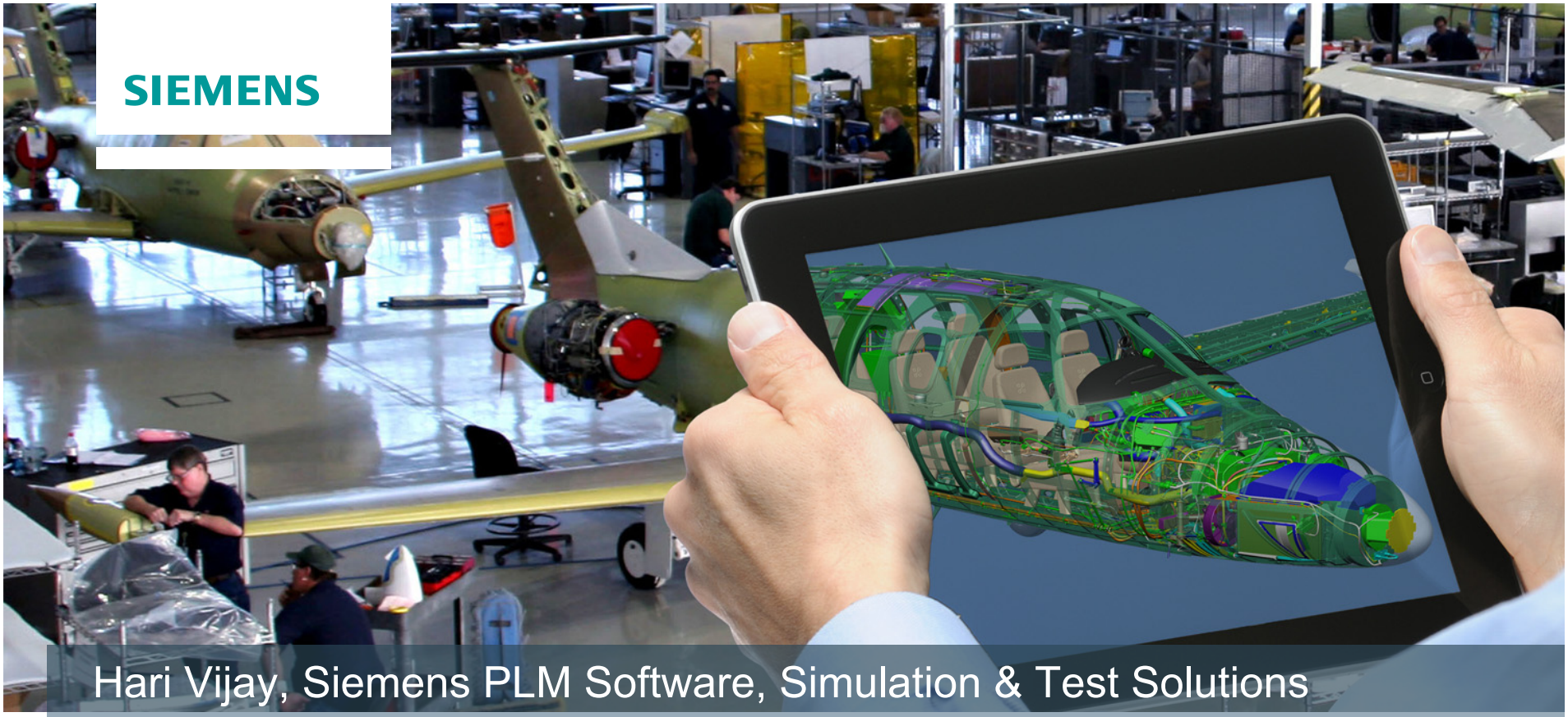
SIEMENS



Hari Vijay, Siemens PLM Software, Simulation & Test Solutions

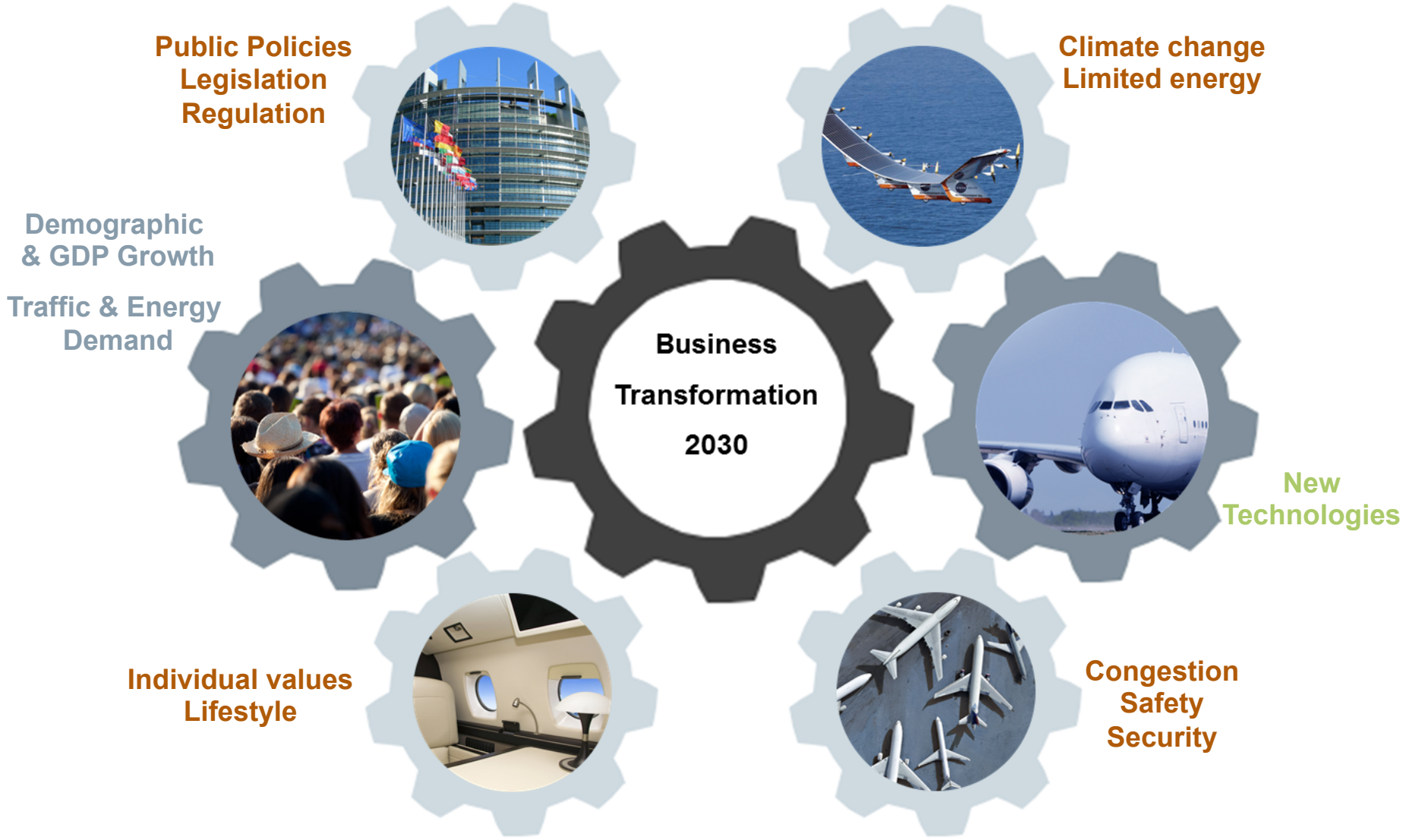
Fly it, before you build it!

Systems Performance Engineering Solutions

Aerospace Industry Challenges & Drivers

… Industry in need of Business Transformation

SIEMENS



Aerospace Industry Challenges & Drivers

From Complicated to Complex Aircraft

SIEMENS

Complicated ➔ Devisable

***Complicated* Aircraft**

- Document Based SE
- Isolated Departments
- Integration Verif. @ End of Dev.

Complex ➔ NOT Devisable

***Complex* Aircraft**

- Model Based SE needed
- Enable dept. Model exchange
- Front-Load Integration Verif.

