ICCM23

Challenges to overcome for relying on multiphysics smarter testing and simulation in aerospace

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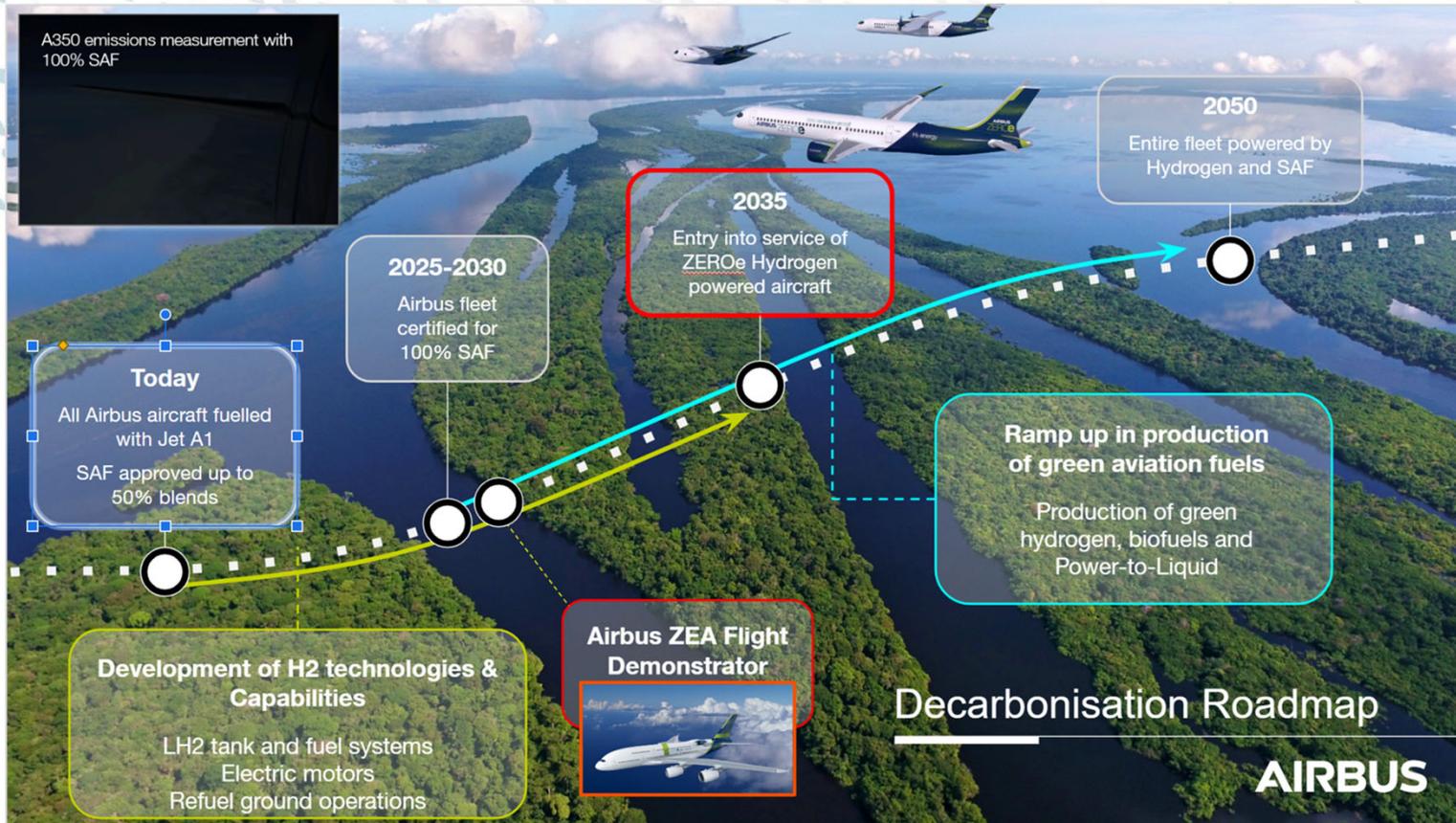DQG#XQLWHG#ZRUOG

