Virtual Verification and certification – Manufacturing technologies

AirTN-NextGen Workshop on Virtual testing, towards virtual certification

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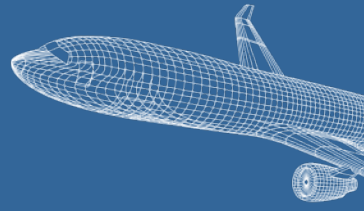
Outline



About GKN Aerospace

“Enabling Technologies”

Verification and Validation

Towards Virtual Certification?

Summary and message

Widest capabilities of any Tier 1

AEROSTRUCTURES

- Fuselage, wing, nacelle & pylon
- Inflight opening doors and empennage

GLOBAL NO. 2

ENGINE SYSTEMS

- Static & rotating structures
- Titanium engine inlet parts

GLOBAL NO. 2

SPECIAL PRODUCTS

- Transparencies
- Ice protection systems
- Lightweight missile canisters

GLOBAL NO. 1

WIRING INTER-CONNECT SYSTEMS

- Electrical Wiring Interconnection Systems (EWIS) for aircraft and aircraft engines

GLOBAL NO. 3

LANDING GEAR

- Helicopter landing gear
- Composite load carrying landing gear components (drag brace)

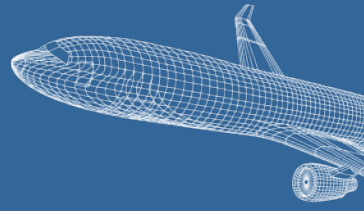
GLOBAL BRAND

GLOBAL SERVICES

- Availability services, MRO, conversion and completion for mature and legacy aircraft

GLOBAL BRAND

Outline



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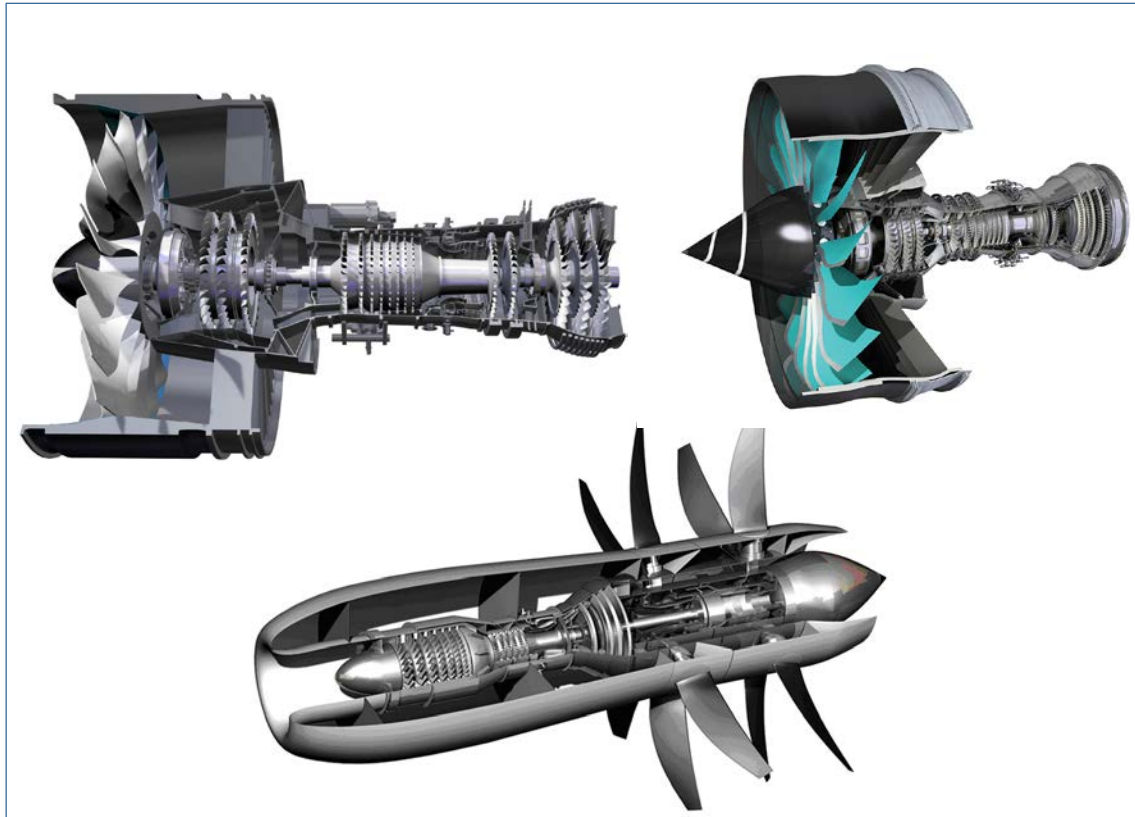
Value generated once technology is in use

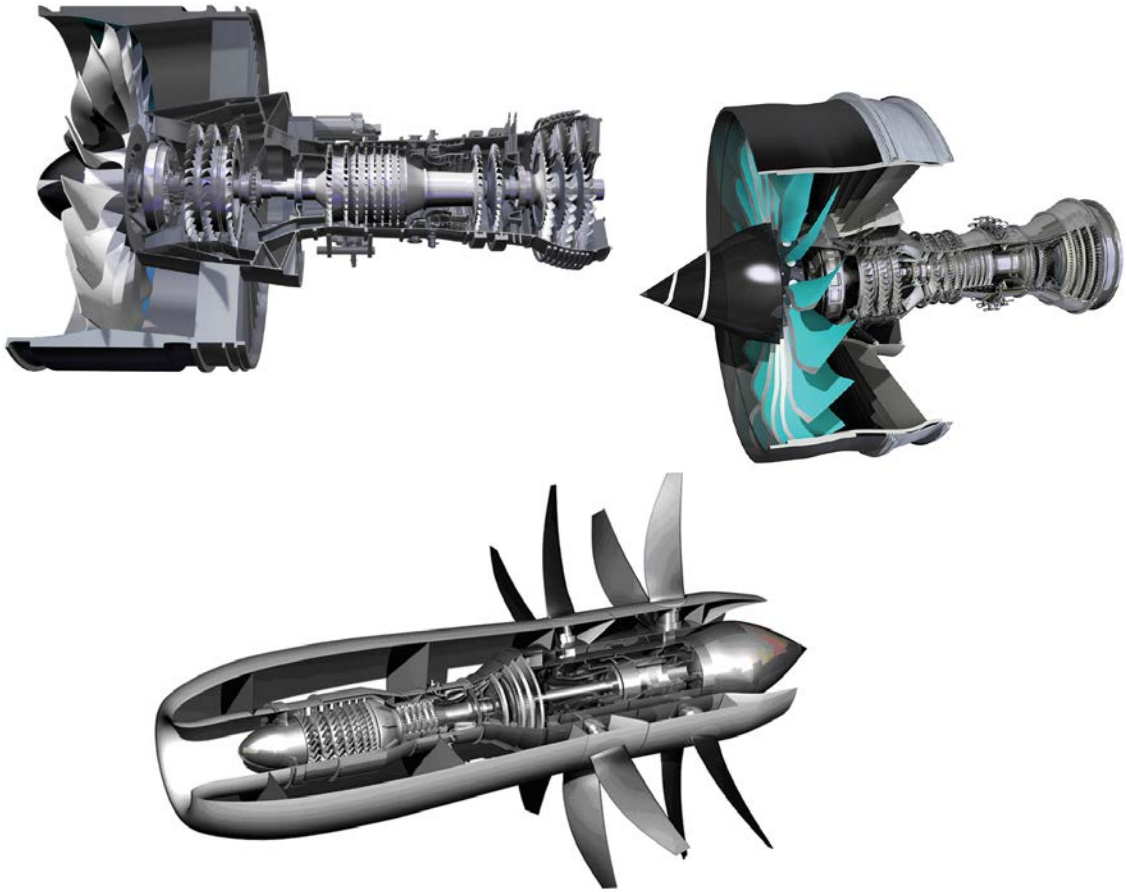
Innovative air transport products..

