

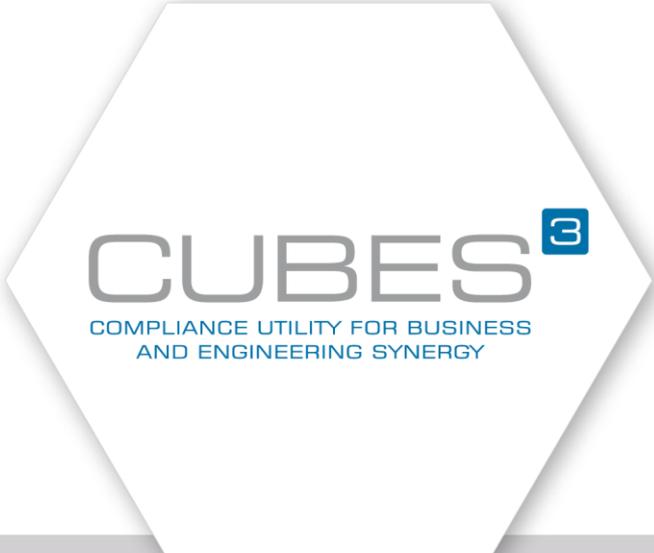
# CUBES<sup>3</sup><sup>®</sup>

Process tailoring and management solution  
to develop standard compliant products

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CUBES<sup>3</sup>  
COMPLIANCE UTILITY FOR BUSINESS  
AND ENGINEERING SYNERGY

## 1 Introduction

Engineering development projects are predominantly subject to a multitude of standards, tools and stakeholder interests; this is especially true for the aeronautical, defence, space, healthcare and automotive domains.

Demanding time-to-market requirements result in a reduction of the development time and mandate new strategies such as component or code re-use. To this end, the Product Line and Variant Handling features of CUBES<sup>3</sup> inherently define new requirements as input to the development process and to the configuration management.

There are various system development models established in the industry such as V-MODELL<sup>®</sup> XT, IEEE1220, ISO26262, CMMI, SPICE, DOD Standards, or company specific development standards (Blue-Books etc...). However, these Development Standards do not (or only partially) cover the Project Management Processes and Commercial Processes giving rise to inconsistencies and misinterpretations between the Processes for:

- Process Definition and Project relevant Tailoring
- Functional Definition
- Systems Engineering
- System Qualification
- Project Management
- Financial Management

All 6 Processes are interconnected, and yet there are no common rules or interfaces existing which define or control these interconnections.

## 2 Scope

ADS developed the CUBES<sup>3</sup> as a vehicle to support the engineering development phase by providing a generic process model based on the V-Modell XT and required standards compliance. It defines rules and terms for a better understanding of the principles underpinning development projects. Furthermore, customer development processes can be integrated and analysed to gauge **standard compliance**.

In addition to clearly defined system architecture and standard-compliant processes, CUBES<sup>3</sup> further intends to provide various stakeholders with individual information and task-specific details in form of best practices, input validation, or performance indicators. Therefore, different CUBES<sup>3</sup> views provide stakeholders with relevant information on a custom level of detail.

Besides managing complex relationships between system components, work products, and standards, CUBES<sup>3</sup> also

organizes a custom set of performance indicators and relevant dependencies. Therefore, it allows for the integration of various externally and internally defined parameters to centralize project-specific information and keep projects on track.



## 3 CUBES<sup>3</sup> Methodology

CUBES<sup>3</sup> provides an easy to use methodology for process-specific knowledge management and an intuitive project setup.