Prof. Linden Harris - Airbus, Technical expert
1 Aug 2023
ICCM Belfast

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Agenda

- *Summary;* LH2 - Introduction
- Multiphysics challenges for ATA based certification
- SAFE life systems?
- Multiphysics CAF Aleatoric and Epistemic uncertainty
- Conclusion

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Summary; LH2 - Introduction

A350 emissions measurement with 100% SAF

Today
All Airbus aircraft fuelled with Jet A1
SAF approved up to 50% blends

2025-2030
Airbus fleet certified for 100% SAF

2035
Entry into service of ZEROe Hydrogen powered aircraft

2050
Entire fleet powered by Hydrogen and SAF

Development of H2 technologies & Capabilities
LH2 tank and fuel systems
Electric motors
Refuel ground operations

Airbus ZEA Flight Demonstrator

Ramp up in production of green aviation fuels
Production of green hydrogen, biofuels and Power-to-Liquid

Decarbonisation Roadmap

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(Aerospace testing symposium 2022, Farnborough)

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Summary; LH2 - Introduction

(Aerospace testing symposium 2022, Farnborough)

Summary; LH2 - Introduction

(Aerospace testing symposium 2022, Farnborough)

Summary; LH2 - Introduction

(Aerospace testing symposium 2022, Farnborough)

Multiphysics challenges for ATA based certification
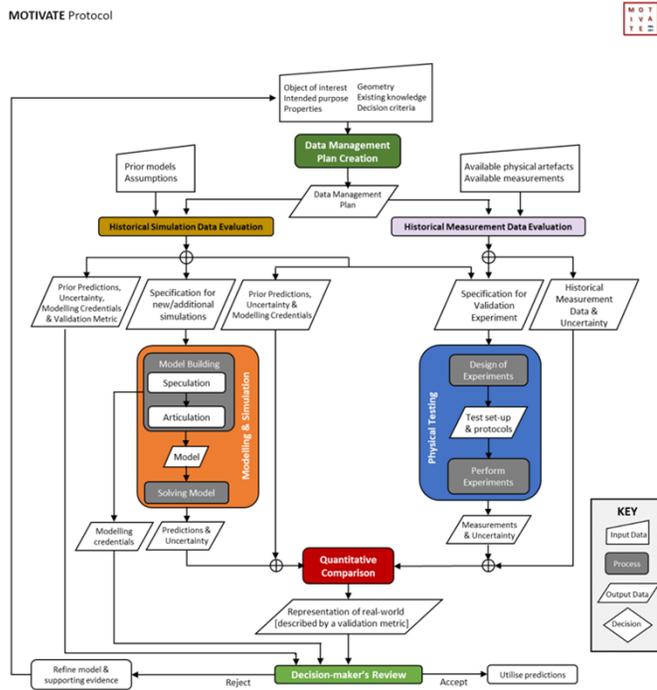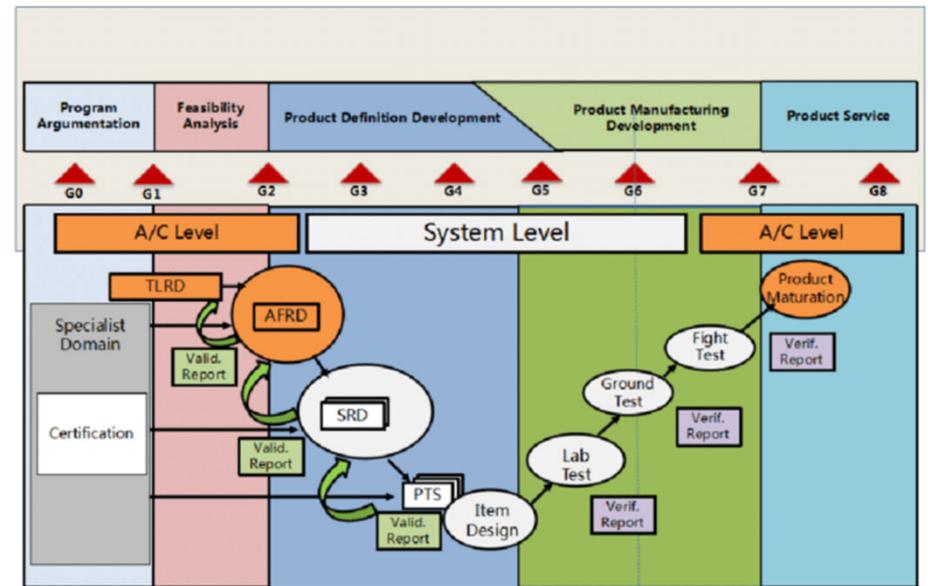
Structure V&V