..enabled via innovative systems



Need for new technologies

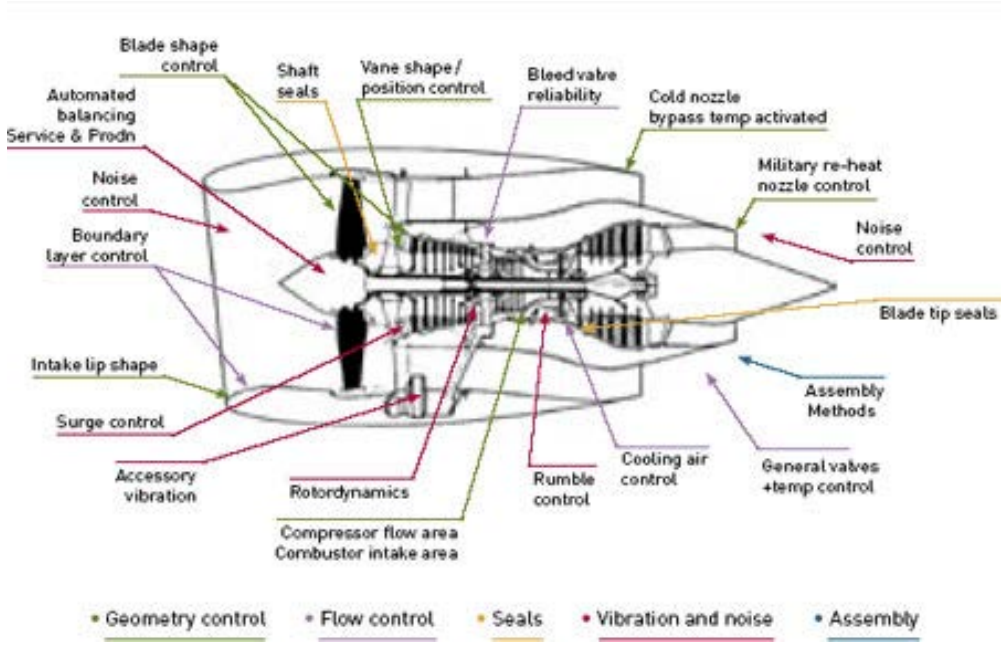
Innovative systems …



..enabled by innovative technologies

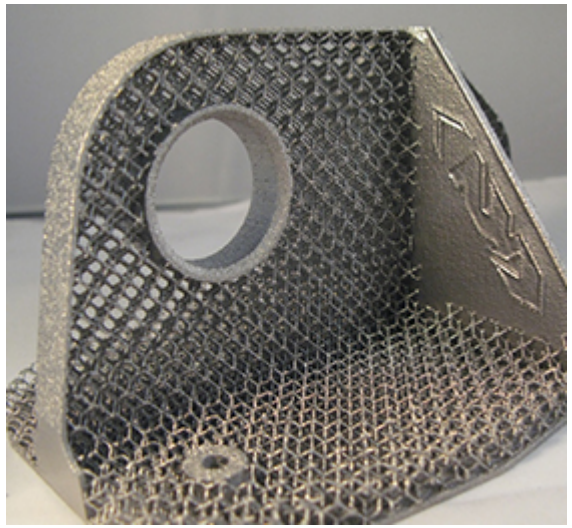
Example – Rotating Frames for the Open Rotor

Example – Light Weight Composite Designs

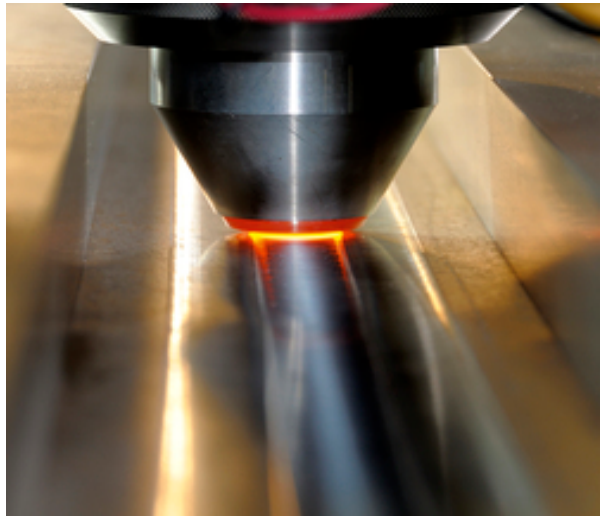


Materials and manufacturing

Example: Additive metal manufacturing



Credit: ARCAM



Credit: The Welding Institute

Benfeits

- More efficient utilization of materials (Buy to fly ratio)
- Enable new designs
- Radically new production and manufacturing

Need

- Understand physics – identify criteria
- Model phenomena
- Find limits and boundaries
- New design, inspection and repair technologies

Enabling materials and manufacturing

Example: Increased use of Composite Technologies

Hybrid design – Mid Frame demonstrated VITAL

Radical reduction in weight

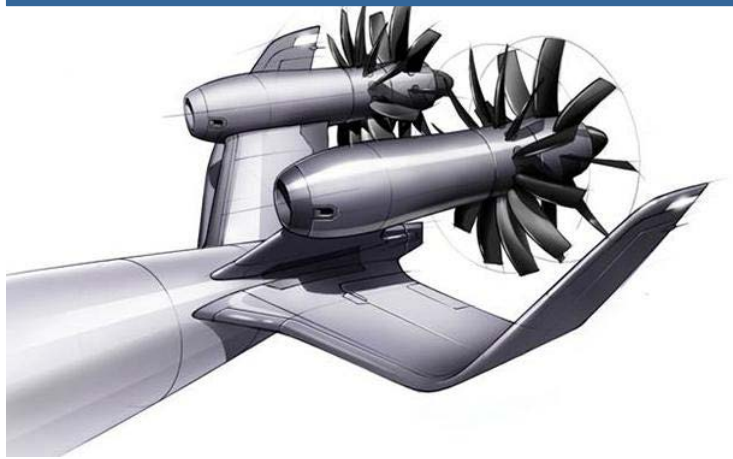
Require new design solutions

Radically new production and manucacturing

Simultaneous advancements

Installation, use, loads, constraints in flight change.

