26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

# Defining an Architecture Trade off Management Capability

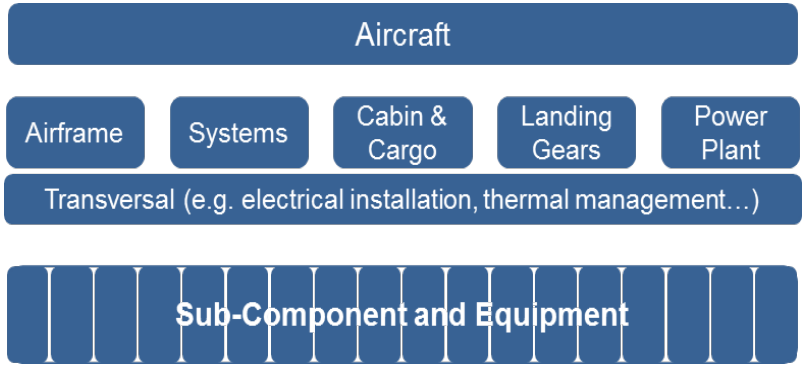
Anne Monceaux, Alexandre Arnold (Airbus Group), and Pascal Gendre (Airbus SAS)

26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

# ARCHITECTURE CONVERGENCE PROCESS

# Product development layers

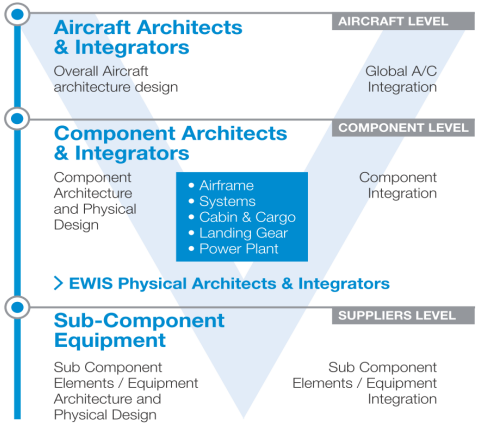
The development process is broken down into Product Development Layers




…reflected by an architect organization


E Architect

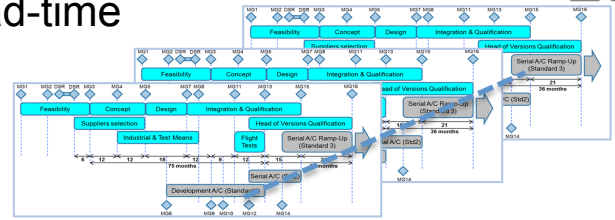
Define the component overall virtual architecture.
Launch, coordinate and drumbeat MDTO studies



# Convergence process

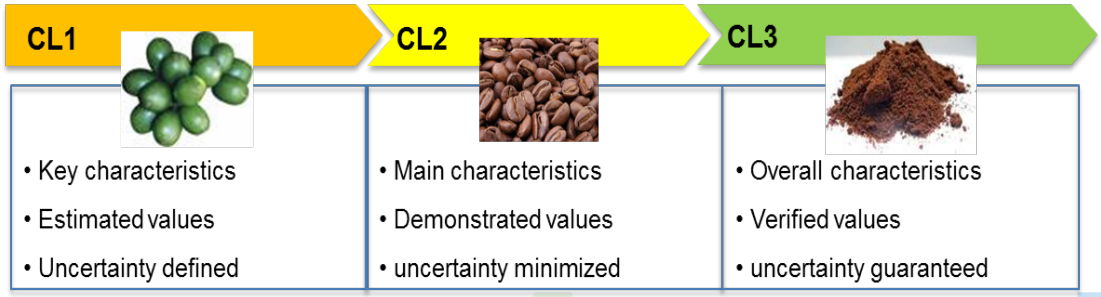
26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

Strategies to reduce the development cycle lead-time require to run activities in parallel

**Convergence** relies on collecting and consolidating information & data out of these activities

**Convergence levels** reflects the granularity & maturity of the data

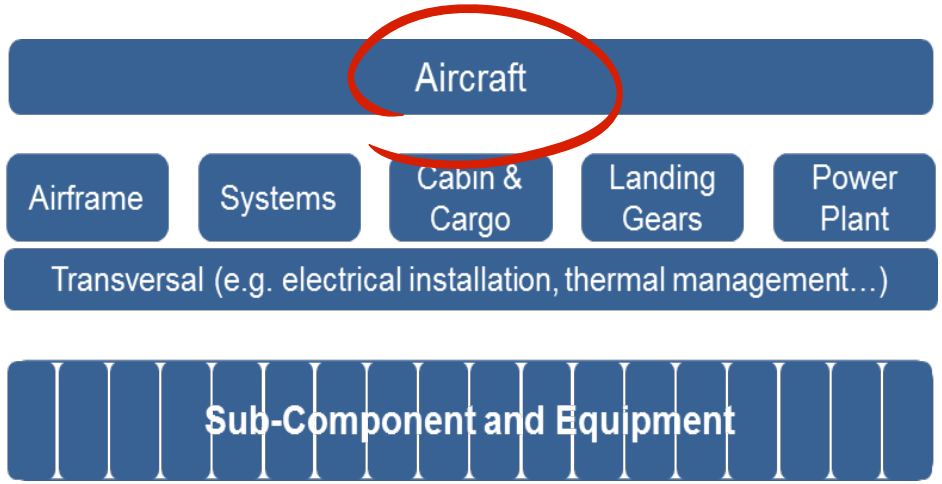


26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

# MULTIDISCIPLINARY TRADE-OFF CAPABILITY

# The aircraft mechanical system

Interviews of architects in charge of the Flight Physics perimeter




**CL1.x**

Aero shapes
Flight Control surfaces
Landing Gear
Power Plant
Airframe
Etc.