### 3.1 Standard selection and tailoring

Development projects are performed according to one or more development standards defining **artefacts, design-, validation-, verification- and management- processes**; these processes are followed to demonstrate product maturity and safety. In many cases these standards overlap or complement each other and it is a complicated task to select the most suitable processes and resultant artefacts. To support this complex selection task, CUBES<sup>3</sup> offers a default set of development standards

- V-MODELL<sup>®</sup> XT
- ARP4754A
- ARP4761
- DO-178B/C
- DO-254
- DOD-STD 2167 A
- IEEE 12207
- CMMI

- SPICE
- ISO 26262

The user is able to select the required development standards and CUBES<sup>3</sup> provides a **tailoring proposal** to optimise the volume of artefacts to be produced during the development.

### 3.2 System selection and definition

Most development projects will start not from scratch. They are based on a set of system components already used in an existing product or a prototype. CUBES<sup>3</sup> offers the possibility to import existing **System Breakdown Structures** and the related artefacts such as specifications, test procedures and qualification documents.

### 3.3 Merge of Standard and System

When the development standards and the system are selected by the user, CUBES<sup>3</sup> will allocate to each level of the system architecture the relevant documentation and artefacts to be provided.

### 3.4 Definition of Development steps and effort

Having broken down the system hierarchy, the user is able to identify the components to be modified or developed. CUBES<sup>3</sup> will identify all relevant artefacts in the system break-down which need to be modified or developed to satisfy all the applicable selected standards. This identification leads automatically to the **Work Breakdown Structure** and hence to work packages for the envisaged development project.

### 3.5 Definition of Development project

Based on the Work Break Down Structure CUBES<sup>3</sup> sets up a **Project Plan (Gant Chart)**, where the user is able to enter the estimated efforts and start- and end-dates for each work package. CUBES<sup>3</sup> also provides the possibility to enter for each work package (SOW) the required role and skill necessary to perform the work. This will define the **resource management plan** for the development project.

### 3.6 Project monitoring and control

CUBES<sup>3</sup> is able to **monitor and display the progress** of each work package (SOW). The data such as progress or actual costs can be entered directly in CUBES<sup>3</sup>; however the possibility to interface to a customer installed system like SAP is preferred to guarantee consistent and reliable data and information. If the Cost Breakdown Structure is set up in the same manner as the **Work Breakdown Structure** – CUBES<sup>3</sup> will provide a clear and detailed control tool to monitor the costs and progress (i.e. **Earned Value Management EVM**) in the development project

## 4 CUBES<sup>3</sup> Data and Interfaces

CUBES<sup>3</sup> is capable of interfacing directly to customer tools and systems to acquire the relevant data to be processed. CUBES<sup>3</sup> also provides the possibility to enter data manually, although it is recommended to interface to the source of the data to avoid inconsistencies

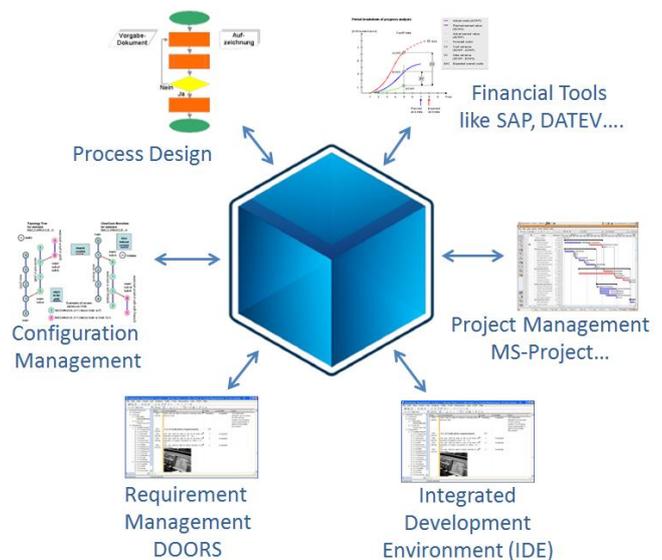


Figure 1: Interfaces of CUBES<sup>3</sup>

## 5 Concept

The CUBES<sup>3</sup> presents the 6 processes mentioned in §1 as 6 Views of a Cube and manages their relations and impacts on each other.