Characteristics of new materials, component design and manfacturing solutions change.



Require ”Rotating Frames”

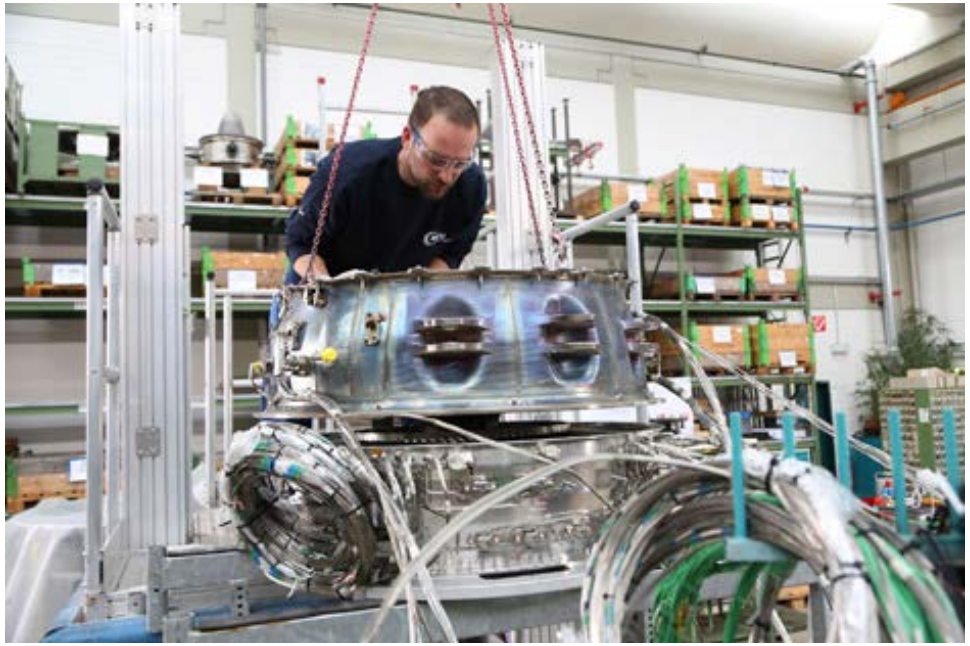
Flight Cycles
Energy use
Thermal condtions
Mechanical conditions
Aerodynamic conditions
Etc.

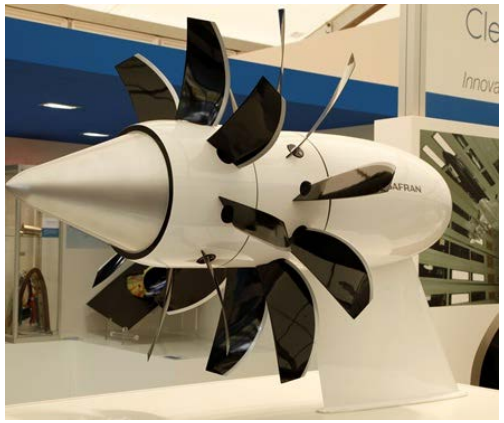
Material Characteristics

Product and Production – dependent properties

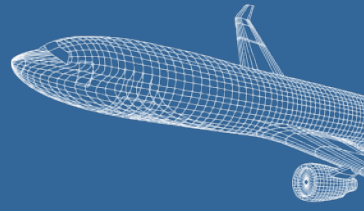
Develop and demonstrate novel design-manufacturing technologies

Rotating Frames in Clean Sky – SAGE 2





Outline



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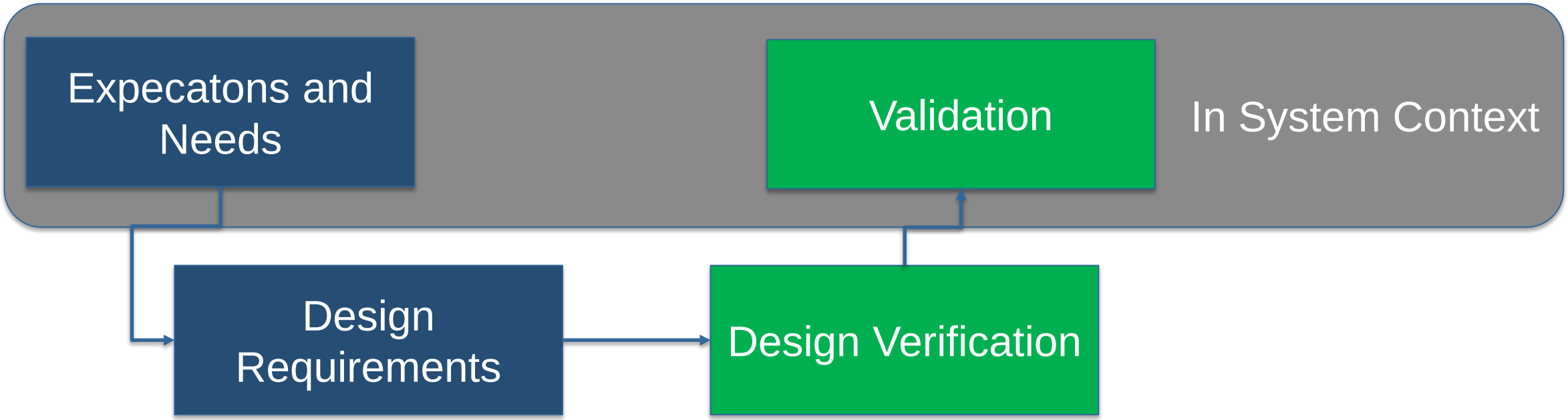
Verification and Validation

Towards Virtual Certification?

Summary and message

A note on verification and validation



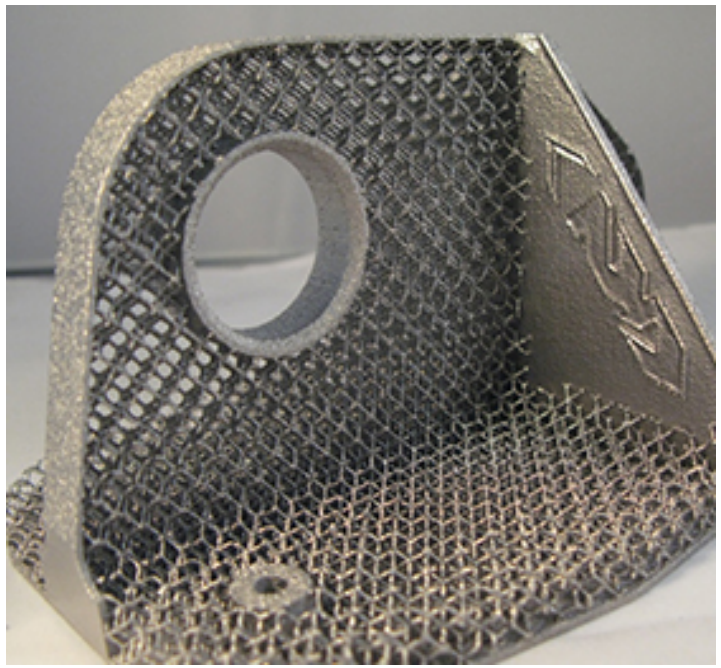
Challenge #1 – Verification through demonstration programs – application in Business Applications