Systems V&V

Fig. 1: A revised version of the MOTIVATE validation flowchart, updated relative to Hack et al.[2] following user feedback. The coloured boxes represent sub-charts broken out in tabular form over the next sections.
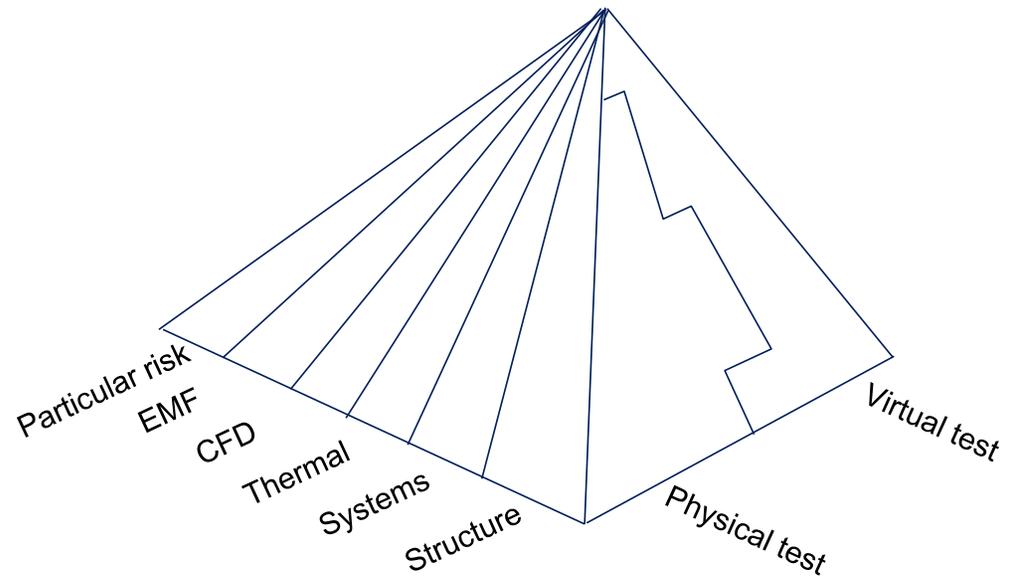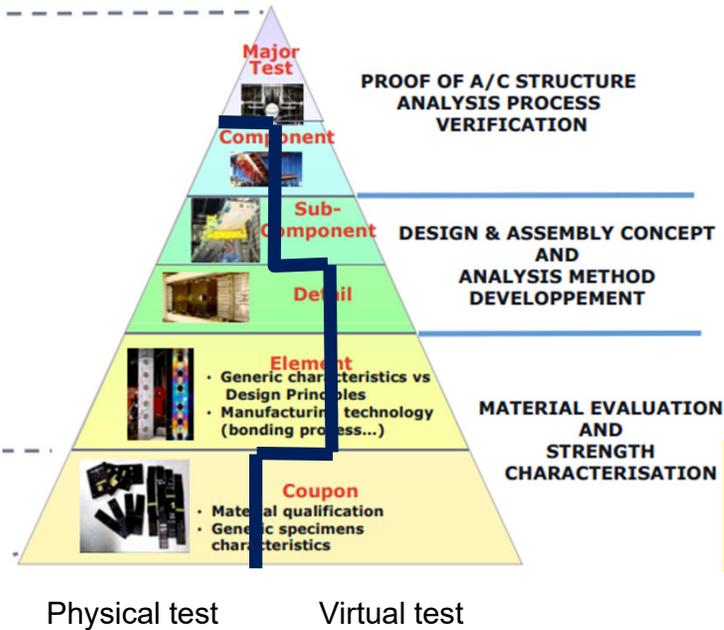
The civil aircraft requirement based development process.
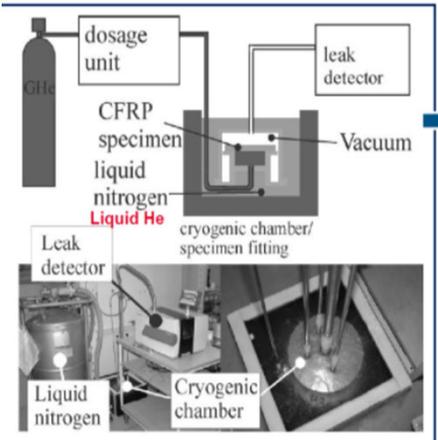
Is it a Structure or a system; Depends on the regulations……