- View 1: *Process*
- View 2: *Function/Requirement*
- View 3: *System*
- View 4: *Qualification*
- View 5: *Project Management*
- View 6: *Costs*

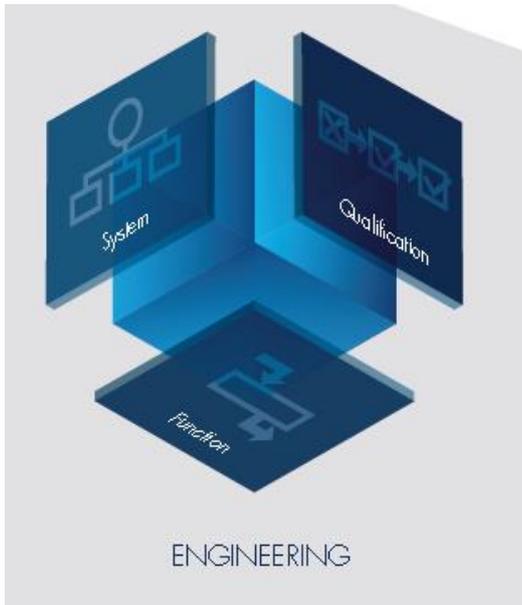


Figure 2: the 3 Engineering Views

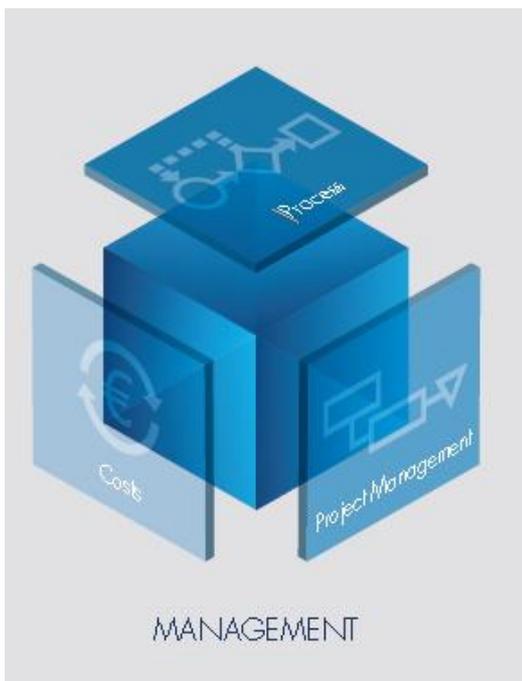
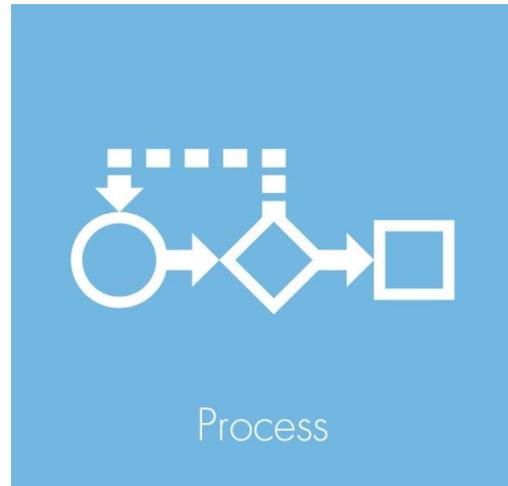


Figure 3: the 3 Management Views



### 5.1 View 1: Process

The CUBES<sup>3</sup> is pre-loaded with a set of processes (e.g. V-MODELL<sup>®</sup> XT, ARP4754A, ARP4761, DO-254, DO-178B/C, IEEE1220, MIL-STD's...) to produce and manage the development of a product. Companies frequently define their own development processes to reflect their specific needs and combine the requirements of different processes (like V-Model requested governmental customers and DO-178B for safety aspects). Therefore, the CUBES<sup>3</sup> can be customised to adopt a company specific model while continuing to provide comparisons with other standards for the purpose of compliance.