Need to understand *range of validity* - and ensure re-applicability in commercial development

- **”Bandwidth” of technologies**
- **Robustness and resilience**

Challenge #2 – Matching new conditions with critical modes

Traditional requirements may be insufficient, new failure modes need to be understood, engineerd and validated



- Material – Manufacturing – Design : Concurrently designed
- Understanding underlying physics
- Inspection
- Multi-dimensional Environmental parameters

Challenge #4 System Optimization drive Integration

Good Design Practice – Separate Functionality- Modularize

Optimization - Maximize use of resources

- E.g. Topology optimization
- Mixed Domain solutions (Mechanical, Electrical, Cyberphysical,..) as Integrated Sensor Technologies

A tension between optimal product- and optimal platform-configurations

Reflection – Verification and Validations

Challenges

Range of Validity for new technologies?

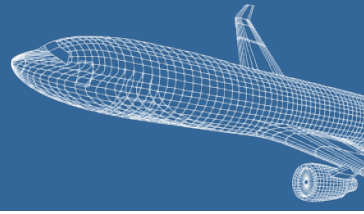
Robusness of design solutions?

Validity of requirements?

Attractiveness of opportunities

Verification → Validation

Outline



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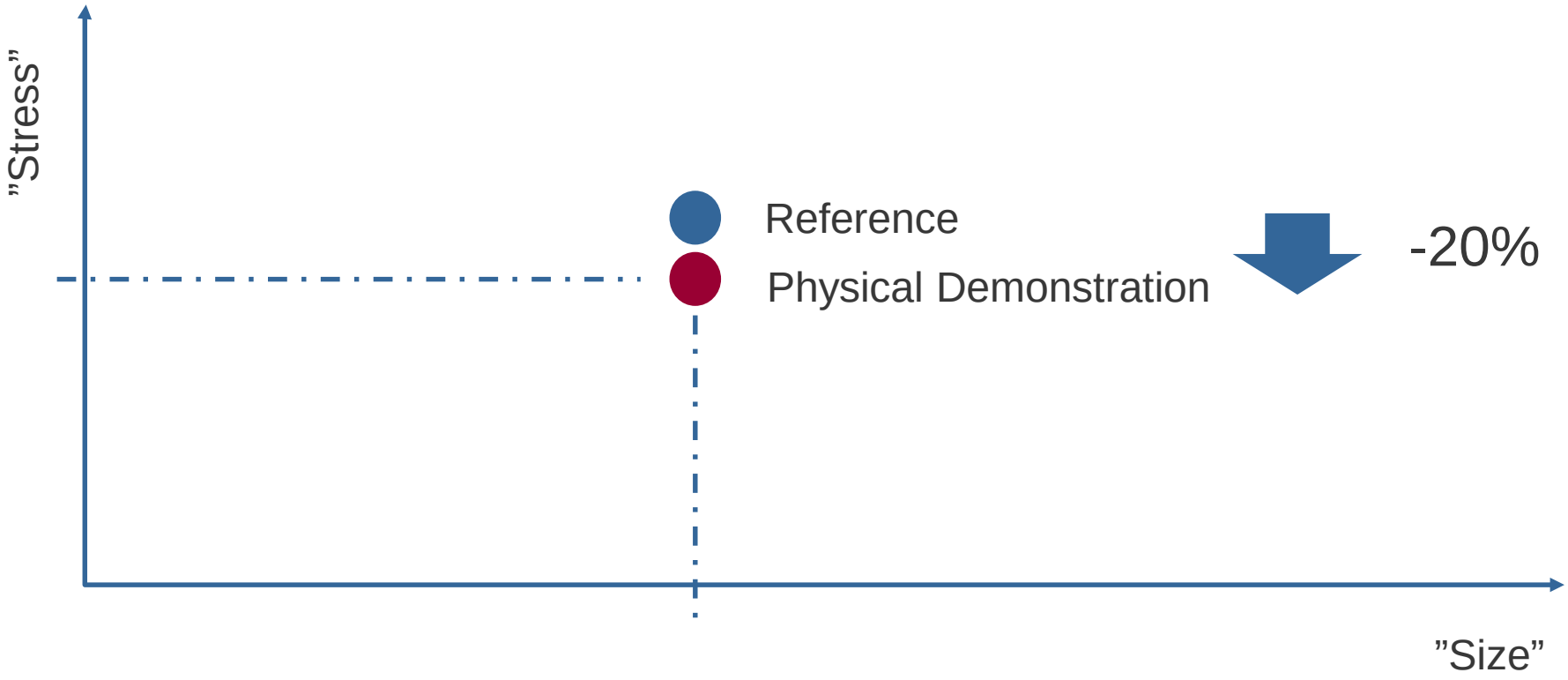
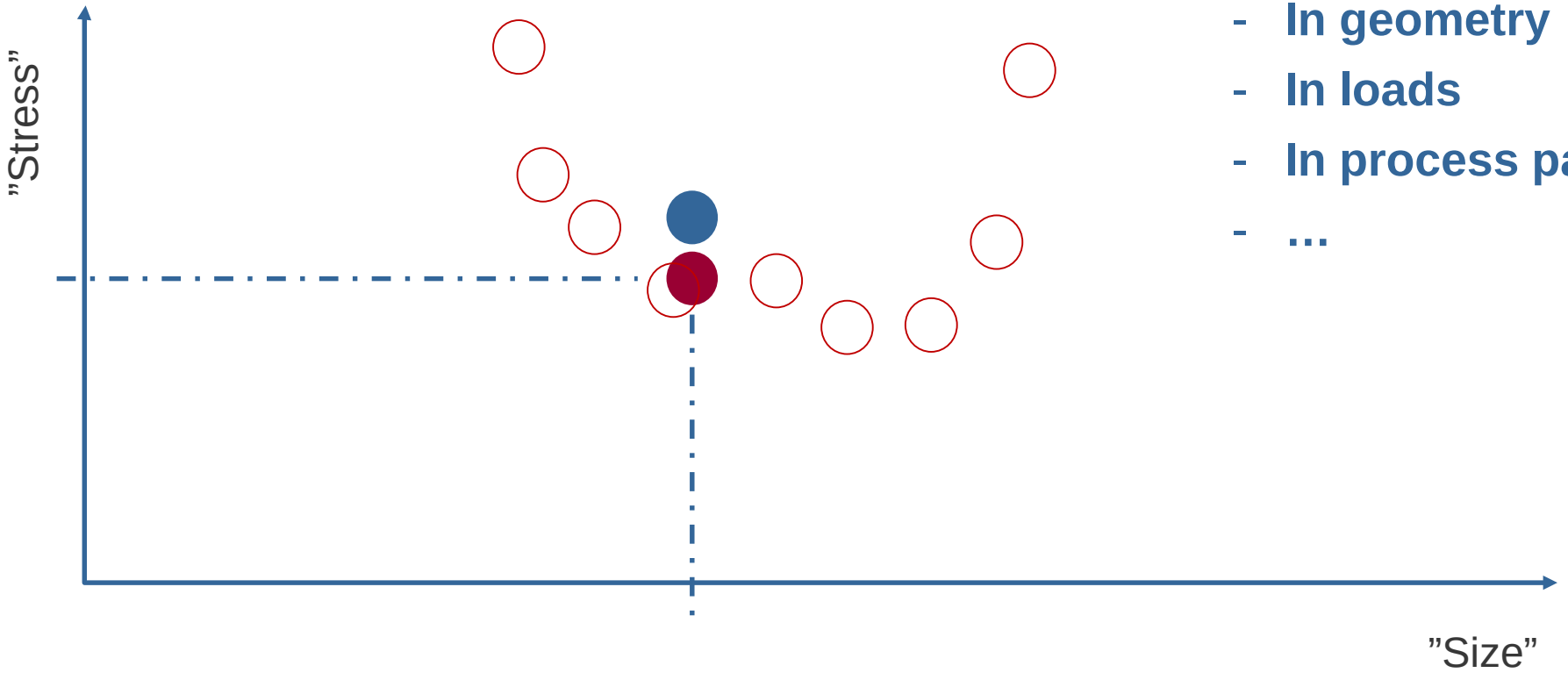
Summary

