Stable & Control
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La Modélisation et la Simulation au service de l’Innovation
AGENDA

• Airbus group presentation and simulation history

• Challenges

• MATLAB & Simulink at Airbus

• Innovations
  o Brake To Vacate system
  o AP2633 standard
  o Model Based System Engineering (MBSE)

• Conclusion
Airbus Family

A full range of market leading civil airliners

> A320 family:
  A take-off or landing every 2.5 seconds,
  7 billion passengers carried since EIS in 1988

> A330 family:
  > A take-off or landing every 25 seconds,
  More than 800 A330s sold since 787 launch

> A350 XWB:
  EIS Q4 2014
  812 orders from 39 customers

A380:
  Takes-off or lands approx. every 6 minutes
  125 flights per day and 1 million pax per month

2013 orders: 1619 – 2013 deliveries: 626
Where I am?

Domains

Management

Programs
Tools

Architect
R&T
IS/IT

Production and many others
Tests
Physical design
Hardware & simulation
Systems

Finance, HR...

Control
Who I am?

Domains

- Management
- Programs
- Tools
- Architect
- R&T
- IS/IT

Experts

- Production
- Tests
- Physical design
- Hardware & simulation
- Systems
- Control
Who I am?

A connected employee

Domains

- Production
- Tests
- Physical design
- Hardware & simulation
- Systems
- Control

Experts

Management

- Programs
- Tools

- Finance, HR...

Programs, Tools, Management
Control and model based design

• Control synthesis needs
Control and Model Based Design

• Tuning of the laws has been performed using a simulator
  - Model based design is efficiency
  - It is direct, measurable cost reduction

* The control laws tuning has be almost completely done on simulator
Our challenges

- Safety
- Complexity control
- Certification
- Extended enterprise
- Master costs & developments
- Innovation
- Security
- Support (short to long term)
- Connect heterogeneous worlds (operations, engineering…)

Programs
Tools

Management

R&T
IS/IT

Architect

Finance, HR

Production

Tests

Physical design

Hardware & simulation

Systems

Control
Why MATLAB and Simulink?

- New methods
- Standards
- Certification
- A/C Models
- Simulations & Rapid Prototyping
- AP2633

Reduce tools
Efficiency
Integration

EffICIENCY

COTS
Which is a standard

COTS® Component off the shelf / Produit commercial externe
What is innovation?
Creativity is about coming up with ideas whereas Innovation brings ideas to life.

2 types of Innovation

Incremental
On the product itself
Disruptive
On the way to make it
Incremental product innovation – Brake To Vacate System

A new idea, that could be bring value the product line
Incremental product innovation

Current use of MATLAB during innovation process

Current Validation and Verification AC development scheme on the first target

A340

Concept phase

Prototyping Phase

Function early development
BTV: a continuous innovative development function

A detailed system specification development process

2 first hosts of the function

Flight Control computers specification

Braking steering computers specification

SAO specification (Simulink like)

“Supplier” product

Reference documents (certification)
Innovative development → Step 1: convince stakeholders

SAO specification (Simulink like)

Convince managers/ experts

Convince pilots On 100% virtual A/C

Fidelity / current AIRBUS simulators

Build and refine requirements
Function descriptions
Innovative development → Step 2: implement embedded software

SAO specification (Simulink like)

Implementation (verification)

Simulink

Process flight test results

Simulink

Maturation
By the design loop

Simulator

Flying prototype
Incremental product innovation

From one AC to another

Performance simulator

V&V A380 now embed MATLAB tools & Simulink models (for BTV/ROPS function)

In service support analysis

System architecture is different. MBSE Tools were used, some were coupled with MATLAB when requiring accurate simulation results

Prototype product on a real demonstrator

Innovate on the product

Innovate on the way to embed it
In a nutshell,

- MATLAB/Simulink provide an efficient environment for:
  - Concept validation
  - Prototyping

- New approaches can be embedded into heavy development processes

- When providing that capability to designers, new ideas emerge naturally…
ROP, a new idea supported by the new mean

Inspiration coming from tools
Development:
A mature process, often necessarily heavy, with a known target
Efficient ways of validate, verify and certify the A/C

Concerns on product and methods and tools:
• New A/C development
• Family improvements
Product standards are the proposed solution to optimize the A/C operations from the beginning.

From the 80’s

With a quite good success

To nowadays
Effect on the AIRBUS mindset

Invest into internal standards: **AP2633**

Example on simulation tools and modelling

- **A lot of simulation means!**
- **A lot of models!**
- **A lot of integration (model into simulators)**

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**AP2633** → **INTEGRATION**

Scheduler

New

Old

_A typical simulator, with or without real parts_

 Internally, externally, with suppliers models…

How to do it efficiently?
AP2633 a coding standard for quick integration

A coding standard → standard tools for efficient code generation

Models are coded in templates
AP2633 a coding standard for quick integration

Template for AP2633 C code generation with correct compilation options

Double click on buttons to execute actions

SL2AP2633

APMANAGER

Interface management (Simulink objects)
AP2633 a coding standard for quick integration

ARINC 429*: It defines the physical and electrical interfaces of a two-wire data bus and a data protocol to support an aircraft's avionics local area network.

A new data, ex: even ARINC 429* for a virtual aircraft bus connection

Data managed in the model workspace
Model interface, a specific block
A dedicated browser

Referring to a single data file

Model interface, a specific block
A dedicated browser

Referring to a single data file

Model interface, a specific block
A dedicated browser

AP2633 a coding standard for quick integration
AP2633 a coding standard for quick integration

Code & documentation generation (interfaces)

Code & documentation generation (interfaces)
AP2633 a coding standard for quick integration

AIRBUS Simulator,
A bunch of standard models

Integration

Need a change of data?
Change only data file…
Benefits

50% of the models are coming from Simulink Deployment even on legacy programs

The AIRBUS Model Data Bank: sharing the same standard on a lot of simulators
Deployment of AP2633 standard

This standard will be available in the common Simulink environment

- Code compliance from Embedded Coder
- Will produce automatically a part of the documentation (interfaces generation)
- Easily available for suppliers

Trends

Self explanatory model
Embedding requirements
Connection to V&V
(credit for certification)
Next Challenges

• New tools and processes to:
  o Speed up innovation
  o Improve A/C design/ incremental developments
• Domain connections (physical / system)
• Complexity control
• Specification based processes should be helped by new types of models
  (failure analysis, physical architecture validation…)

MBSE objective
Conclusion

MATLAB & Simulink allow

As an engineer, generating new ideas and make them reality

As a manager, supporting evolving strategy and reducing costs thanks to
  • Model exchange with suppliers
  • Early simulation
  • Model production easiness

As a visionary person, supporting more efficient ways to design aircraft through
  • New types of models
  • Functional approaches
  • Connections between antagonist worlds
  • New standards like FMI
Q&A