Processes are the key drivers of the entire project and specify:

- all required development steps
- all management activities
- all integration/qualification steps

Consequently, processes are the key drivers for the development costs.

Each Process Element is described by the required input (document or product...), what activities need to be performed to develop a product and the output which will be developed (document or product...). Each Process Element is also characterized by a set of parameters (KPI's such as progress, costs, duration, required skill, Risks, Opportunities...).

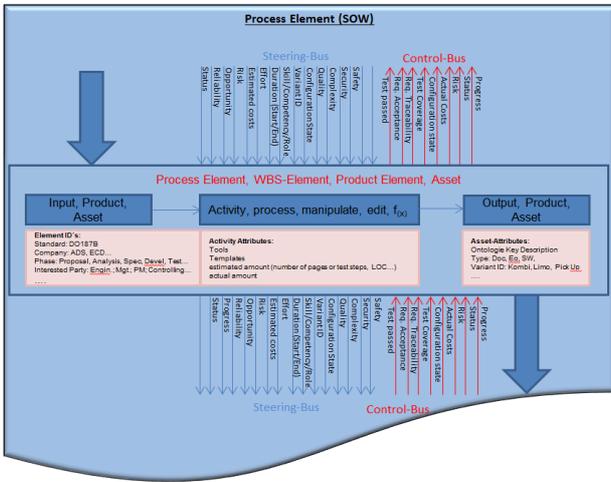
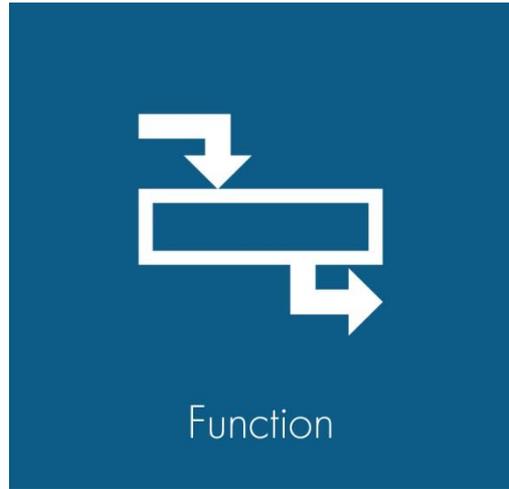


Figure 4: Process Element

These Parameters are driven and modified by the process step itself and are “steering” and “controlling” related process Steps in the development chain.

The **Change Management Process** becomes transparent because CUBES® identifies all artefacts and their dependencies by updating the planned and agreed development process.



### 5.2 View 2: Function/Feature/Requirement

A *Function* is an intended system behaviour based on a consistent set of requirements, regardless of the method of implementation [1]. The Functions are described in a hierarchical set of documents, depending on the selected Development Model. The documents to be produced may vary.

Typical aircraft functions may include: Ref [1] ARP4754-Rev\_A

- Flight Control
- Ground Steering
- Aircraft Aspects of ATC
- Automatic Flight Control
- Cargo Handling
- Engine Control
- Collision Avoidance
- Ground Deceleration
- Environmental Control
- Passenger Comfort
- Communication
- Guidance
- Navigation
- Health Monitoring
- ...