Designs for Success

AVIATION WEEK & SPACE TECHNOLOGY/NOVEMBER 1/8, 2010

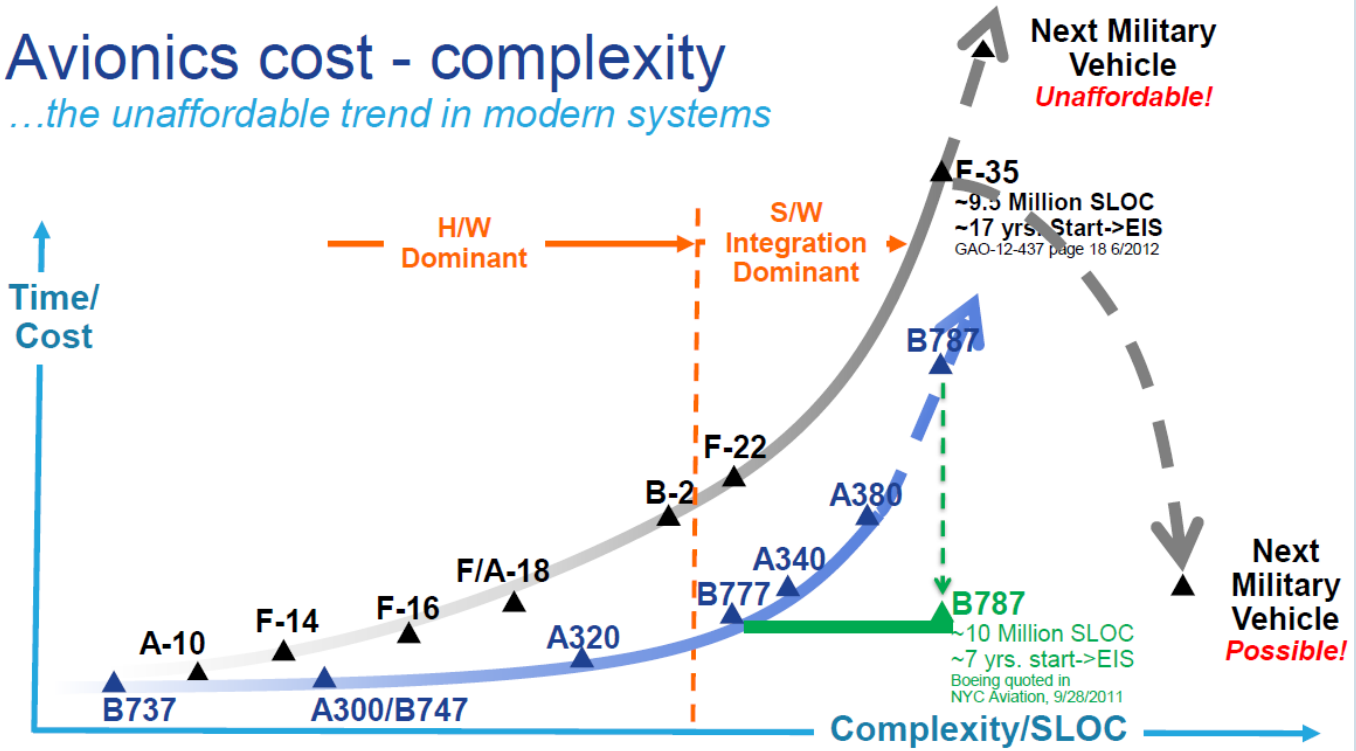
Systems engineering must be rethought if program performance is to improve

GRAHAM WARWICK/WASHINGTON and GUY NORRIS/FORT WORTH

Aerospace Industry Challenges & Drivers

Software is Everywhere ...and becoming unaffordable

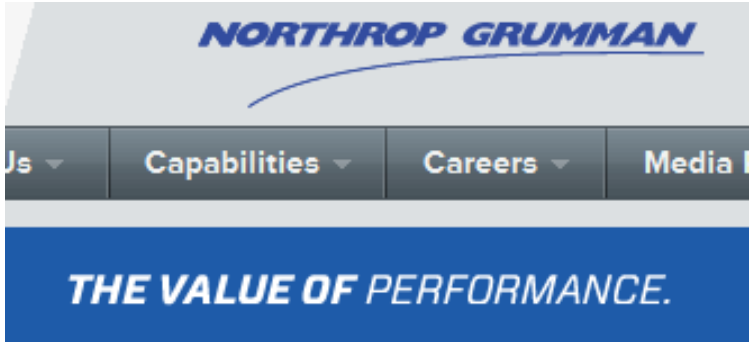
SIEMENS



Aerospace Industry Challenges & Drivers

…Corporate Focus as a Market Response

SIEMENS



Aerospace Industry Challenges & Drivers

... Bringing it all together for the future.

SIEMENS

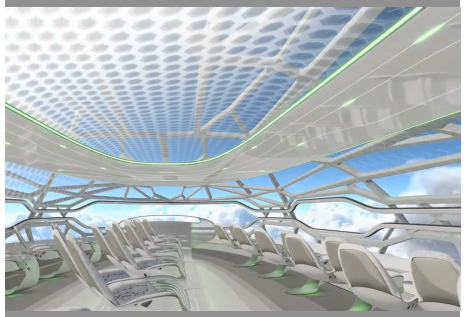
Concepts

- More Composites
  New Materials
- Right Technology
  & Architecture
- Passenger Safety
  & Comfort

Propulsion

- Clean Propulsion
  Low Emissions
- Increased Efficiency
  & Reliability
- Decrease
  operating costs

Systems



- More Electrical
  More Integrated
- Manage Complex &
  Integrated Systems
- Manage
  Power & Energy

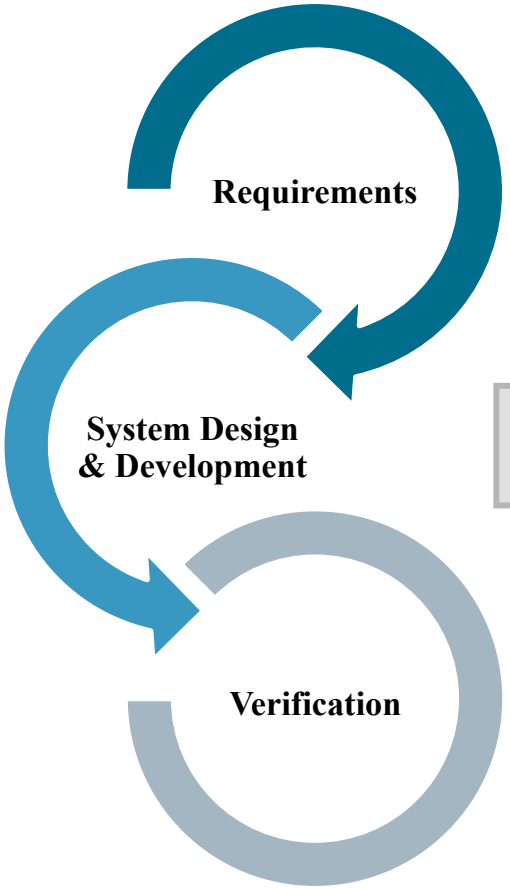
Consistent Trend towards
More Integration – Software – Global – Innovation - ...

Aircraft Development Process
needs Paradigm Shift to tackle complexity

Virtually Fly it before you build it!

... Leveraging Test towards "smarter" verification

SIEMENS



Simulation
"Virtual Test"

Verification -
Proof of Compliance

Physical Test

Applications:

- De-risk Physical Certification Test
- Reduce Certification Timing & Costs
- Complement Physical tests
- Front-Load systems integration

Based on previous evidence

Applications:

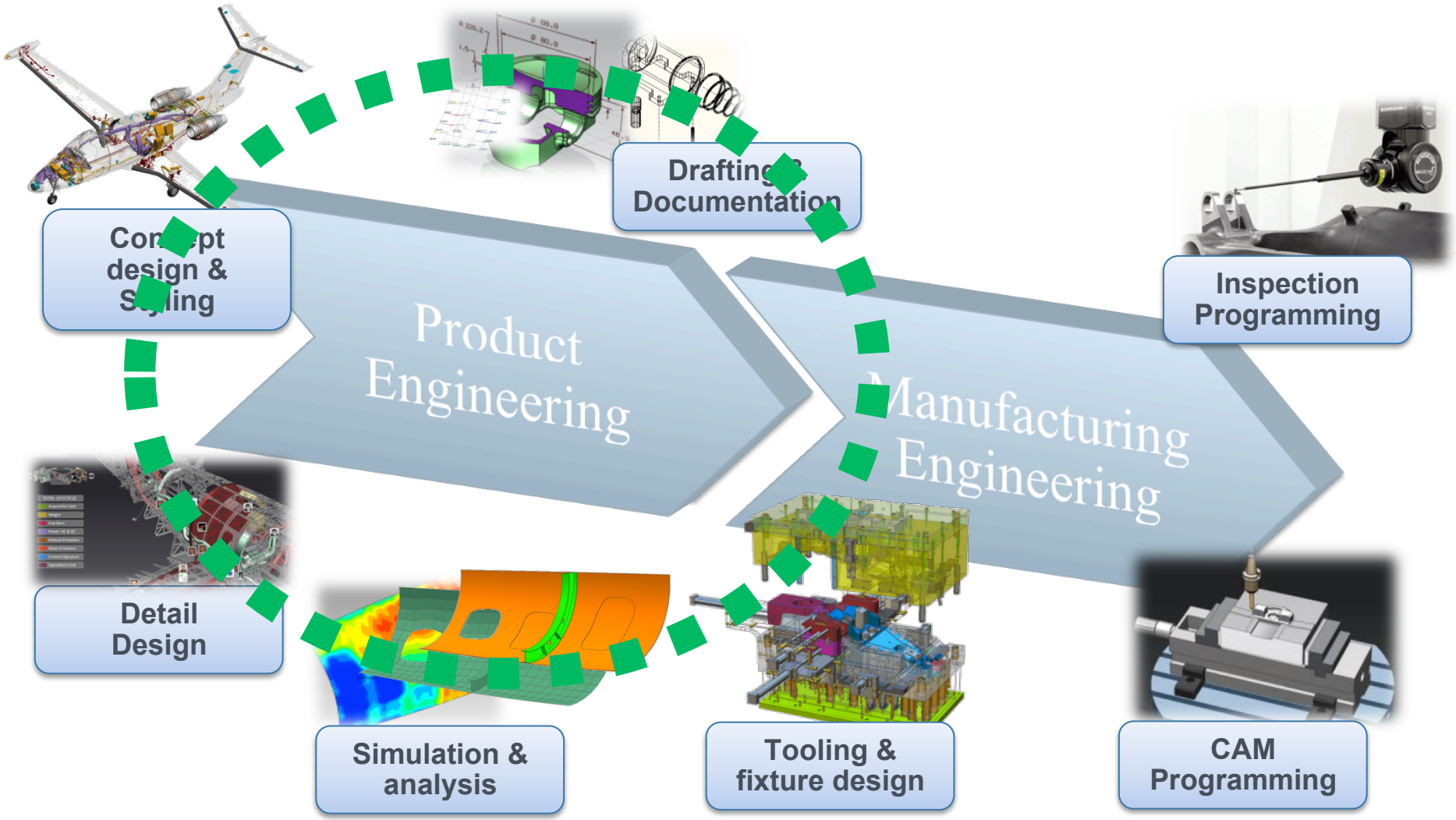
- Focus on critical cases / conditions
- Increasing Engineering Insights
- Build confidence in Methods/Processes
- Create Validation evidence for *Virtual Tests*

Build Evidence for next program

Virtually Fly it before you build it!

... Product Engineering & Development Solutions

SIEMENS



Virtually Fly it before you build it!

Unique Portfolio of Product Engineering Solutions

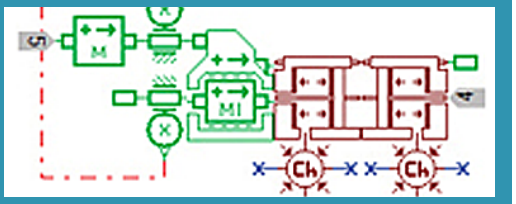
SIEMENS

Product Design

3D CAE - Simulation

NX CAE - NX NASTRAN
LMS Virtual.Lab
LMS Samcef Suite

Controls Engineering

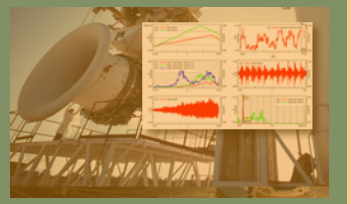


Mechatronics System Simulation

System Synthesis	System Data Management	Multi-physics Modeling
System Synthesis	LMS Imagine.Lab SysDM	AMESim

Test-based Engineering (modal, noise and vibration, acoustics, durability)

LMS Test.Lab
LMS SCADAS
SoundBrush

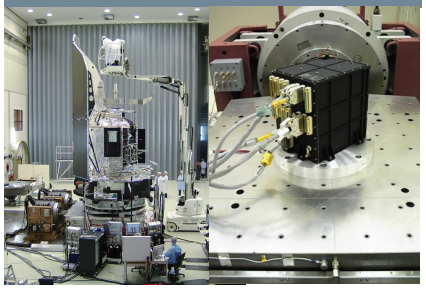


Virtually Fly it before you build it!

Global Leader: Integrated test-based engineering solutions

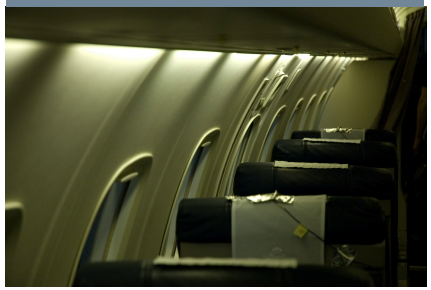
SIEMENS

Vibration Qualif.



Structural / GVT

Acoustics / Loads

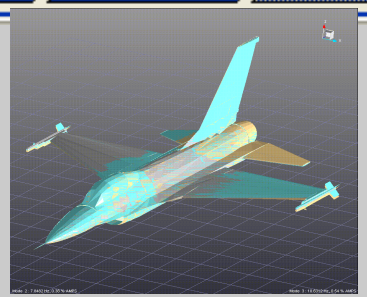


Jet-Engine

- Flexibility: Multi-Test Coverage
- Scalability: "Lab Mobility"
  - Test Wherever, Whenever
- Efficiency: Ease of Use
  - 1-Stop: Setup through Analysis
  - Best Practices / Std. Work-flows
  - Consistent Format / Quality

Deliver Engineering Insights…

… not just results & plots



Virtually Fly it before you build it!

... trusted global partner for Aircraft GVT certification

SIEMENS

April, 2013 – *Airbus A350XWB*

The GVT of the A350 XWB was successfully performed by the joint ONERA-DLR team

"The GVT of the A350 XWB was successfully performed by the joint ONERA-DLR team who combined their LMS Test.Lab GVT systems for a single 768-channels system. Thanks to the high level of Airbus support and our experienced teams familiar with the highly reliable LMS hardware and software that easily integrates our in-house procedures and proprietary methods, this GVT was the fastest ever performed."

Mr. Lubrina ONERA

ONERA THE FRENCH AEROSPACE LAB

DLR

June, 2013 - *Bombardier CSeries*

Bombardier successfully completed the Cseries Aircraft Ground Vibration Tests

Bombardier uses:

- LMS SCADAS Front-end
- LMS Test.Lab for GVT & Flutter
- LMS Engineering Services

Virtually Fly it before you build it!

Unique Portfolio of Product Engineering Solutions

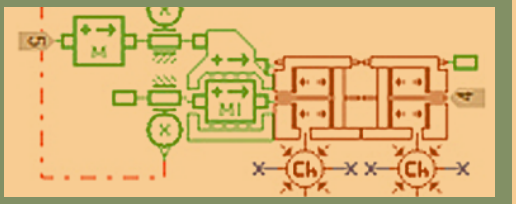
SIEMENS

Product Design

3D CAE - Simulation

NX CAE - NX NASTRAN
LMS Virtual.Lab
LMS Samcef Suite

Controls Engineering



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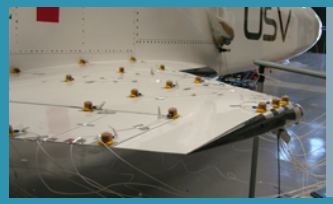
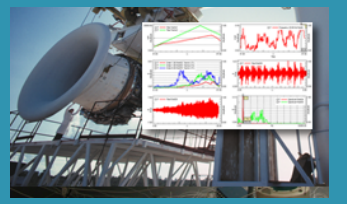