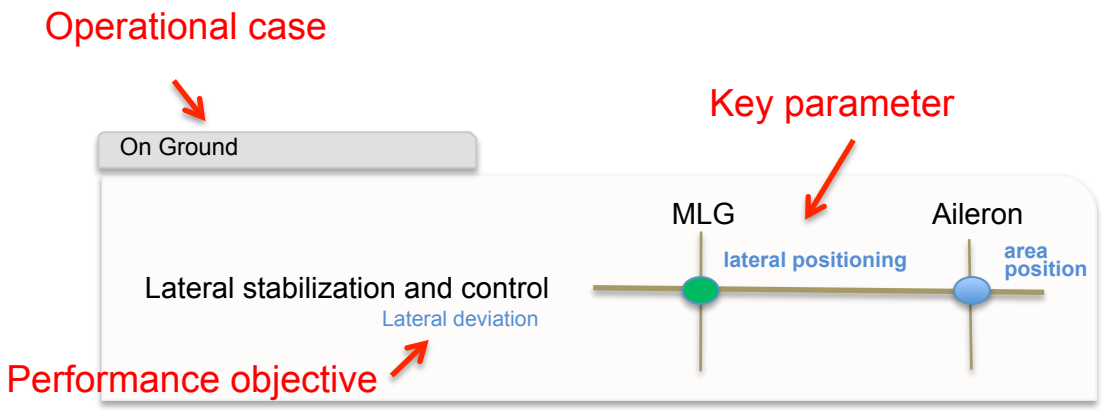
major parameters of Components + functional propagation of parametric variations

Aerodynamics
Loads
Structure: FEM, stress
Propulsion
Handling Qualities
Etc.

Disciplines involved in mechanical studies

# Simplified example



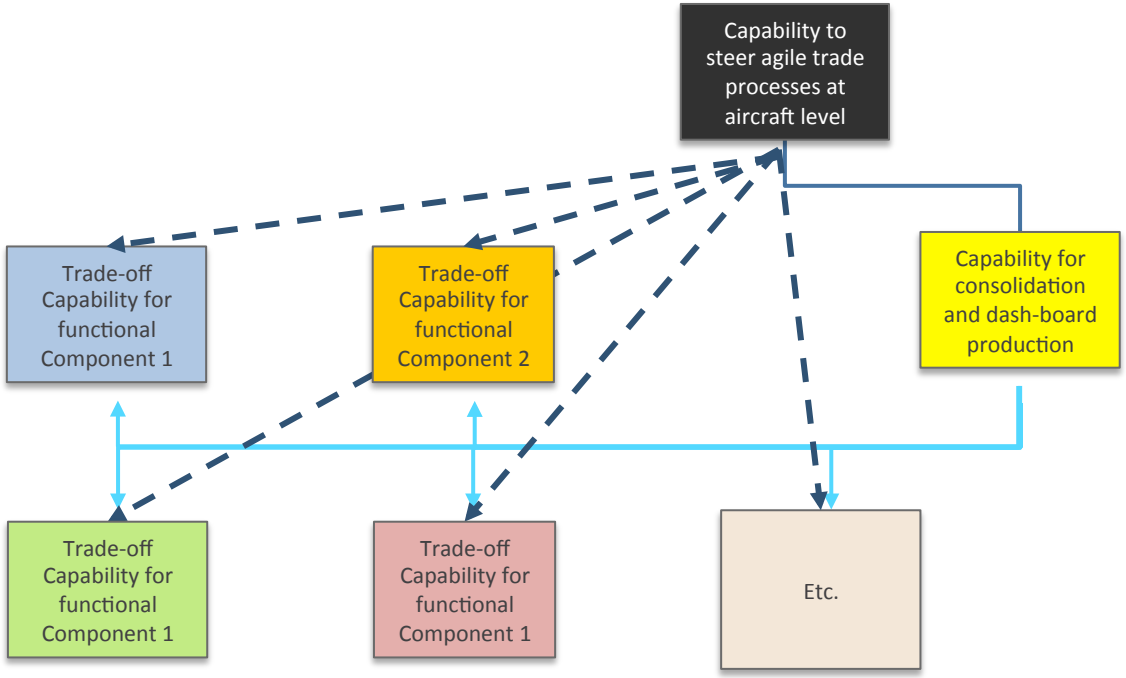



For a given performance, a trade can be done between lateral positioning of the main landing gear and ailerons parameters

We call MDTOC the process – operated by a dedicated multidisciplinary engineering team, using dedicated component models and function simulation methods – that can size these components according a tested configuration chosen by the architect

# Multi Disciplinary Trade Off Capability

26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016



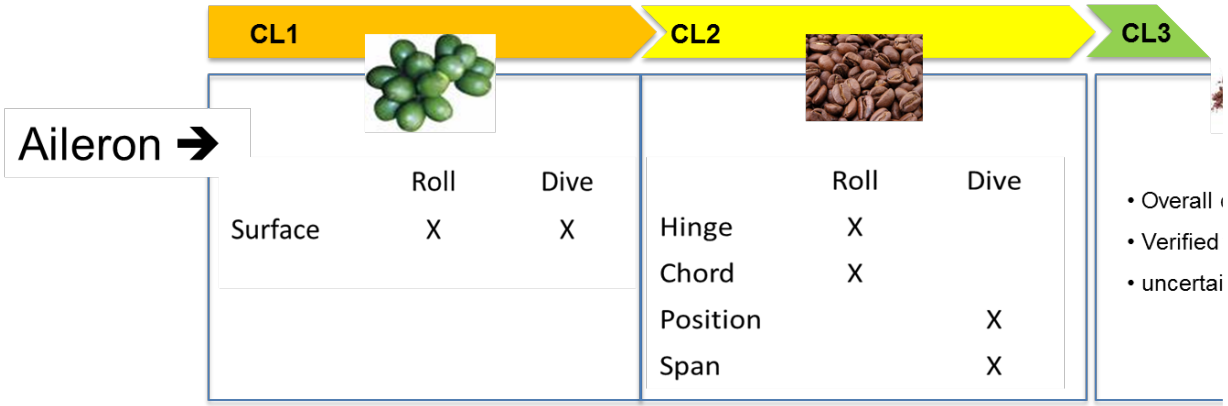

Generalizing the analysis for classical civil aircrafts:

- Describe functions of the Flight Physics System
- Allocate functions to physical components of this Flight Physics System
- Cut out into this allocation map, consistent perimeters of trade-off capabilities, in charge of sizing some components with regards to the functions they were allocated to.

