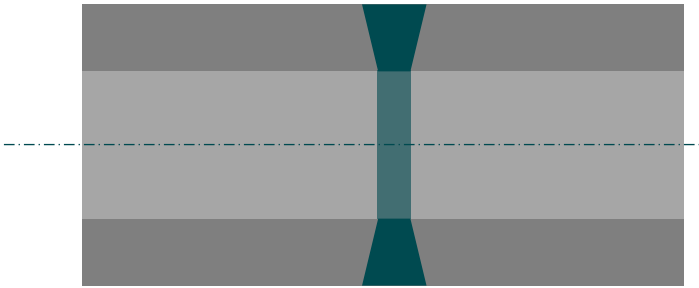

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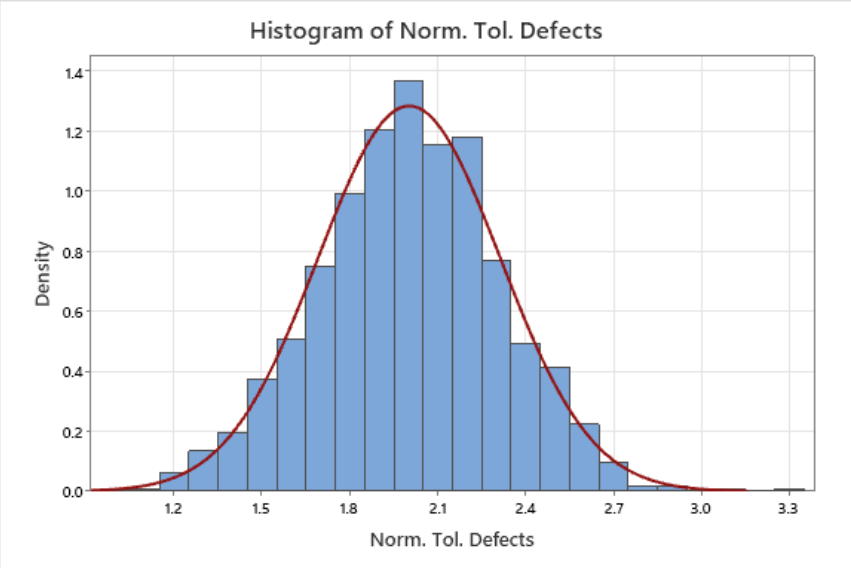
- Statistical view on loading
  - As-built data
  - Quantification of reliability required



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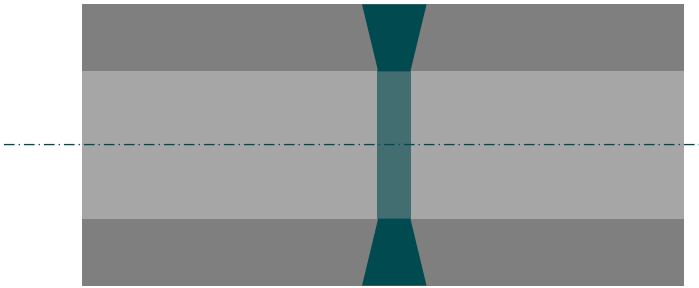