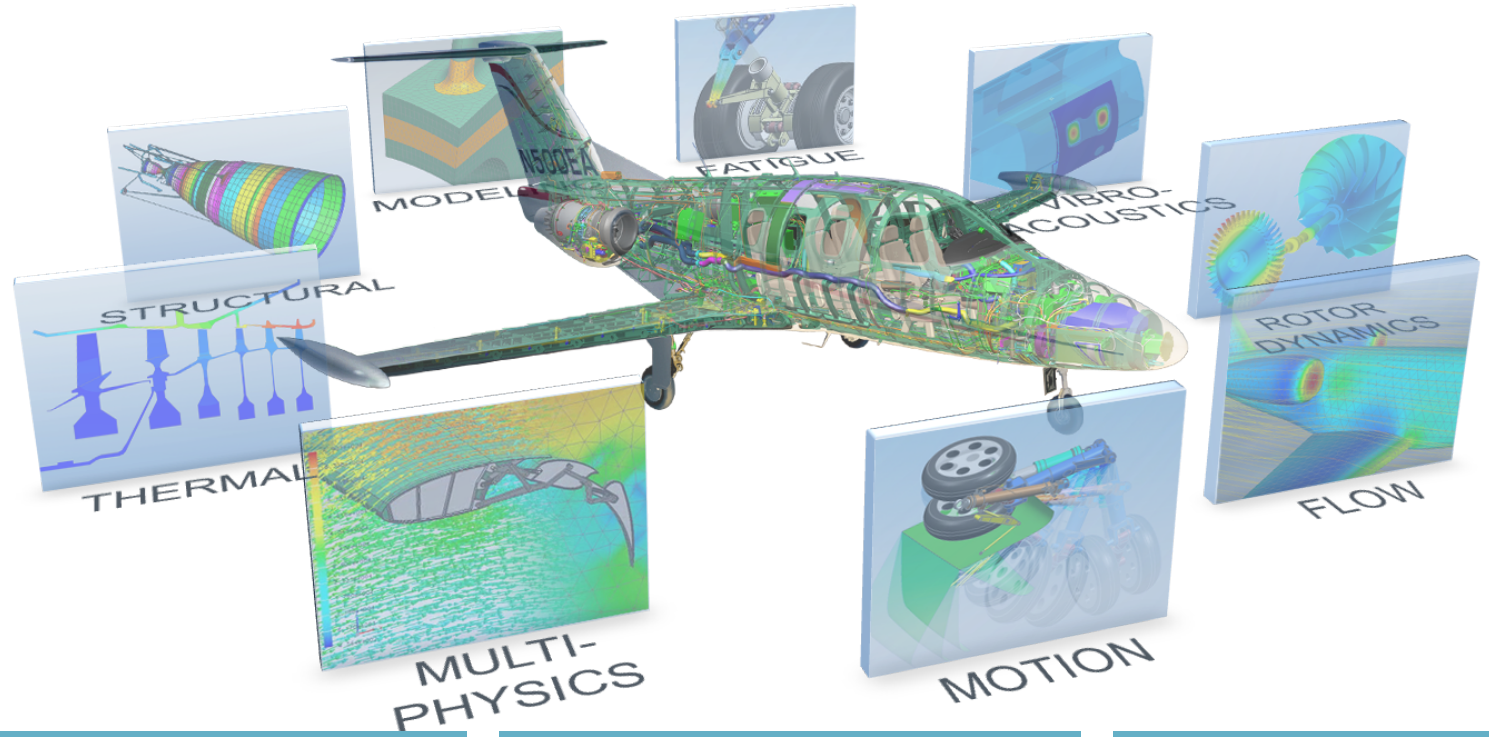
LMS Test.Lab
LMS SCADAS
SoundBrush



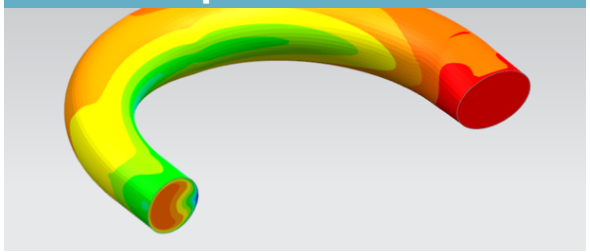
Integrated System Performance Simulation

A Comprehensive Suite of Integrated 3D Simulation Solutions

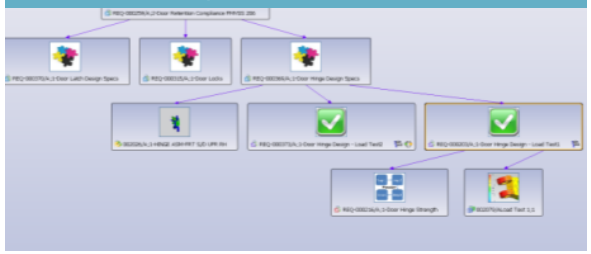
SIEMENS



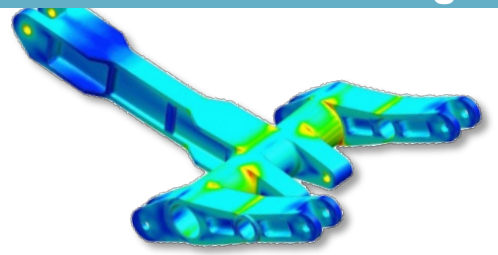
Optimization



Data Management & Automation



Simulation Driven Design

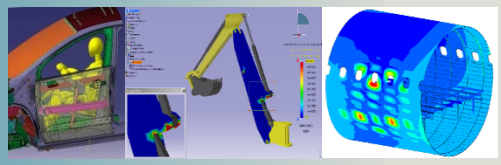


Siemens 3D Simulation …
… a Strategy for 3D CAE Leadership ✓

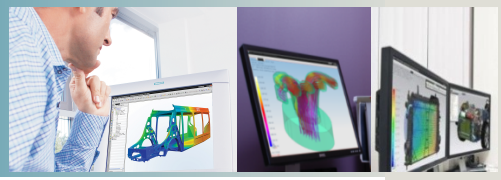
SIEMENS

Continuation of the current 3D Simulation Solutions

- LMS Virtual.Lab
- LMS Samtech

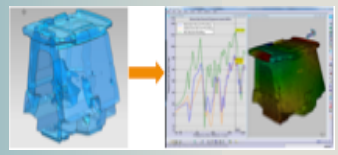


- NX CAE
- NX NASTRAN



Support of Combined Multi-Discipline Workflows

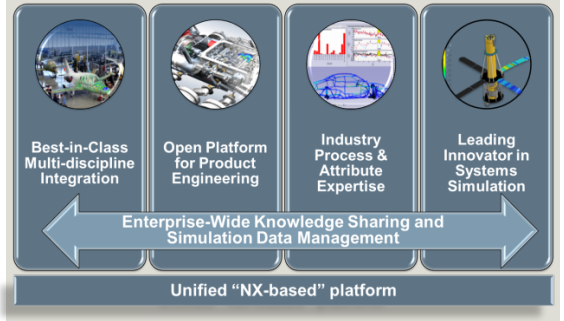
- Combined Workflows across Siemens NX CAE and LMS 3D simulation solutions



Next Generation Integrated 3D CAE

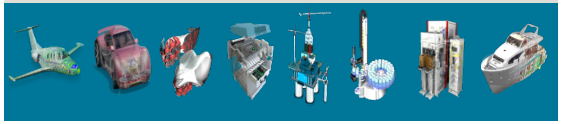
Next Generation 3D CAE Solution and Industry Vertical Applications via unified "NX-based" platform

A Common Strategy



Leadership in 3D Simulation

In support of Systems Driven Product Development with Closed-Loop Performance Verification across Industries



Virtually Fly it before you build it!

Unique Portfolio of Product Engineering Solutions

SIEMENS

Product Design

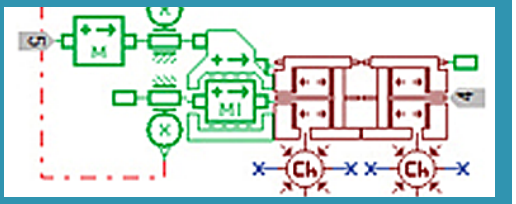
3D CAE - Simulation

NX CAE - NX NASTRAN

LMS Virtual.Lab

LMS Samcef Suite

Controls Engineering



Mechatronics System Simulation

System Synthesis

System Synthesis

System Data Management

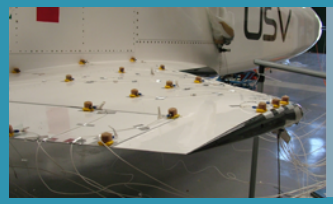
LMS Imagine.Lab

SysDM

Multi-physics Modeling

AMESim

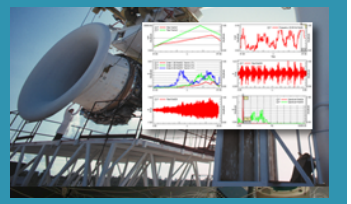
Test-based Engineering (modal, noise and vibration, acoustics, durability)