# Multi Disciplinary Trade Off Capability



Along the convergence process, sizing methods have growing fidelity level, meaning that different aspects (sub-sets of parameters) of the Component can be evaluated and sized



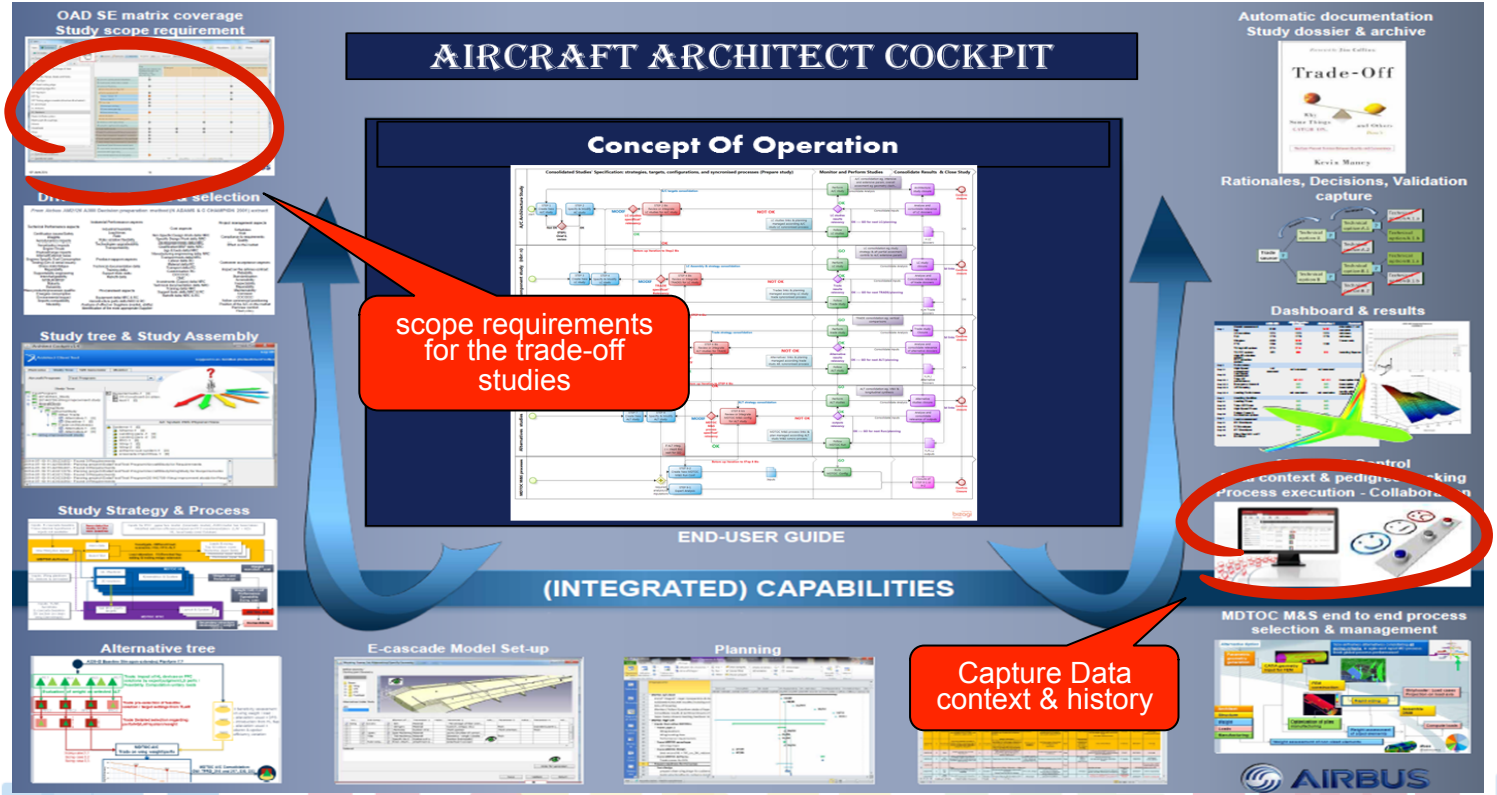

MDTOC methods shall ensure the transition

- from highly integrated and very rapid sizing methods supporting the feasibility phase
- to downstream processes for highly accurate design phase

26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

# A DEDICATED WORKBENCH FOR THE ARCHITECTS

# A dedicated workbench for the architects




Architecture
Trade off
Management
Capability

P. Gendre "*System of MDTOCs synthesis*". December 2015

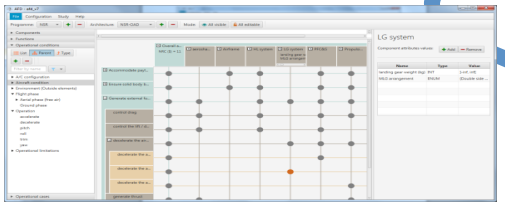

# DEFINING AN ARCHITECTURE TRADE OFF MANAGEMENT CAPABILITY

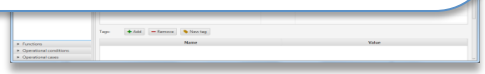
# Sketching a process


Create architecture alternatives by instantiating components and valuing their attributes