Opportunities with Virtual Verification and Validation



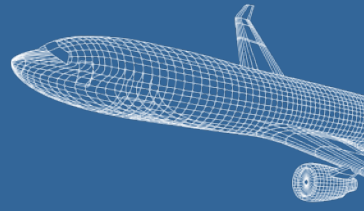
Opportunities with Virtual Verification and Validation



Possibility to Explore Behavior of technologies/product subject for variation

- In geometry
- In loads
- In process parameters
- …

Pre conditions for Virtual Verificaton and Validation



Validity of behavioural models and methods

-> Underlying phenomena must be understood

- identify criteria and influencal factors

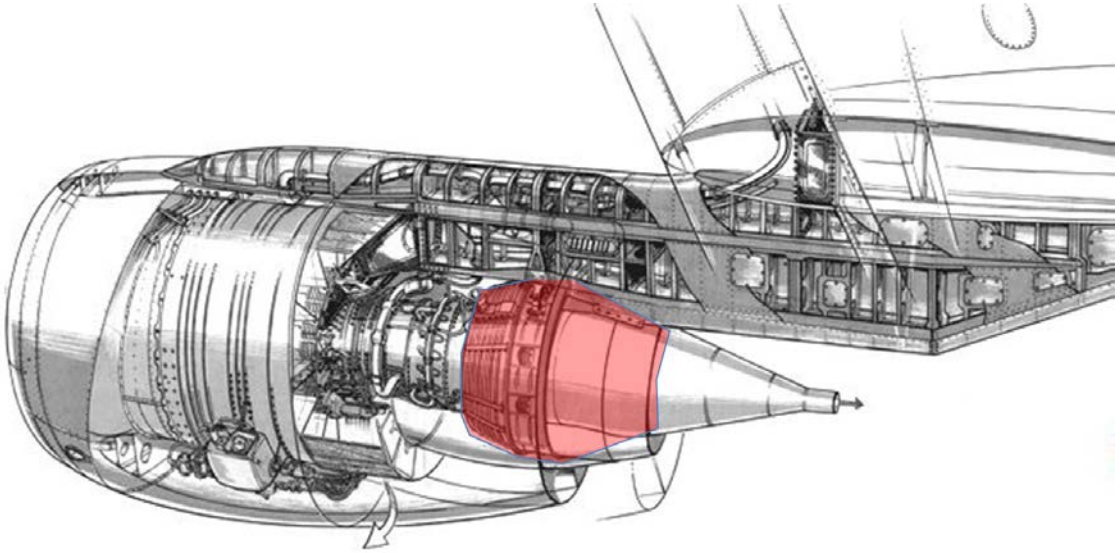
Ability to generate alternatives and variation

-> To allow exploration of bandwith

Possibility to control verification dimensions

-> Enable controlled experimentation

An Example



Scenario:

Next generation engine display an increased thermal load on engine components

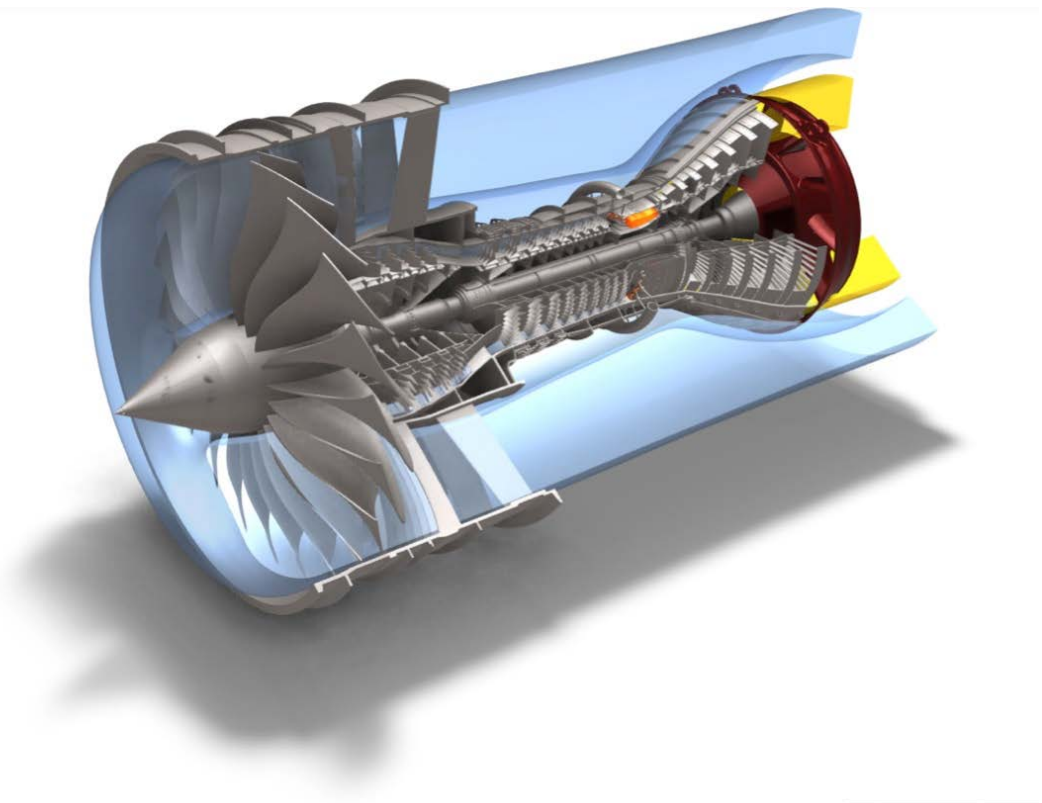
The Ability to design, experiment and trade new architectures from a thermal behavioural view is currently developed in TOICA.