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Multiphysics challenges for ATA based certification

Structure test pyramid triangle

"True" pyramid……

Physical test   Virtual test

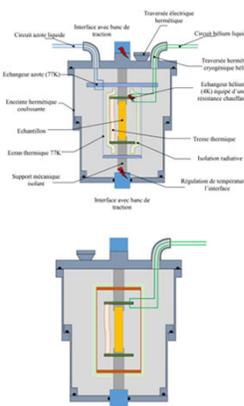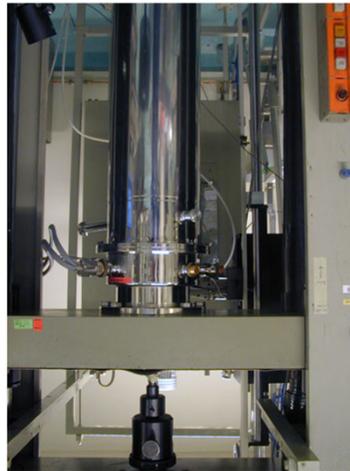(Aerospace testing symposium 2022, Farnborough)

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Multiphysics challenges for ATA based certification
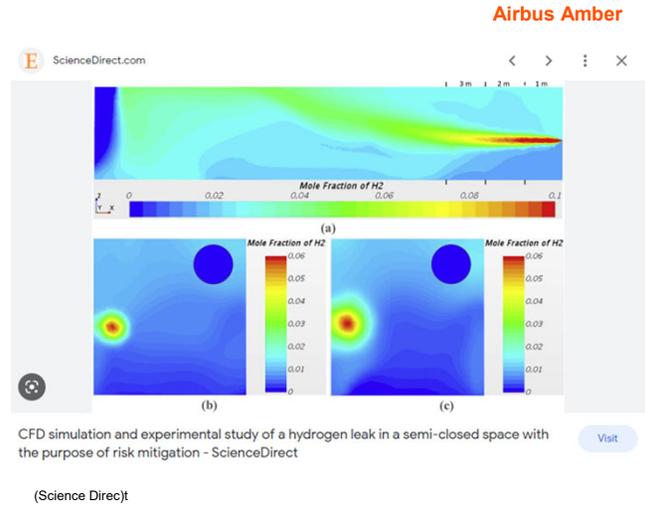
Physical & chemical