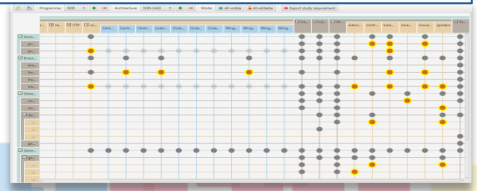

" Ailerons, elevons and rudder are defined to "maneuver from air flow", to "trim and stabilize from air flow" in engine failure cases. These surfaces also contribute to "ensure air lift at low speed" (drooped ailerons) and to "transmit external forces & moments and resist to consequent internal loads" through the Load Alleviation Functions (MLA and GLA) "

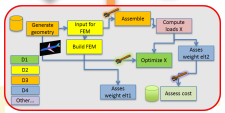
Formalize links between functions and components using an allocation matrix





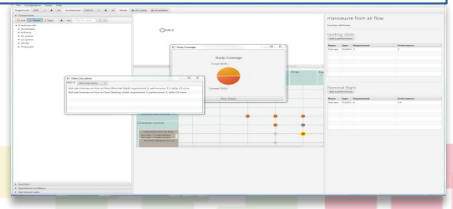
Export study scope requirement - defined by selecting allocation points



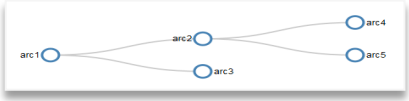


**MDTOC method is ran**

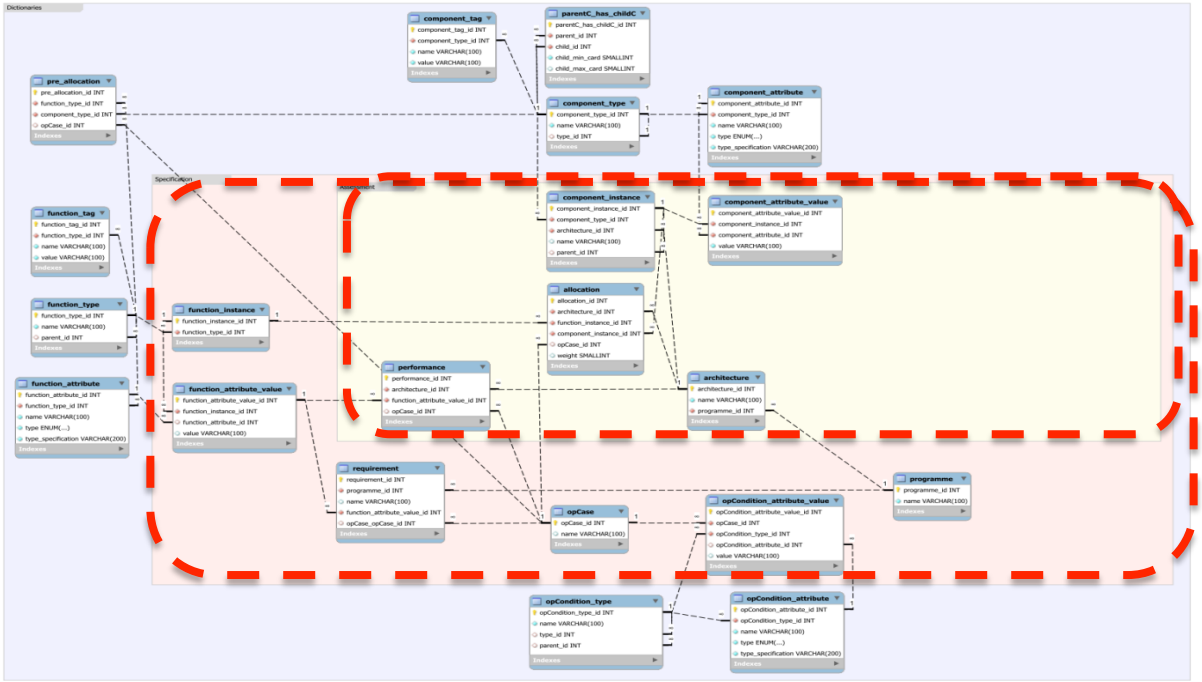
Collect & integrate study results + verify validity of architecture (estimated perf vs req, allocation points covered by studies so far…)