Expect to deliver CAPABILITIES for Virtual Design and Verification

TOICA
Thermal Overall Integrated Concept Aircraft

SEVENTH FRAMEWORK PROGRAMME

A Rear Engine Case



Thermal Conditions drive choise of design and technology

Pre-condition

There is physically verified baseline

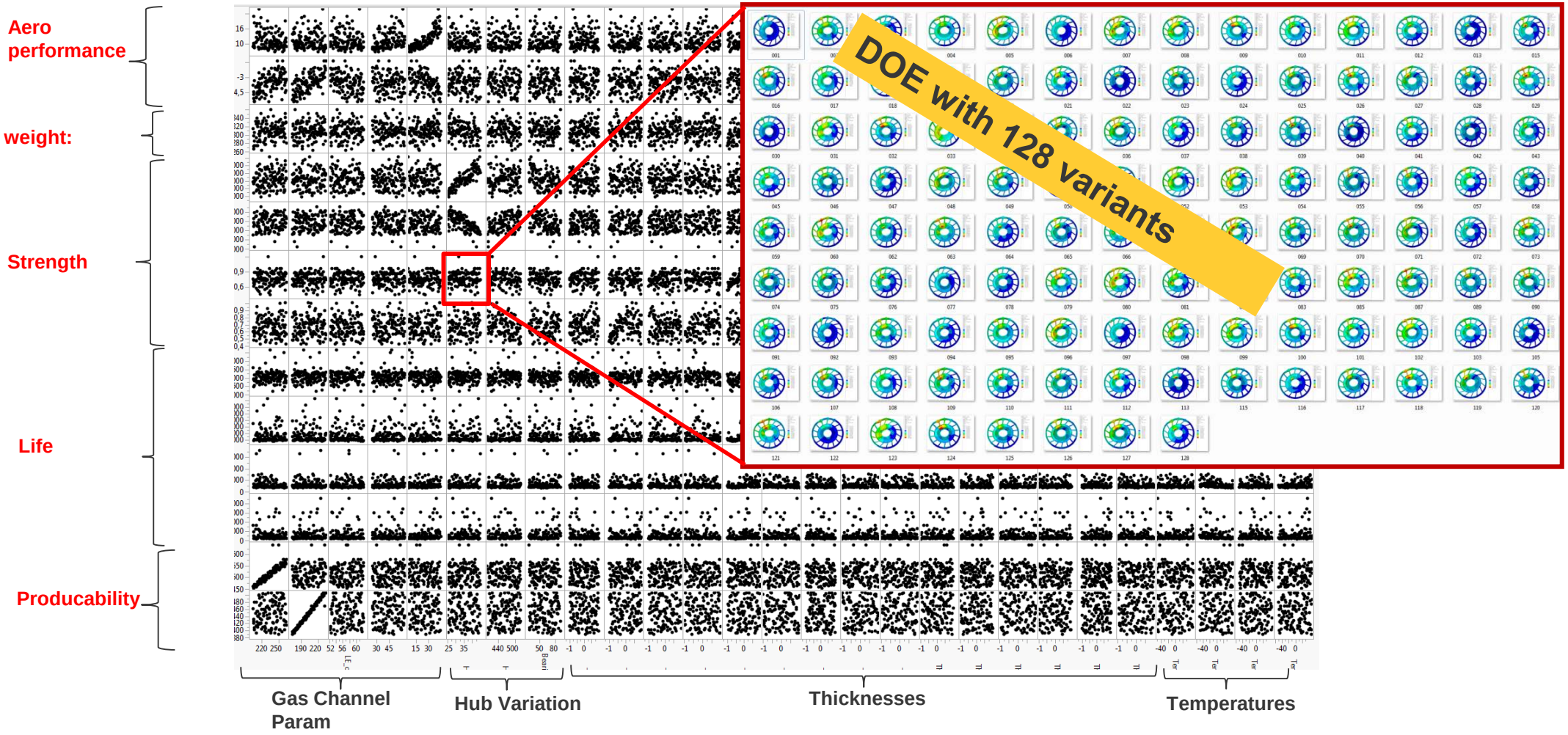
Virtual Experimentation of

- Alternative arrangement/size and technologies

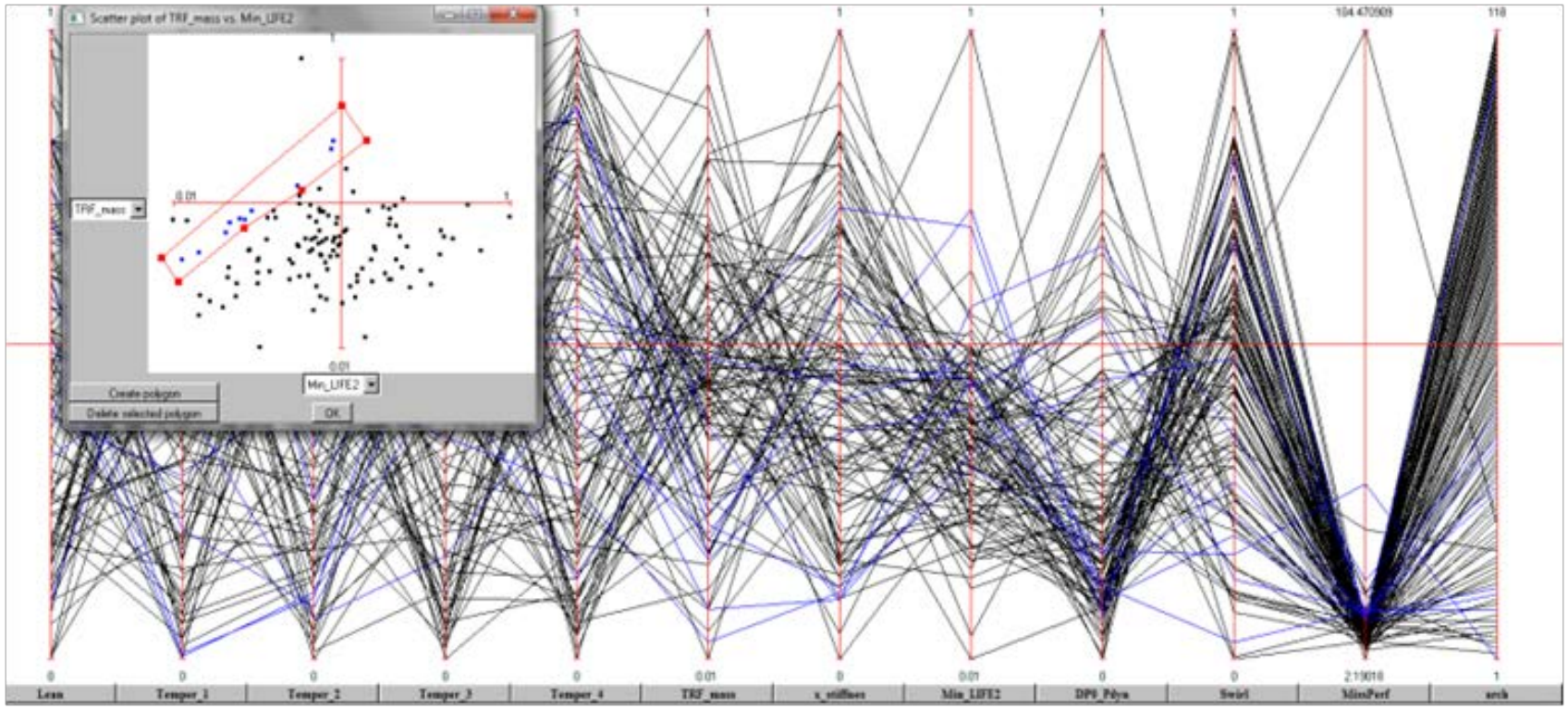
- Evaluate structural, aerothermal and produceability, integrity and behaviour