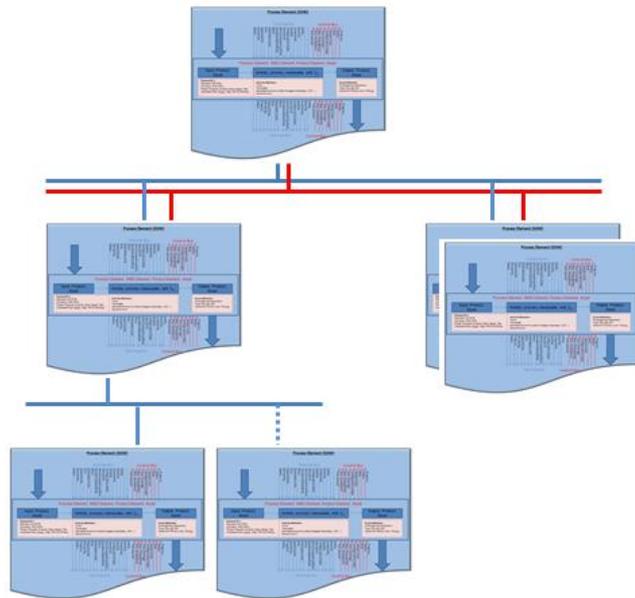
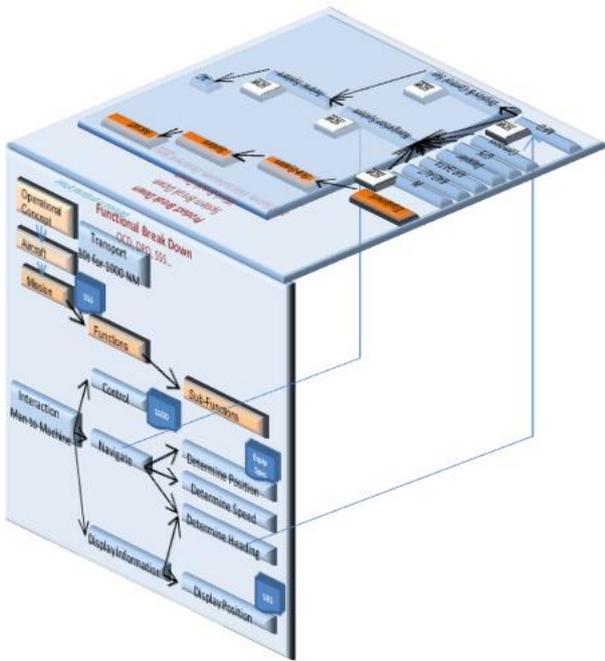


Figure 4: related Process Elements

This view is mainly relevant to the **proposal phase**, ensuring completeness and consistency; it helps **proposal engineers, sales representatives, program managers** and therefore end customers to prepare the proposal and its estimation in a timely fashion. Throughout the project **definition phase, process designers and project managers** are supported to create and maintain transparent and consistent project plans.

The *Function/Requirement View* defines requirements to be satisfied in the *System View*, which are in turn to be validated in the *Qualification View*. Functions are processed by physical items such as components, subsystems or systems. The Functional

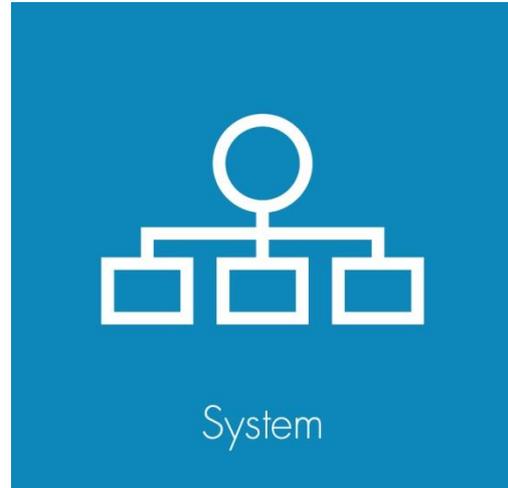
Breakdown Structure (FBS) directly defines the Product Breakdown Structure (PBS), which in turn directly defines the System Breakdown Structure (SBS).



**Figure 5: Mapping of functions to physical systems/components**

The documents produced via the *Function View* implicitly define the qualification path for use in the *Qualification View*.