Monitor history & progress of architecture layers



# Core information concepts





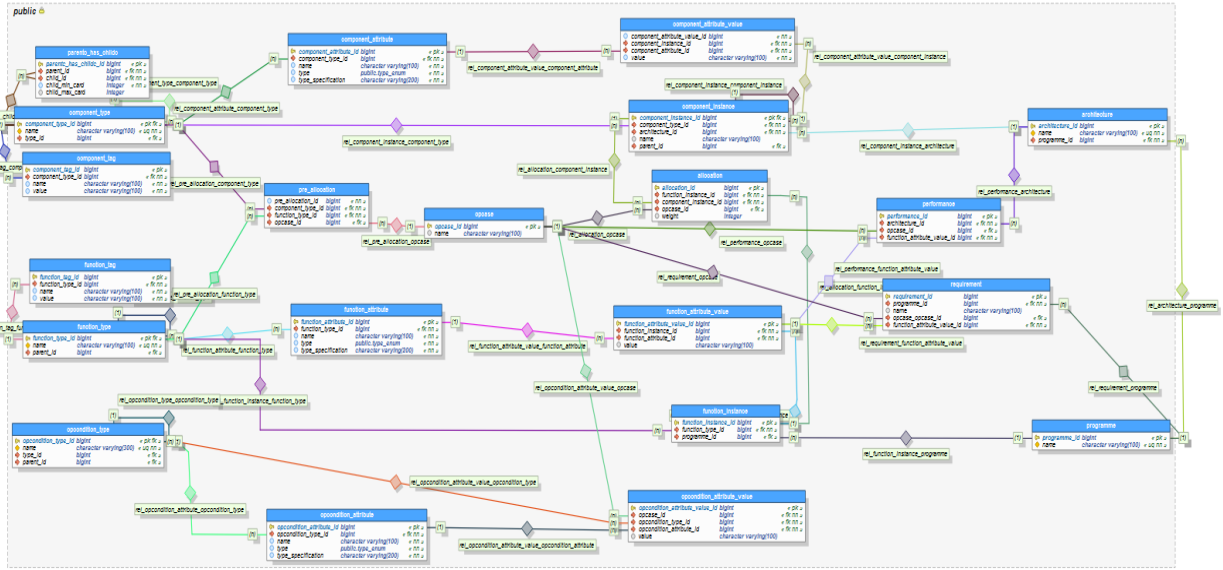

Architecture modelling elements

- Functions & attributes
- Operations & attributes
- Components & attributes

Views

- Dictionary
- Specification (Program context)
- Architecture

# Extended information concepts



Process modelling elements