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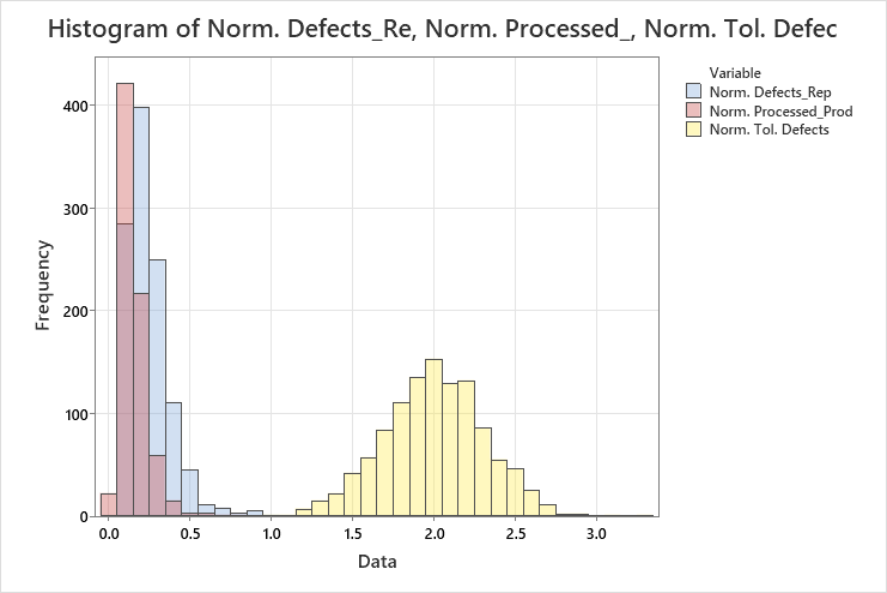
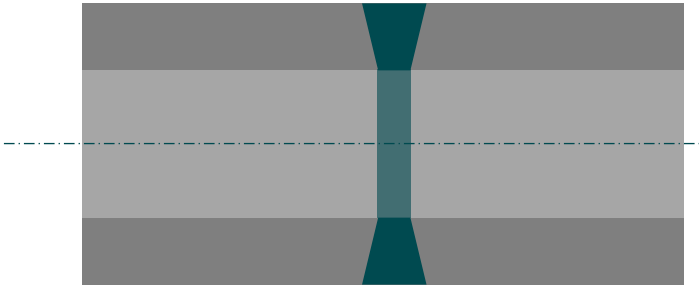
- Statistical view on loading
  - As-built data
  - Quantification of reliability required
- Combined assessment
  - Understand true worth of the inspection method

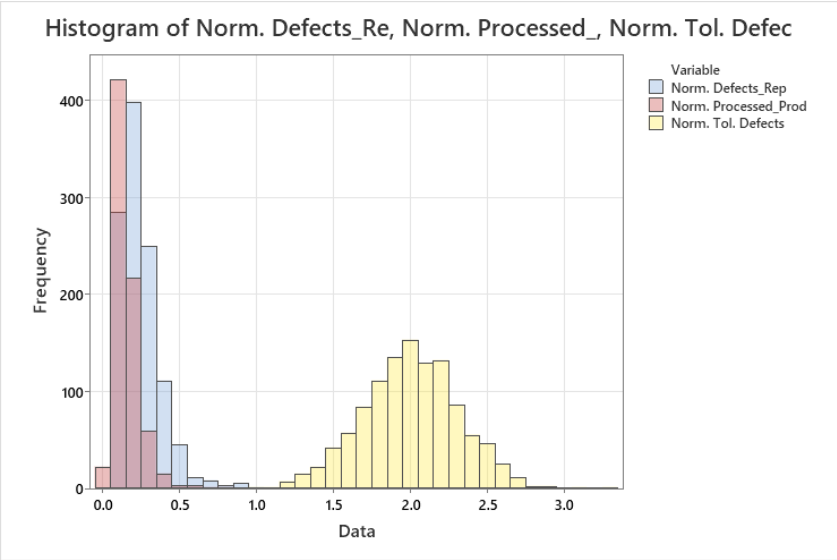


03 Improved Position

Improved Position



- Statistical view on defect generation
  - Structurally significant defects highly unlikely
  - Process understanding conducted to prevent damage
- Review of current measurement capability
  - Capability limited
- Statistical view on loading
  - Deterministic assessment reliability quantified
  - Variation across component understood
- Combined assessment
  - Likelihood of failure acceptable without inspection
  - Inspection shown to not significantly improve reliability
  - Significant time and cost saving implemented
- Collaboration across disciplines key to outcome



Thank you for your attention!

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