LMS Test.Lab

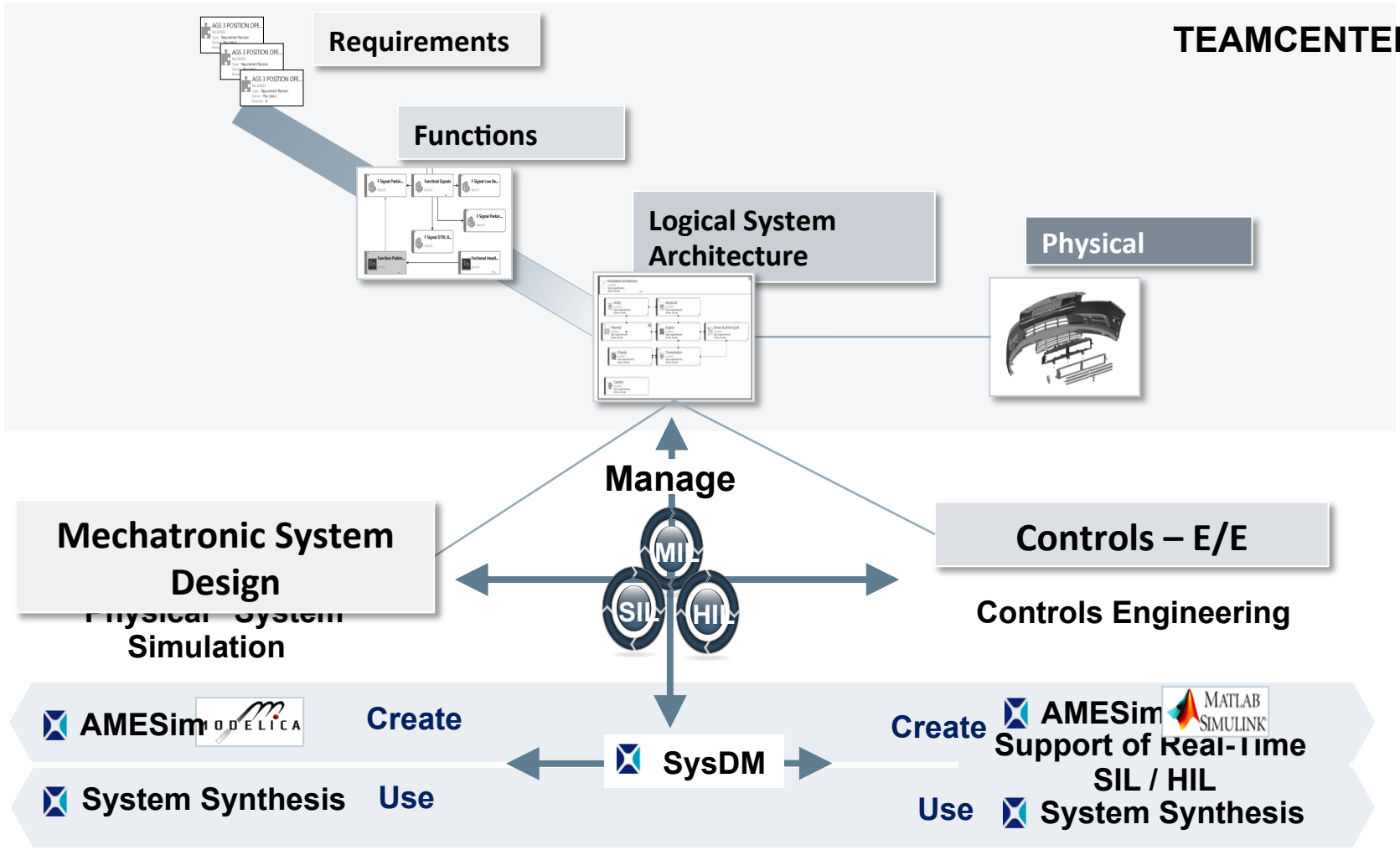
LMS SCADAS

SoundBrush



System Performance Engineering
Heterogeneous System Simulation

SIEMENS



Integrated System Performance Simulation
Amesim

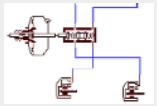
SIEMENS

HYDR Power Systems
Actuation Systems
Flight Controls

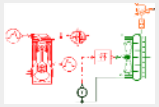
AIR Power systems
Pressurization, ECS
Ice Protection …

ELEC Power Systems
Actuation,
Power Conversion

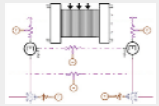
ENGINE Systems
Lubrication,
FUEL systems



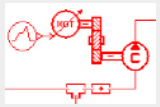
Fluids



Thermodynamics

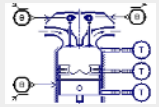


Energy

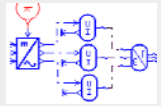


Control

Mechanical



Engine / Propulsion



Electrical

4,000+ Validated System Models
Documented & Maintained
Supporting Multiple levels of complexity

Open and Customizable

python
VBA

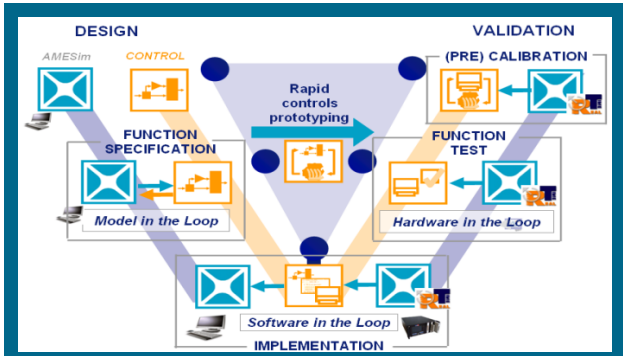
Scripting / Customization

MODELICA

MODELICA
Import / Edit / Assembly

The MathWorks
modelisar
AutoSAR

Interfacing
- **To Simulink/Matlab**
- **To numerous 3D CAE**
- ***"FMI" Interface* for**
- **Mechatronic Co-simulation**



Scalable Simulation
Connecting "Mechanical" – "Controls"

Variable-fidelity Systems Modeling

Model reduction for Real-time – SIL, HIL
Supporting Multiple SIL/HIL Platforms

dSPACE
IPG
The MathWorks
RT-LAB
ETAS
NATIONAL INSTRUMENTS

Interlock "Mechanical" and "Controls" Engineering (Mecha-tronics)
Enable ISO 26262

System Driven Product Development

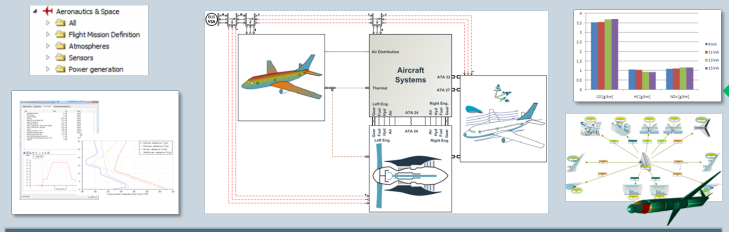
Platform for deploying across the extended enterprise

SIEMENS

Siemens – Product Lifecycle Management

Aircraft Architect
Aircraft Systems Integration

Scenarios | System model – Synthesis & analysis | Performance



Sub-Systems Models

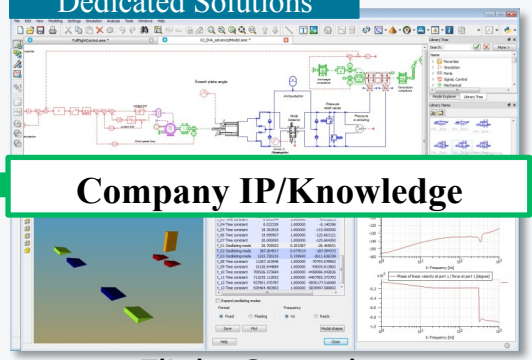
Landing Gear | Flight Controls | Engine Equipment | Fuel Systems | ECS | Aircraft Engine | Electrical Aircraft

Functional Groups – Supplier/Partners

- Scalable depending on needs
  - MDAO – fast, high iterations
  - Validation – Accurate vs Reqs
- Leverage /Re-use Validated Models
- Extending to the larger enterprise

Engineering Specialists
Sub-systems Development

Dedicated Solutions



Company IP/Knowledge

Flight Controls

Fuel Systems

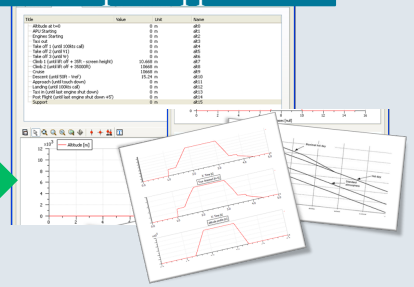
Thermal

Electrical

...

Enterprise 'Consumers'
Design, Decision Support

Non-Expert Applications



Systems Eng.