- Study
- Convergence Layer

Views

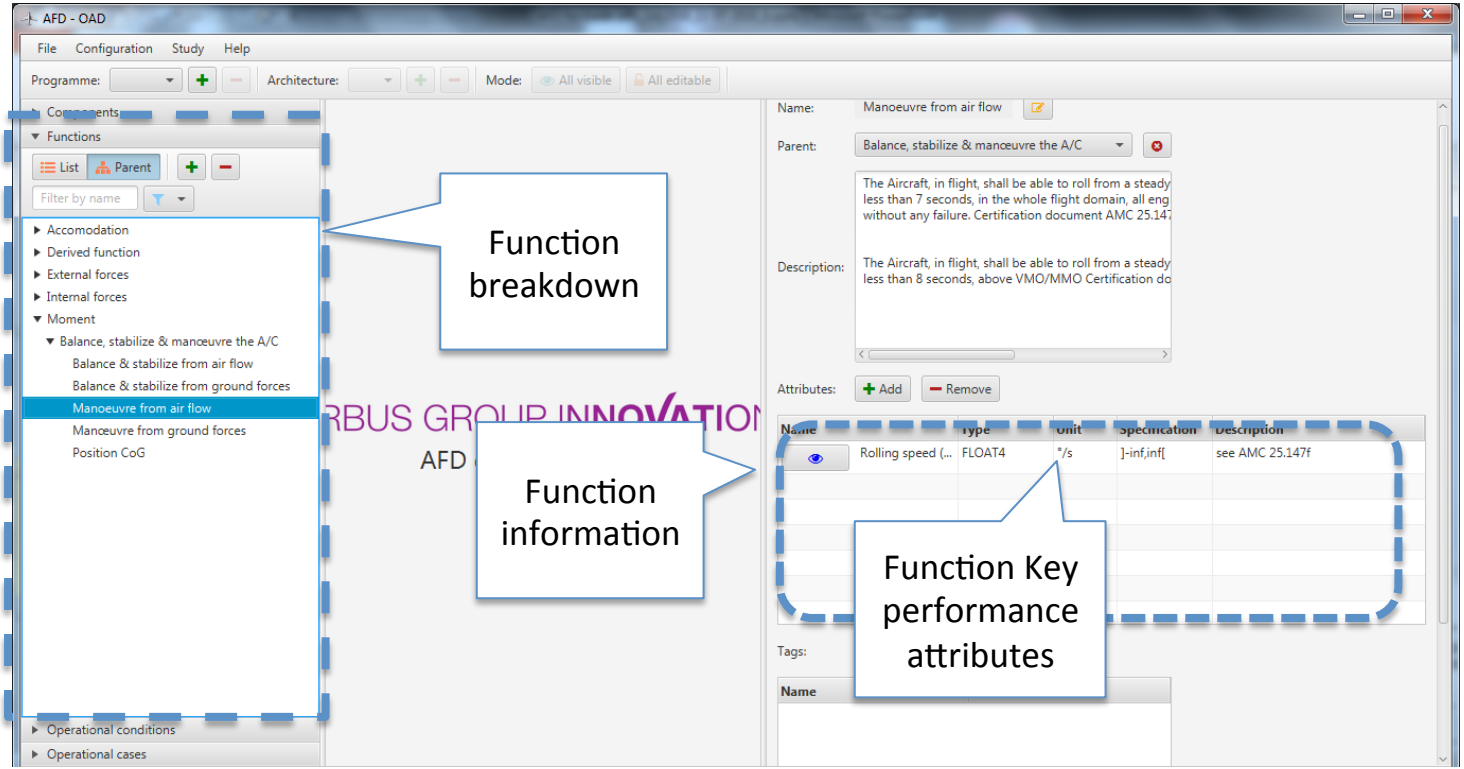
- Architecture refinement
- Value delta

# SKETCHING A CASE STUDY

User driven prototyping – agile - to sketch a process and to test our ideas

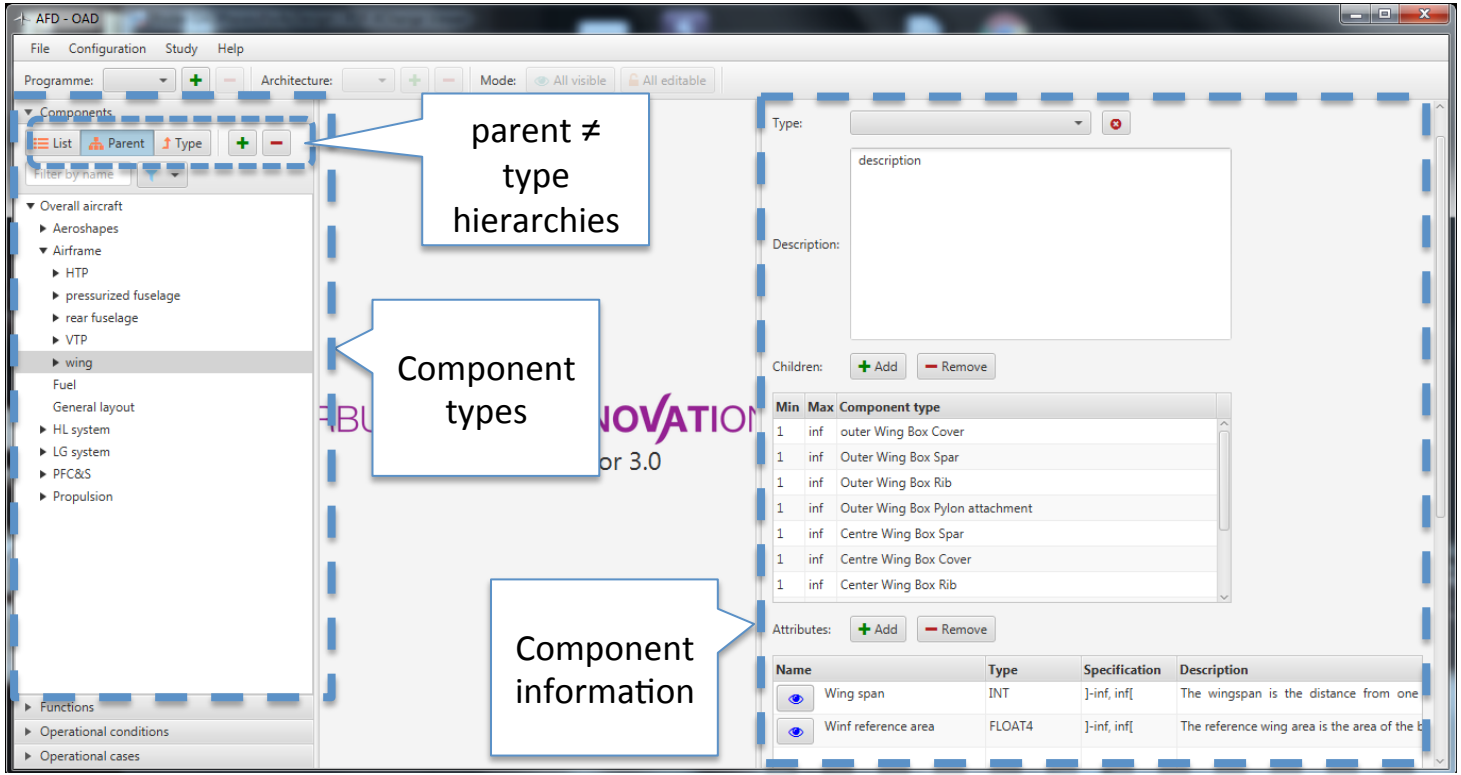
No fully mature tools but rather ideas to be handed over R&T