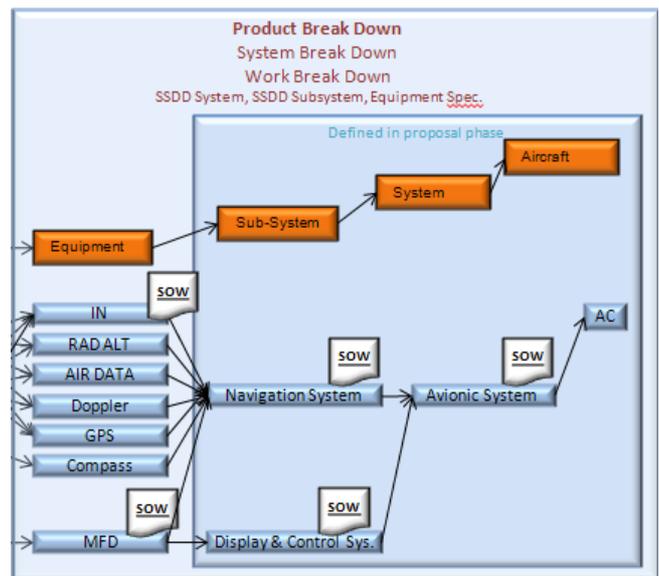
This view supports **the project analysis and design phase** and is intended to help **System Analysts, -Designers and Architects** to trace their activities.



### 5.3 View 3: System

A group of components/sensors/equipment's can be assembled to form a subsystem, a group of subsystems can be assembled to create to a system and a collection of systems creates the end product.

Definition: All components, sensors, equipment's, subsystems, systems, and their related documents/HW/SW are products necessary to fulfil the customer required functions and therefore the contract. For each component / equipment / subsystem / system, a statement of work is established to describe the activities/work to be performed to develop that item; therefore, the Work Breakdown Structure (WBS) parallels the System Breakdown Structure (SBS).



**Figure 6: Break down Structures**

The SOW describes also how the parameters of the process element will be modified. The SOW describes the work itself and

consequently will also define the role or competency required to perform the work. As a result CUBES<sup>3</sup> is able to support the **Resource Management Process** and **the workload estimations** to help **line managers** to provide the right resource at the right time.

System Analysts, -Designers and Architects are supported by mapping the required system functions to the systems and their components.

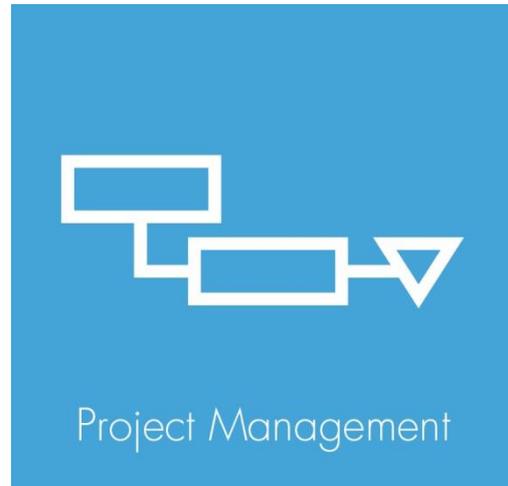


#### 5.4 View 4: Qualification

The *Qualification View* identifies all artefacts relevant for the Qualification/Certification process. CUBES<sup>3</sup> supports the reviews to be held at the end of each development phase by showing each artefact and its current status (i.e. proposed, planned, specifying, reviewed, developing, integrating, certified). In the integration phase the status of each test and its results can be traced providing transparency in “real time”.

**Certification-, Qualification-, Airworthiness-Engineers and Configuration Managers** are able to monitor the entire project progress for review-, integration- and qualification purposes during the complete course of the project.

To satisfy certification requirements from certification authorities like EASA or Eisenbahnbundesamt, CUBES<sup>3</sup> contains for example the Certification Specification **CS-27 Small Rotorcraft**. CUBES<sup>3</sup> generates **Certification Plan** and **Certification Sheets** for each relevant CS-27 Paragraph and tracks and traces the certification process by connecting the certification requirement with the artefact satisfying the requirement.