- Include uncertainty in thermal loads

Automation enable physical simulation exploration



Multi Dimensional Evaluation

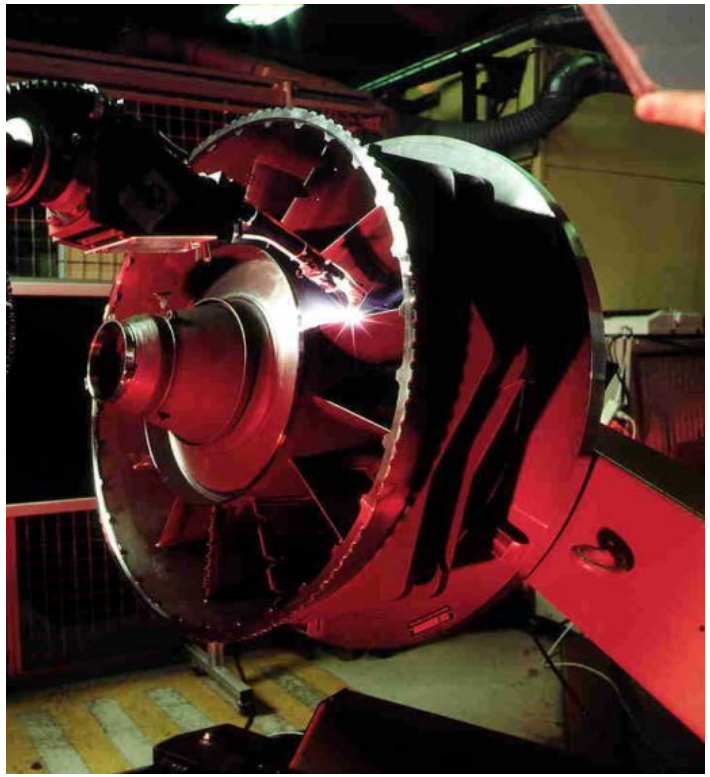


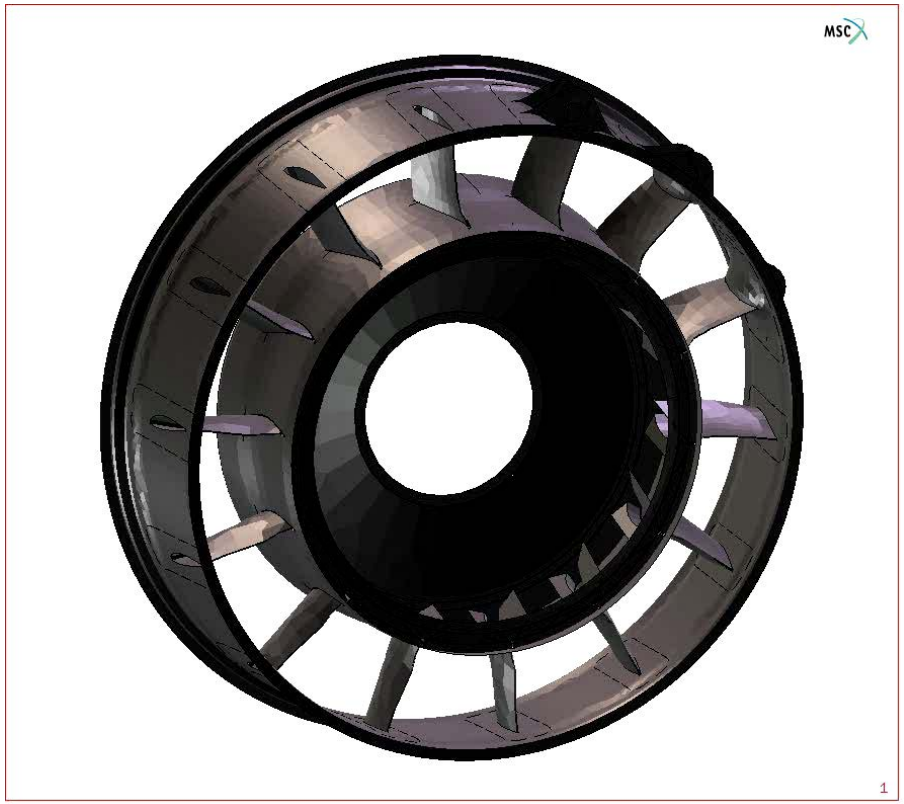
128 alternatives

Variables and response – post processing simulation results

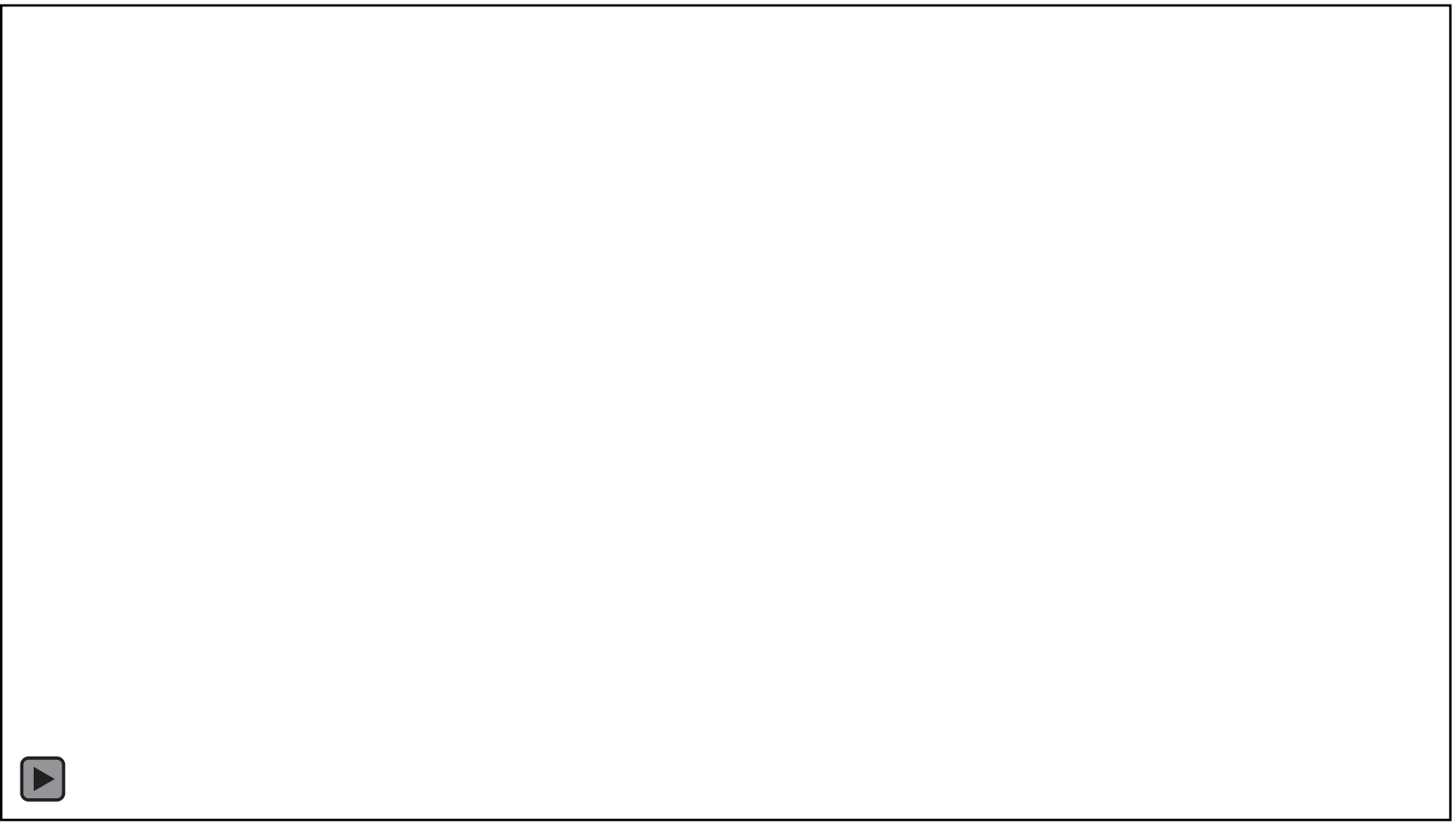
Example – Simulation of welding process

Virtual evaluation of distortions and induced stress during manufacturing



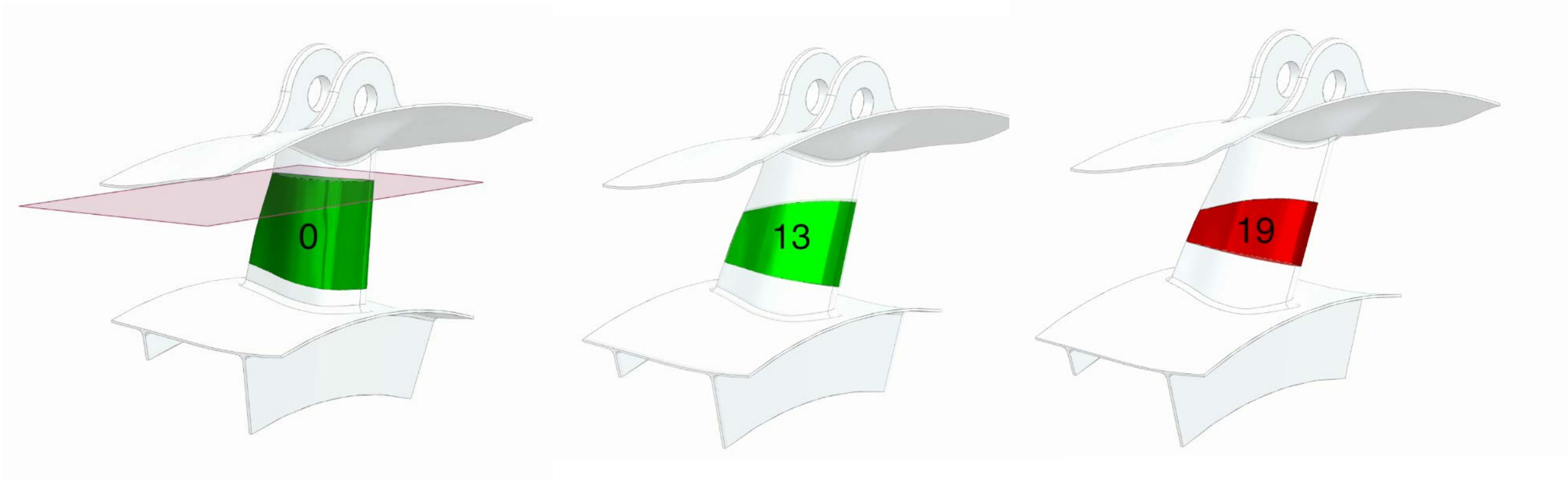


Example on Produceability



Accessability of Welding Manufacturing Equipment

J.Landahl, Chalmers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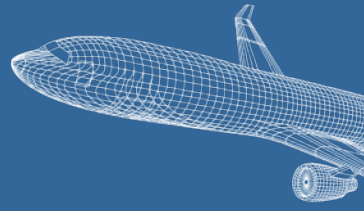
Towards Virtual Certification?



Trend of stronger coupling/depedency on Product Design Parameters and Manufacturing Parameters

- > Technologies need to be certified in a product context

Trend in system optimization and increased integration

-> Drive the need to explore robustness of designs

-> Increasingly sensitivity to multi-disciplinary, coupled effects

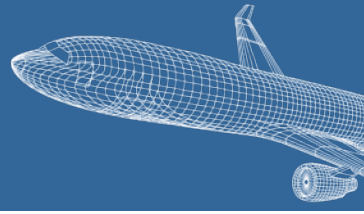
Advancements in ICT (Virtual modeling and simulation) create opportunities