mechanical tests

Fire safety
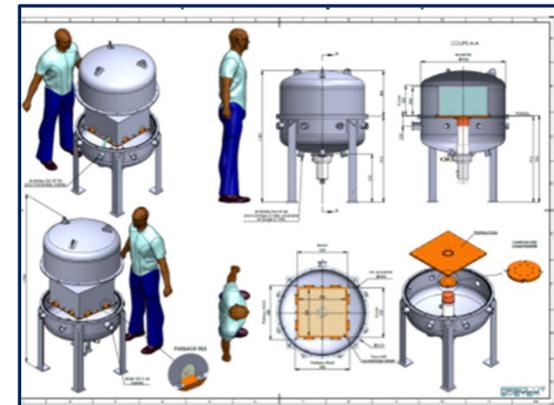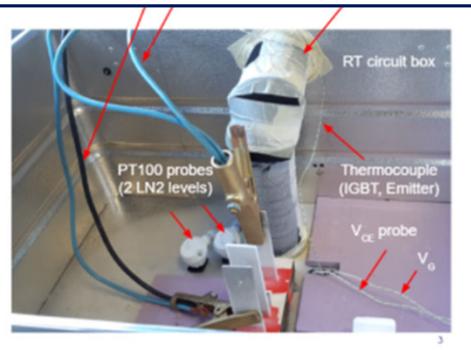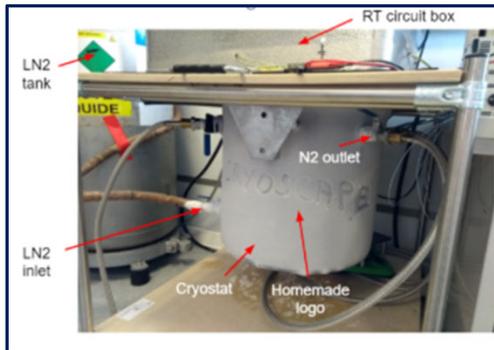
Airbus Structures Test capability development

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Safe Life systems?

(NASA Artemis open source data).

CFD simulation and experimental study of a hydrogen leak in a semi-closed space with the purpose of risk mitigation - ScienceDirect