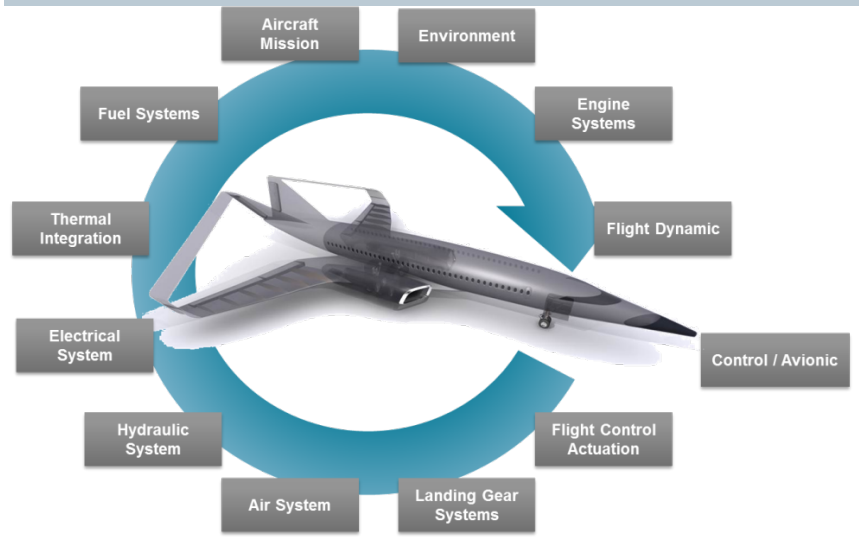
Controls Eng.

Program Dev.

Systems Driven Product Development

Extension into full 'Virtually Integrated Aircraft"

SIEMENS



Integrate multiple aircraft systems:

- Virtually fly before flight testing
  - Justification for new tech added to flight test
  - 1,000's of trade studies for focused testing
- New Technology Deployment

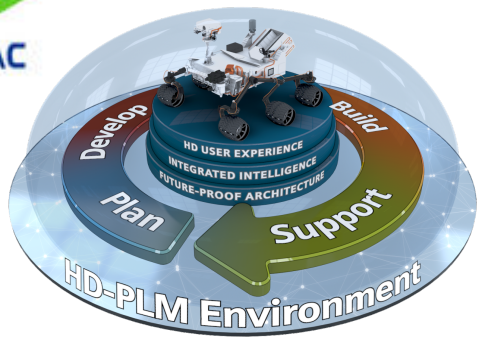
Evaluate Aircraft Integrated Performance:

- Performance, Insight
- Thermal, Energy, Safety, ...
- Mission Performance
- Support Controls Development

Upfront Aircraft Systems Engineering:

- Insight & Value for efficient Full Aircraft Simulation
- Proven with global air framers
- Supports Verification Management

AIRBUS COMAC AVIC I ЦНИИМАШ TSNIIMASH



Virtual Integrated Aircraft analysis
on board on Irkut MC-21

SIEMENS

Aerospace and defense

IRKUT

Russian aircraft company reduces modeling time for new commercial airliner by 80 percent using LMS Imagine.Lab

Product
LMS

Business challenges
Predict subsystem and system behavior once integrated into aircraft
Consider design options without mobilizing considerable financial and human resources
Minimize the number of errors discovered at the verification phase
Obtain optimal design within the shortest timeline

Keys to success
Perform thermal analysis of the avionic bay
Assess system interaction early and accurately
Apply the VIA process

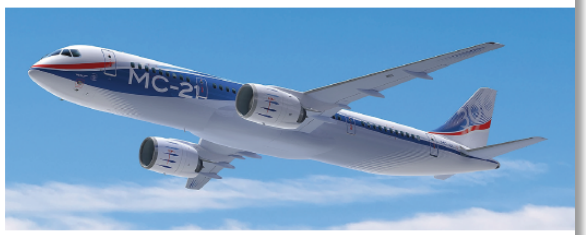
Results
Reduced modeling time by a factor of 5
Established a secured and optimized modeling process
Enhanced model, architecture and configuration management

IRKUT builds Virtual Integrated Aircraft using a secure and optimized modeling process

Conquering global markets
Today, Russian aircraft manufacturer IRKUT Corporation (IRKUT) aims at conquering the worldwide aircraft market by launching the MS-21, a series of three twin-engine short- and mid-range airliners with a capacity of 150 to 212 passengers. The MS-21is designed to compete with the Airbus A320 and Boeing 737.

Implementing a system simulation approach
Under the MS-21 development project, in 2010, IRKUT started using LMS Imagine.Lab Amesim™ software from Siemens PLM Software. Without any prototype available at that time, IRKUT's standard approach did not allow design engineers to answer questions as to how these systems would interact, or how they would behave in case of abnormal situations. Implemented at the detailed design phase of the project when main system parameters had already been chosen, LMS Amesim is currently used for the hydraulic, environment control, electrical, fuel and anti-icing systems, as well as for engine modeling.

"Thanks to its user-friendliness, LMS Amesim allows us to easily build system models by using standard library components, or by creating our own components, and then analyze the system's behavior," says Anton Poplavskiy, deputy chief of the Engineering and Simulation



By launching the MS-21 passenger airliner, IRKUT aims at competing with the Airbus A320 and Boeing 737.

www.siemens.com/plm/lms

"Compared to our previous solution, LMS Amesim allows us to reduce time spent in building our most complex models by a factor of 5."

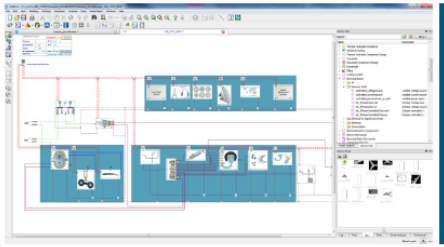
Marina Grishina
Engineer
Engineering and Simulation
IRKUT Corporation

Creating Virtual Integrated Aircraft
Regularly participating in Siemens PLM Software aerospace user conferences, in 2012, IRKUT specialists attended a presentation of the thermal analysis carried out with LMS Amesim. Impressed with the results obtained, IRKUT decided to launch a project aimed at modeling the MS-21's thermal behavior while taking into account boundary conditions for engine, anti-icing, hydraulic, fuel and electrical systems.

Supported by the LMS™ Engineering services team, this project has become the first step in applying the Virtual Integrated Aircraft (VIA) concept, which supports the earlier assessment of systems interaction to predict their behavior once integrated into aircraft.

LMS Imagine.Lab™ Sysdm software and LMS Imagine.Lab™ System Synthesis software have perfectly complemented LMS Amesim already in use.

LMS Sysdm has increased productivity in the simulation process at IRKUT and has reinforced collaboration among its departments and suppliers by bringing an efficient solution for system model and architecture management according to the structure defined jointly by IRKUT and the LMS Engineering team.



Under the VIA project, the hydraulic system is analyzed within the wider context of various aircraft systems.

LMS System Synthesis has enabled a systematic approach for getting an appropriate modeling baseline for each of IRKUT's design considerations. Providing an environment to automate the assembly of complex modeling diagrams, it has also secured the cross-dependencies between systems by ensuring each stakeholder of the modeling activities always has an up-to-date reference dataset properly configured for his work. Each of the design choices can therefore be executed in a controlled process leaving room for innovation in each department.

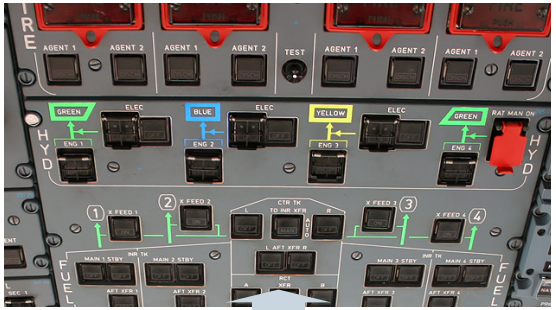
"There are not so many companies offering such a complete simulation solution. Modeling with LMS Imagine.Lab enabled us to minimize the number of errors discovered during the verification phase and obtain an optimal design within the shortest timeline. We are able to modify and test virtually any parameter without mobilizing considerable financial and human resources, which tests would require. We aim at achieving a 90 percent simulation accuracy level."