-> Enable and Require Virtual Design of Experiments

Virtual Certification?

- **In short term strengthen the ability to certify a range of applicability**
- **Still require fundamental understanding of physics**

Impact on Practice?



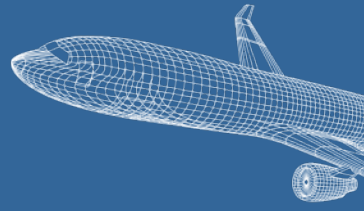
Virtual Design – exploring the allowable design space in many dimensions

Automation of Engineering Activities -> >95% lead time reduction

- ***But automation used to understand robustness and assess uncertainty!***

Value of Physical testing as means to validate virtual methods increase

Outline



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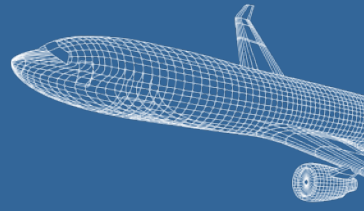
Key Messages



Virtual Verification methods are becoming powerful to explore behaviour

> Methods used critically subject to validity

Physical Verification <-> Method Validation

The path *towards* Virtual Certification require

> Significant effort to bridge ”cupon” level to ”full system” context

> Open / common effort to establish criteria and procedure for (virtual) cerfification

> Shift from certifying results to certifying process

Questions

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THANK YOU