(Science Direct)t

Permeation & Leakage

H₂ permeation through inner tank

outgassing inner tank

leaks

outgassing outer tank

air permeation through outer tank

(Semantic Scholar)
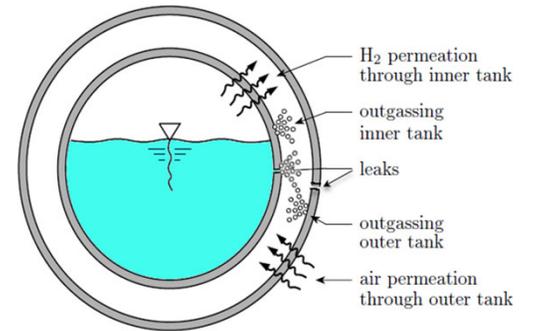
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Safe Life systems?
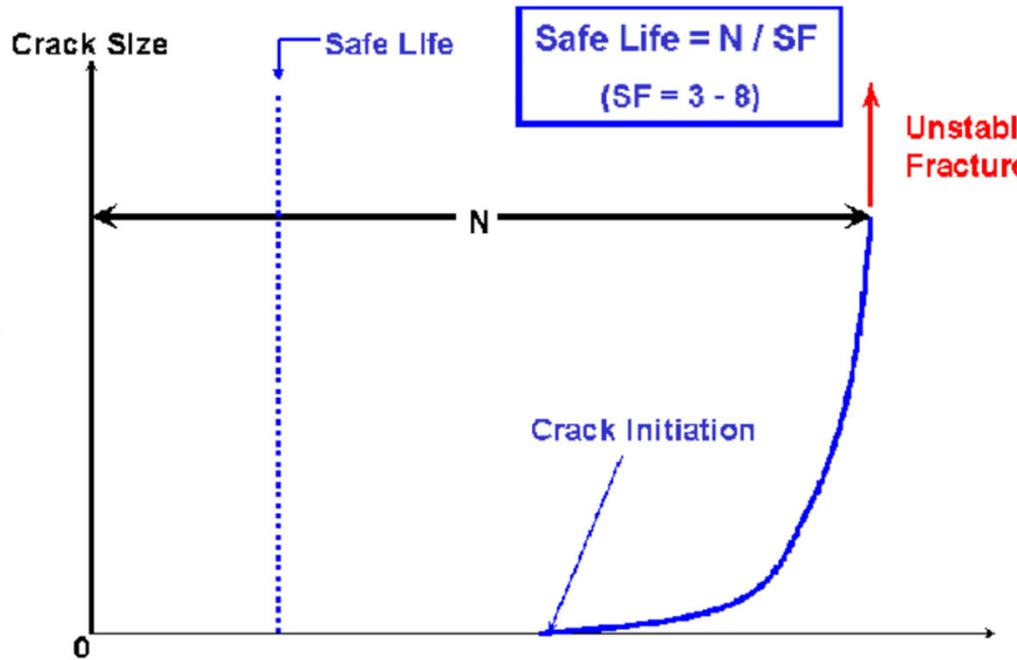
Safe Life = N / SF
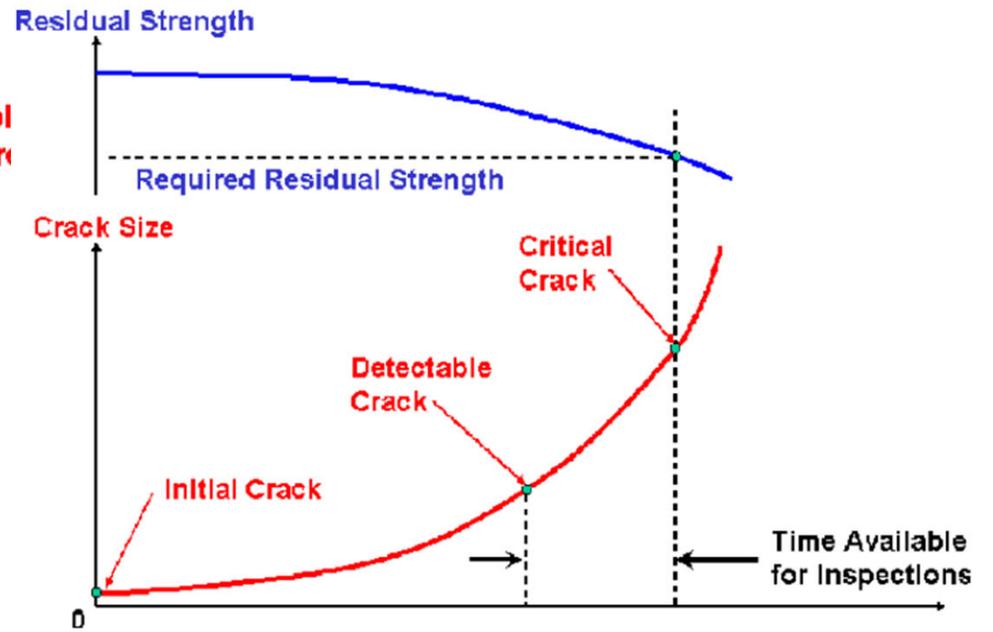(SF = 3 - 8)

The safe-life concept for ensuring a sufficient service life.

The damage-tolerance concept for ensuring a sufficient service life.

(Research Gate)

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Multiphysics CAF Aleatoric and Epistemic uncertainty