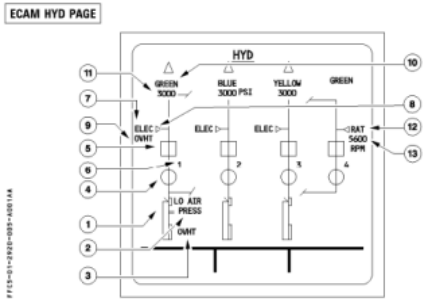
Yury Logvin
Deputy Director, Design Engineering Center
IRKUT Corporation

Virtual Iron Bird (VIB)

Frontloading integrated physical system testing

SIEMENS





HYD Power Generation

Build Virtual Models

Calibrate & Validate with Experim. Data

Reduce models to Real-Time capable C-code

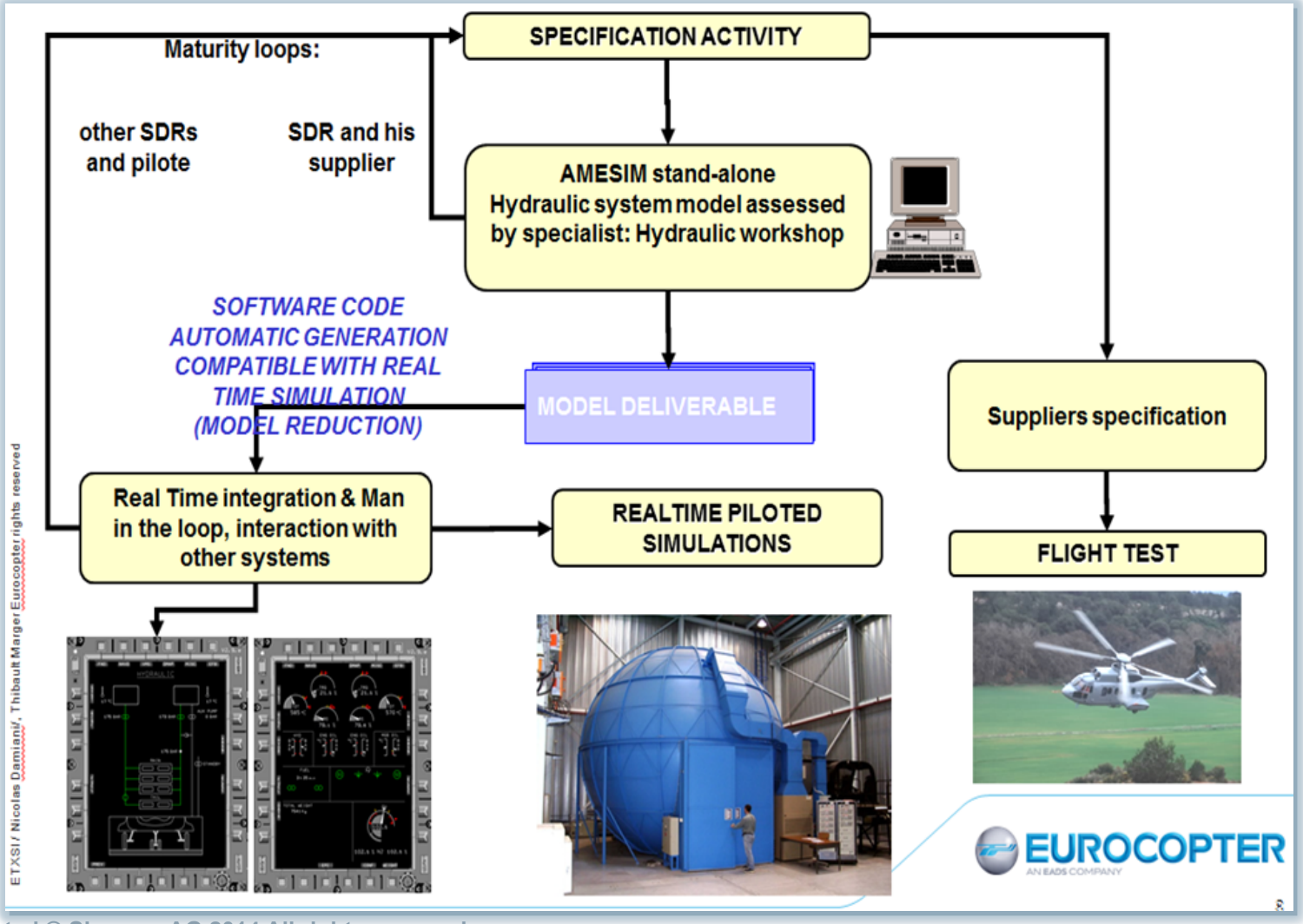
Deploy on RT-platforms on Physical Iron Bird

Enabled by

High-fidelity Real-Time Simulation

Pilot-In-the-Loop

... Early exposure of test pilots to the real physics

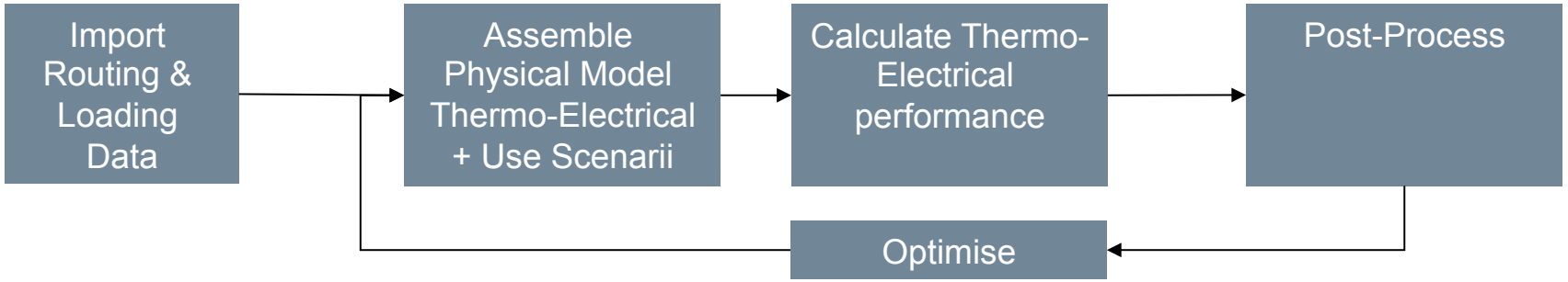


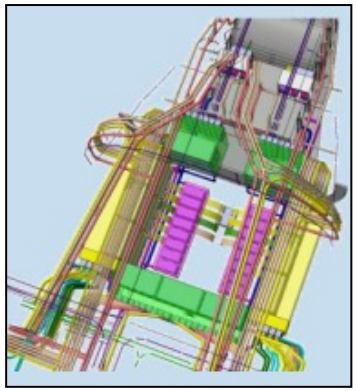
Virtual Integrated Aircraft Analysis (VIA)

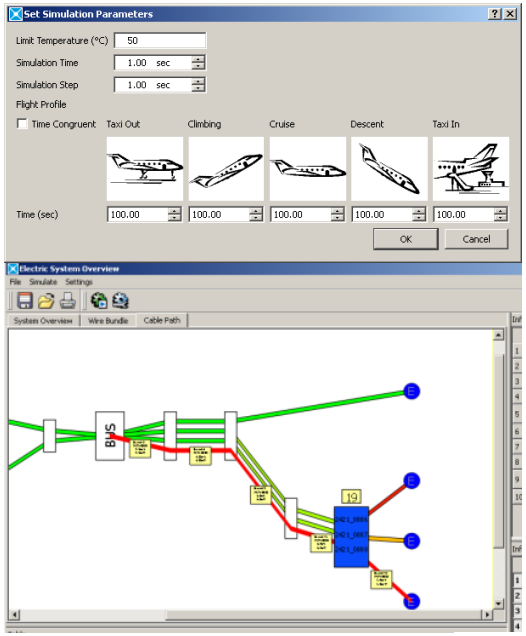
Electro-thermal analysis for harness weight optimization

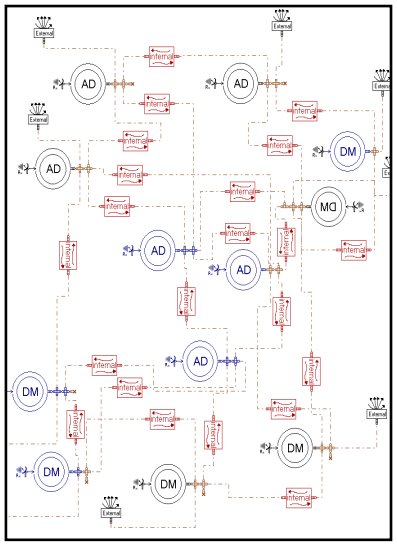
SIEMENS

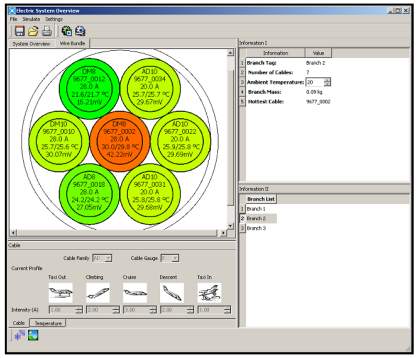
More electrical systems, more cabling... > 500.000 m for large aircraft