# Dictionary: Function breakdown

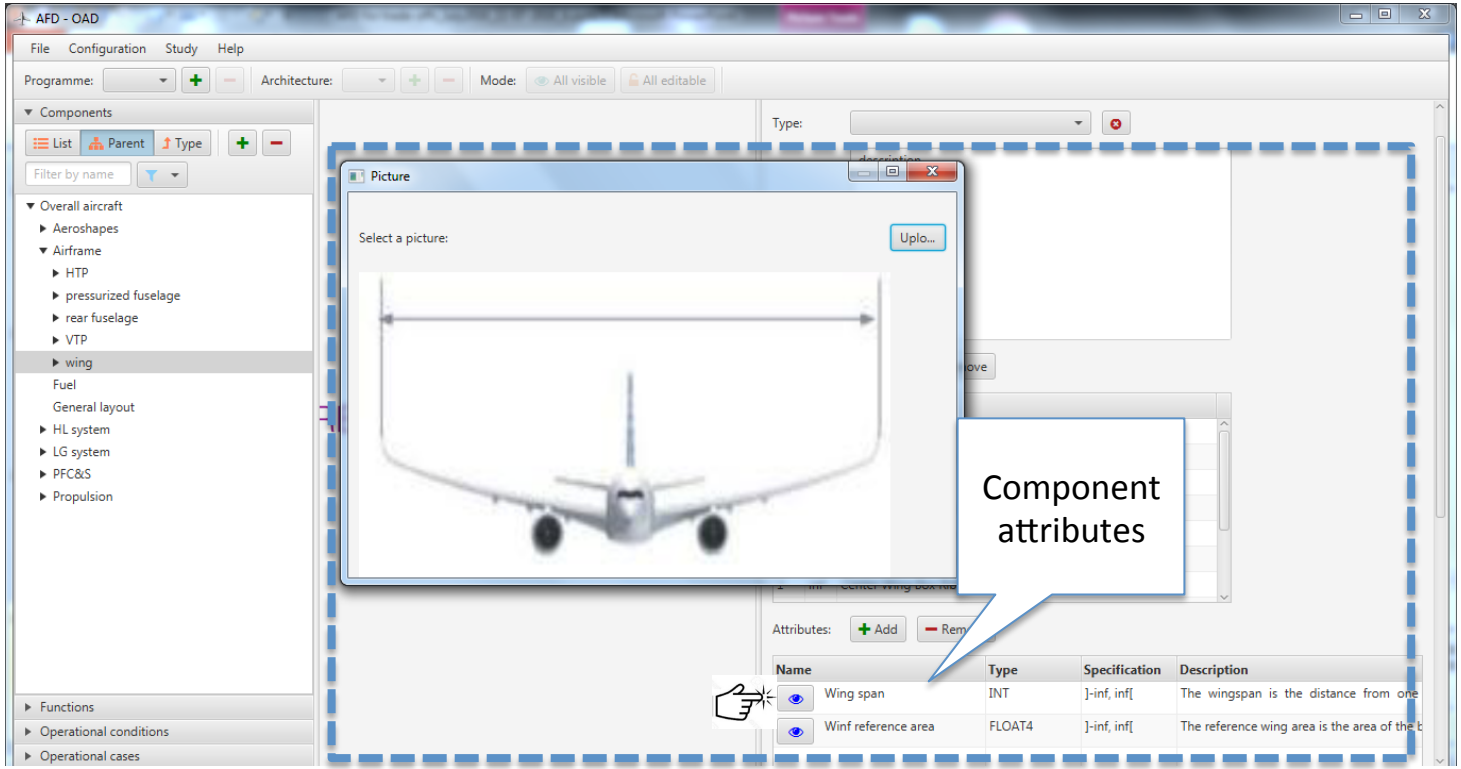



Integration definition (IDEF) for Function modeling framework

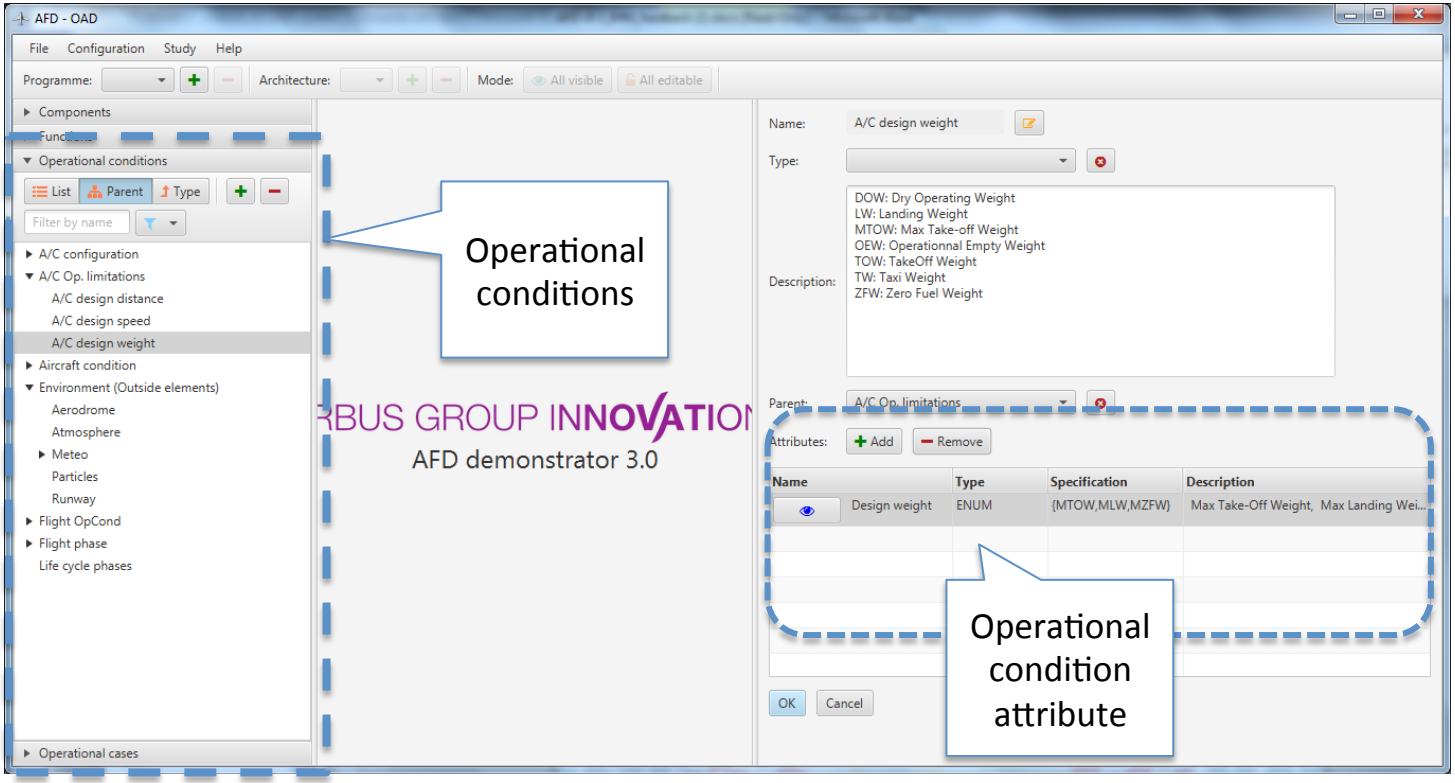
# Dictionary: Components



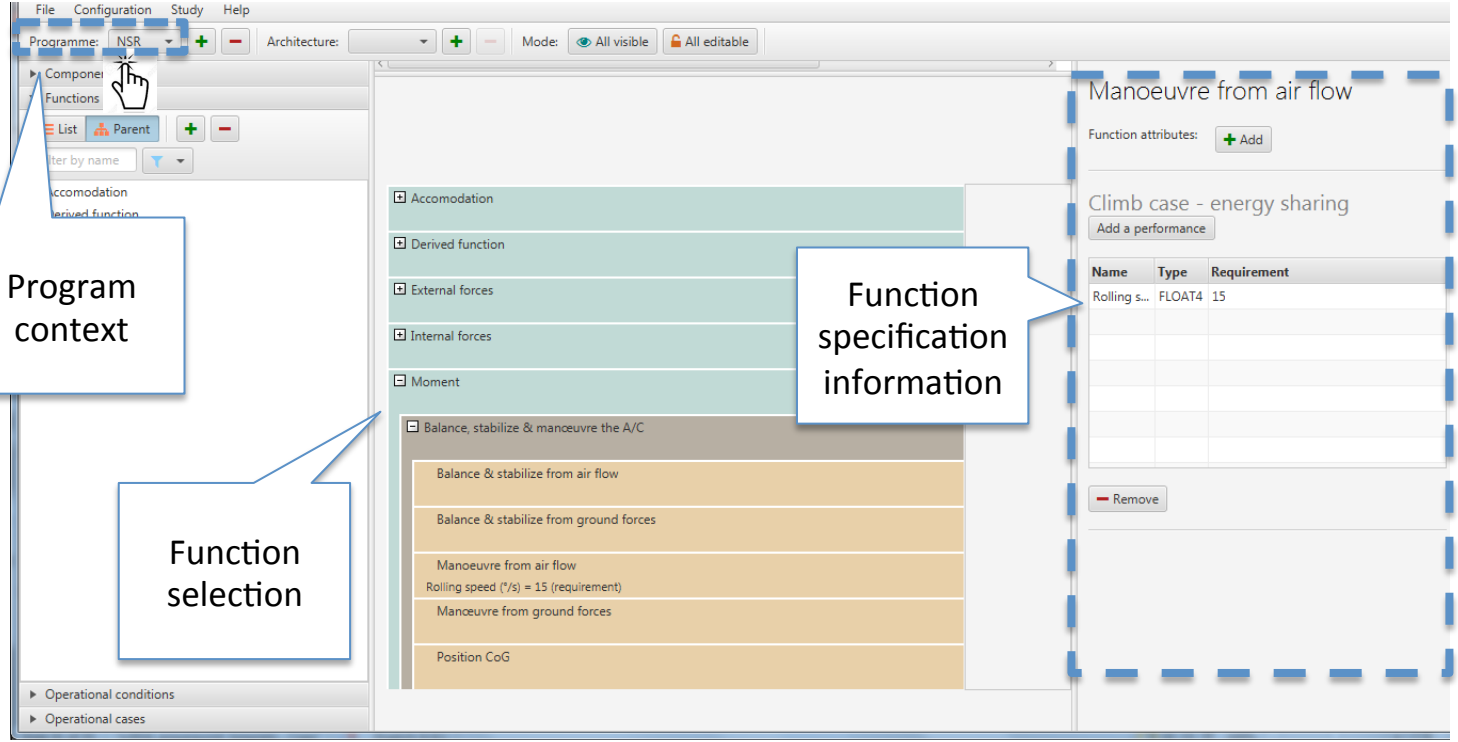