#### 5.5 View 5: Project Management

The *Project Management View* provides the project plan and progress to Project Managers and Line Managers. Change Management is realised in CUBES<sup>3</sup> by adding or removing work packages to the already planned work packages; schedule impacts are directly determined and displayed.



#### 5.6 View 6: Financial Management (Costs)

The *Cost View* generates up-to-date costing data to Project Controllers and Project Managers and compares this to planned costs providing immediate feedback of potential discrepancies. It is recommended to gather the financial data from a customer system installation like SAP to avoid inconsistencies in the monitoring and control process. CUBES<sup>3</sup> will provide information such as Earned Value Management (EVM) for reporting purposes and present this information as KPI matrices.

Remark: Fundamental to the project organisation capability of CUBES<sup>3</sup>® is the visualisation of all aspects of the project including cost. Therefore, it is recommended to set up a control account for each process element in the Work Breakdown Structure to enable an efficient and consistent monitoring and cost control process.

## 6 Use Cases of CUBES<sup>3</sup>®

CUBES<sup>3</sup>® can be used throughout all phases of the development life cycle to support the necessary activities of all stakeholders in development projects.

### Use Case: Certification Planning Tool

All relevant development standards are already in CUBES<sup>3</sup>®; it is an ideal platform to negotiate a certification plan with the relevant certification authorities.

### Use Case: Proposal Tool

Thanks to the standardised work break down structures, it is easy to prepare project specific WBS and to estimate the efforts for the work packages, thus decreasing estimations effort enormously. Additionally, verification of previously prepared proposals can be easily performed, providing a good level of evidence for both completeness and consistency.

### Use Case: Project Planning

Starting with the WBS prepared in the proposal phase, a good traceability can be provided during the project set up following award of a contract.

### Use Case: Project Management

The agreed process can be directly transformed into a Project Plan.

### Use Case: Validation Process monitoring tool

During the analysis phase, design phase and development phase the progress of the documentation, the reviews and their results can be easily monitored.

### Use Case: Project Monitoring and Control

The CUBES<sup>3</sup>® is capable of interfacing to a wide range of existing industry standard tools and data resources, and can be easily tailored to interact with customer proprietary utilities. Hence, a consistent and transparent monitoring and control process can be established without the need for retooling or retraining of affected functions.

### Use Case: Qualification monitoring tool

During the qualification, hundreds of documents need to be prepared, traced and provided; CUBES<sup>3</sup>® provides an excellent

overview for all stakeholders.

### Use Case: Standard Migration and Evolution

Ongoing Projects can easily be upgraded to be compliant with changing standard-requirements or regulations; shortfalls can be identified and resolved.

### Use Case: Product Family Support

Over time, projects which have been executed using the CUBES<sup>3</sup>® methodology provide a perfect basis for upcoming projects by isolating reusable features as required in a product line which must develop innovative products while minimizing efforts.

### Use Case: Process Knowledge

Beside predefined standard processes, company-internal process information can be similarly integrated and managed with CUBES<sup>3</sup>®.

## 7 Summary

CUBES<sup>3</sup>® provides guidance in all complex development projects. It accommodates all roles and responsibilities, and all user specific views into the project. It gathers for various tools the relevant information and provides a consistent and transparent picture of the project.

**CUBES<sup>3</sup>® is the process tailoring and management solution to develop standard compliant products.**

## 8 References

- [1] ARP4754-Rev\_A\_2010\_12 Guidelines for Development of Civil Aircraft and Systems
- [2] DO-178C Software Considerations in Airborne Systems and Equipment Certification
- [3] DO-254 Design Assurance Guidance for Airborne Electronic Hardware
- [4] CS-27 Small Rotorcraft
- [5] MIL-STD-881C Work Breakdown Structures for defence Material Items
- [6] IEEE Std 12207 Systems and software engineering - Software life cycle processes