SAFRAN Labinal

CLEANSKY

LMS Engineering Services

Services Partner for Aerospace & Defense Industry

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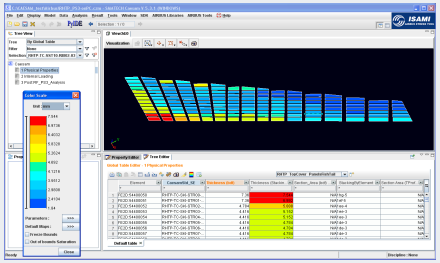
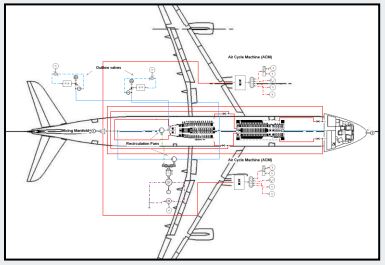
Process Transformation

Structural Analysis Automation – Certification



System Simulation VIA - VIB

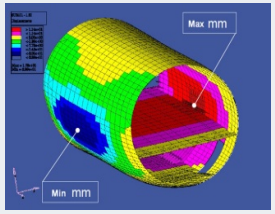


Customization, Methods/Tools Integration, Deployment

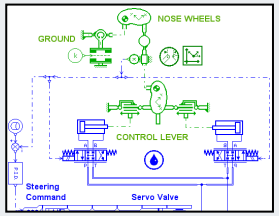
Technology Transfer

Structural Dynamics Testing - GVT

Structural Analysis Static-Dynamic



Aircraft Systems Engineering

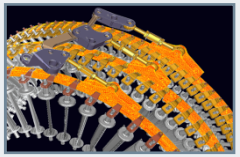
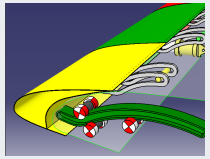
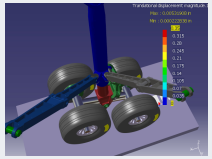
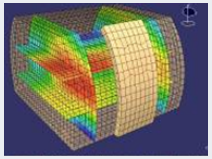


Full Services Provider, for Key Engineering Challenges

Analysis and optimization of structures and complex mechanisms

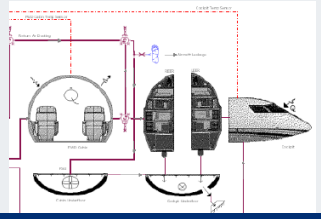
Linear – Non-linear, Mechanical – Thermal

Static to Dynamic

Modeling and Analysis Aircraft Systems

Hydraulic, Electrical...



Structural Dynamics Testing

Modal, GVT, Operational...

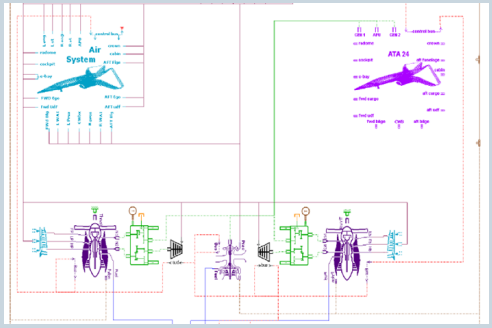

"Engagement in manufacturers' product development practices by LMS's Engineering Services, brings a key asset and differentiator to Siemens PL beyond anything comparable in the PLM industry".

Bruce Jenkens ORA Research

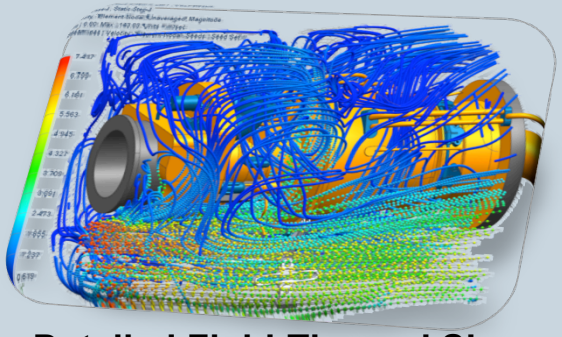
Accelerated Development of A/C Systems

Open, Integrated & Scalable Portfolio of Thermal Simulation Solutions

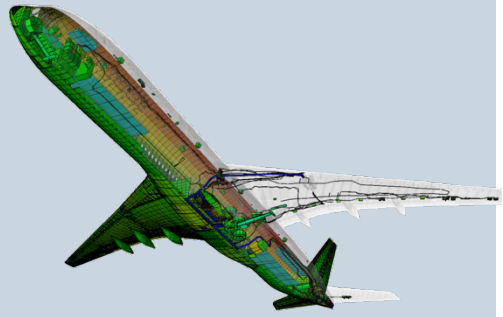
SIEMENS



Virtual Integrated Aircraft



Detailed Fluid-Thermal Sim.



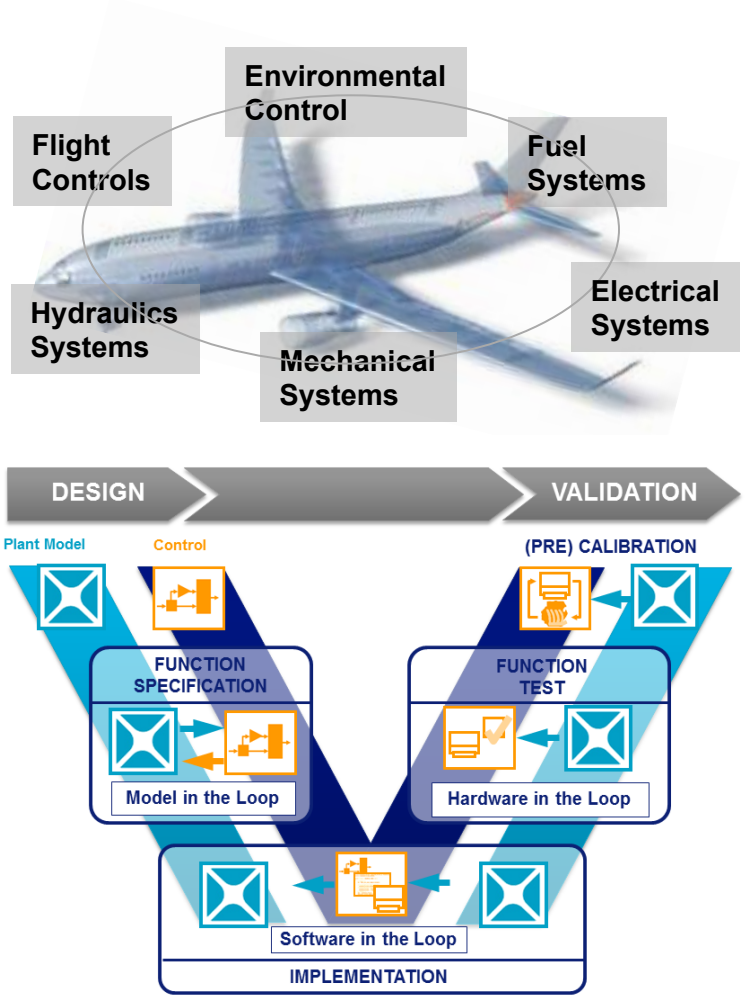
Virtual Thermal Aircraft

System Level 1D	Systems Verification	System Level 3D
Thermal Integrated Aircraft including Heat Generating & Dissipating Systems Thermal Control	Detailed Structural-Thermal-Flow including specifics Lightning Ablation	Radiation Convection Conduction Heat Transfer Electronic Systems Satellite Vertical
Architecture – Synthesis	**Front-Loaded Validation**	**Product Level Analysis**

Siemens PLM Simulation & Test Solutions

Solutions to support Up-Front Aircraft Systems Integration

SIEMENS



Up-front systems integration

- Cross-Discipline systems Integration
- Improved, Model-Based Suppier Integration
- Lifecycle Controls Development (MIL-SIL-HIL)
- Integrated Suite of Solutions (1D/3D/Test)

Supporting Lean Engineering:

- Standard/Validated libraries & templates
- Enforce ‘standard work’ practices
- Embed Corporate knowledge for the enterprise

Enabling Virtual Aircraft Integration:

- Supporting MDAO for Architecture Selection
- “De-risk” your systems integration process
- Virtually fly it before you build it – Insight!

“Get it right the first time...”

SIEMENS

THANK YOU