Design and Development of Transport Aircraft Systems
RAeS, DGLR, VDI, HAW Hamburg
Collaborative Engineering in Systems Development

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• The Systems Development Process and Collaborative Engineering

• Systems Layout integration

• Validation and Verification

• Configuration management, Change Management

• Methods & Tools for environmental hazard protection

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Objectives and Main Drivers for Syst Development

• Top Systems Goals (Business Drivers)
  ‣ Safe aircraft
  ‣ Mature, Service-Ready Systems, meet customer expectations
  ‣ 100% Mission Available Systems
  ‣ A/C operation under all conditions
  ‣ Low cost of Ownership Systems

• Ensure integration with **Airbus Industrial Processes**
  - Take account of full end to end processes:
    Development, Definition to individual aircraft for delivery
  - Ensure quality of process and deliverables

• Early involvement of **Suppliers** and their capabilities

• World class **Technologies** and **Capabilities**

• Master **Collaborative Engineering**
Production work sharing A340
- Higher operational functionality are integration of more functions are leading to more complex systems (hardware, software, loadable software, more interfaces)

- Increasing trend of SIS (Software Intensive Systems)

- More active and controlled communication between systems → Interface Management. Inter-system communication is rapidly increasing

- The systems organisation is wide spread over different sites and countries

- Earlier and more intense Systems Suppliers involvement.

As a consequence: Need to adapt processes and way of working:

- Structured development process, fully synchronised with the programme

- Global view approach (rather than only sum of individual Systems)
  Role of A/C Systems Architects having a functional global view a different levels/sub-levels

- Systems configuration Management (from upstream phases – concept & definition phases - including, requirements, design, material, and production)

- Manage complex software and demonstrate reliability and manageability for certification

- Take account of Human Factors
Systems Layout Integration (1)

Integration of Systems and Environment
- e.g. ATA21/35/38

Inter-systems Constraints

Cabin Lining Constraints
- e.g. Location of Air Outlets in dependence of cabin lining

Structure Constraints
Systems Layout Integration: Benefits

- Avoid late rework
- Target the "right first time": System definition maturity

Diagram:
- Late Rework magnitude
- New Process: Early application of SLI
- With old processes/organisation
- Modifications avoided with new process 50%
A structured development process is recommended by **ARP4754** as an acceptable means for certification. It is also asked by **ISO9001 & EN9100**.

**ABD 200**: Requirements and Guidelines for the **System Designer** (Airbus or system suppliers)

**ABD0100**: **Equipment** – Design/ general requirements for **suppliers** (product and process)
Validation & Verification, Standards

With the spec:
- Validation of requirements,
- Validation of assumptions.

With the system: Complementary Validation of requirements.

Acceptance of the Higher Level Requirements

Validation of system against User Needs.

Verification of product system against SRD.

Verification of system installation against SIRD and SID.

Verification of equipment installation against EIRD.

Validation of product against PTS and SES

Verification of system installation against SIRD and SID.

User Needs

Higher Level Requirements

SRD

SDD

SIRD (SID)

PTS, DFS

EIRD

MANUFACTURE

ABD 100

Supplier responsibility

AP2161
AP2245

User Needs

Aircraft Level

System designer responsibility

AP2288
ABD 200

Validation of Supplier requirements against PTS

ABD 100

Supplier responsibility
IMA: An illustration of Complexity Management

IMA: Integrated Modular Avionics

Functionality
(number of lines of code)
(arbitrary log scale)

Concorde
A300B
A310
A320
A330
A340
A380

Number of electronic equipment

A380
Reverse trend with IMA


-600
A340-600
A380

The Configuration Management organisation and deliverables

- Development plan
  - Process assurance plan
  - Certification plan

- Safety plan
- Configuration plan
- Verification plan
- Validation plan

To provide:

- Technical and administrative control of the configuration of the items to be managed
- Control of changes to the items that are managed
- Identification rules of the items to be managed
- Assurance that archiving and recovery are maintained
- Demonstration that items are compliant with their requirements
Background: Environment considered

**Environment**

- **Internal and external**

**Other environments**
- Cosmic Radiation
- Shocks/ Vibrations/ Acceleration
- Temperature
- Pressure
- Humidity
- Contaminant

**Internal EMC** (Electro Magnetic Compatibility)

**Avionics, PED** (Portable electronic Device)

**Electrical Bonding** is the main means to consider this environment.

This has a strong link with the electrical power and signal that use the structure as return current path. Need innovative interdisciplinary solutions for composite structures.
Implementation of Collaborative Engineering

• Smart collaborative system engineering for large commercial aircraft engineering requires consideration of Interaction of complex systems, and Integrability of the aircraft in the full operational spectrum

• Collaborative system engineering must be Architect driven, and must enable to support 2 key concepts:
  ‣ Aircraft Architect
  ‣ Systems Architect

• Implementation of collaborative system engineering requires thorough consideration of People and Processes (Human Factors) aspects

• Roadmaps: to be the result of a Convergence Process (end-to-end) between aircraft manufacturer and solutions providers
Collaborative System Engineering
Product Model based Capabilities concepts

Product Models:
- Multiview concepts
- Traceability of product information along lifecycle
- Strategies for attributes:
  - Reflect A/C performance oriented design
  - Enables management at the earliest
  - Interactions and autonomy
  - A/C physical behavior
  - Geometry
  - Technology
  - Cost
  - ...

Advanced Product Models for enhanced Architectural Design capability
**Sourcing**: more than Purchasing or Procurement

- **60’s - 70’s**: Integration of internal functions in a process-oriented approach
- **80’s - 90’s**: In-depth integration of external sources in the Supply value chain with mature Suppliers
- **00’s**: Common supplier strategy between Procurement, Programme and Engineering

Integration of internal functions in a process-oriented approach

In-depth integration of external sources in the Supply value chain with mature Suppliers
Concluding Remarks

- Focus on complete **aircraft** product as a whole
- Work **interdisciplinary** and **transnational**
- Early definition and **validation** of systems architecture
- Ensure support for Collaborative Engineering by proven and committed **standards** at company level and compatible with international standards and requirements
- Early identification of **interfaces & risks**. All systems, structures,
- Maintain competence and experience to control as Establish extended enterprise and **Architect and Integrator**