Building Credibility
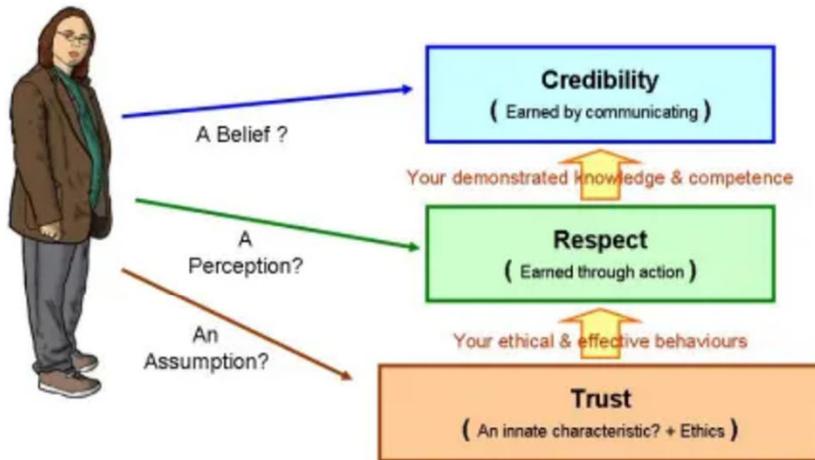
(WWW Stakeholder management)

Model Credibility

e.g. dynamic loads on Mars rover

e.g. nanoparticles interacting with cells

Simplicity, consistency & explanatory power

Epistemic properties

No empirical evidence & physics not understood

Radical uncertainty

PRINCIPLED   UNPRINCIPLED

PREDICTION

RETRODICTION

UNTESTABLE MODELS

TESTABLE MODELS

ASME V&V 10-2006 & CEN 16779

Validation & confirmation

Friedmann approach

Predictive ability favoured over veracity of assumptions

KNOWN PHYSICS   UNKNOWN PHYSICS

e.g. residual stresses in 3D printing

Patterson, E.A., On the credibility of engineering models and meta-models, J. Strain Anal., 50(4):218-220, 2015

MOTIVATE (Project No. 754660) Joint Workshop with INSTRUCTIVE a

(Patterson, 2018)

(Aerospace testing symposium 2022, Farnborough)

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Multiphysics CAF Aleatoric and Epistemic uncertainty

Flying Test Bed confidence

Crew safety

Airframe safety

System safety

(Aerospace testing symposium 2022, Farnborough)
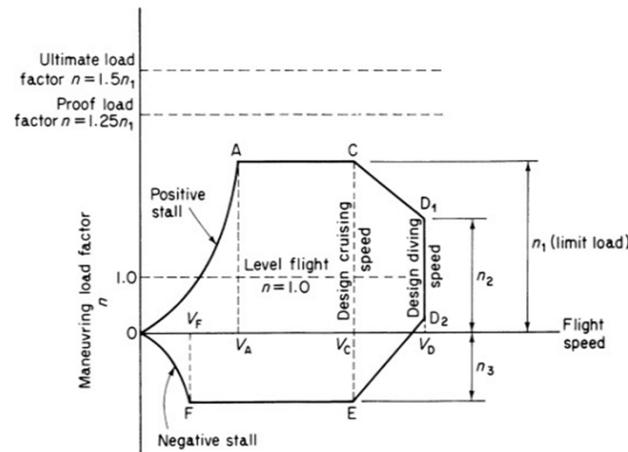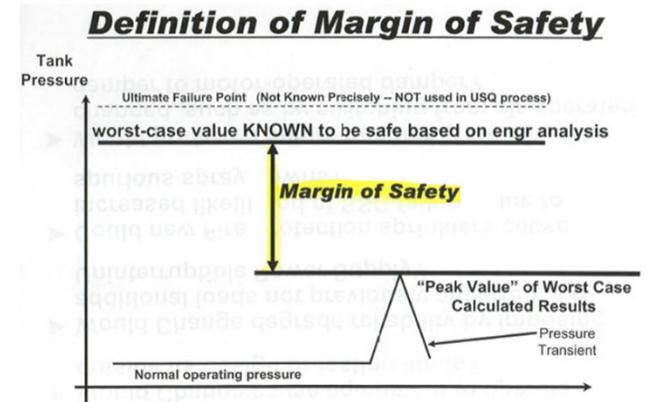
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Conclusion

TRL6 requirements

(Aerospace testing symposium 2022, Farnborough)

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Thank you

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