# Dictionary: Component key characteristics



# Dictionary: Operational conditions



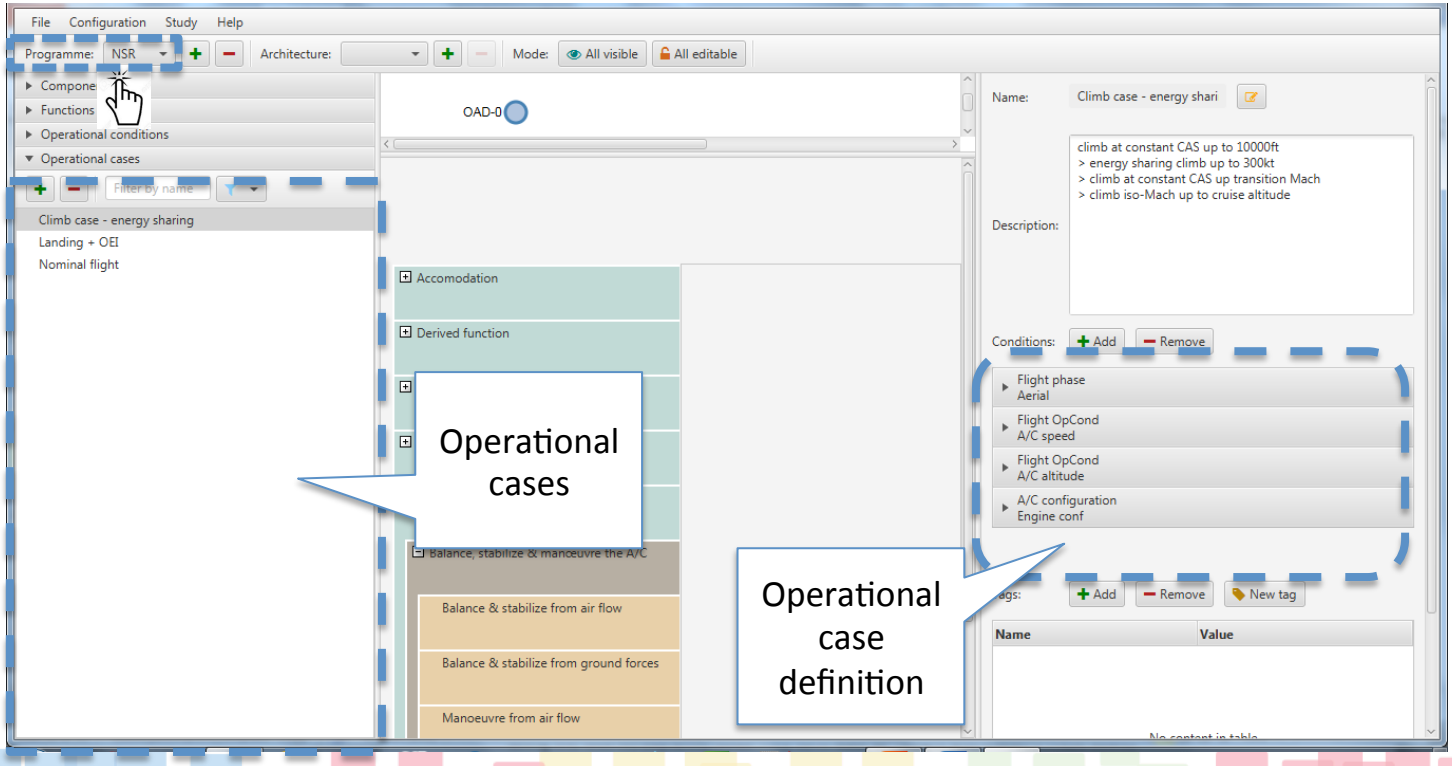
# Specification: Functional requirements




From requirements

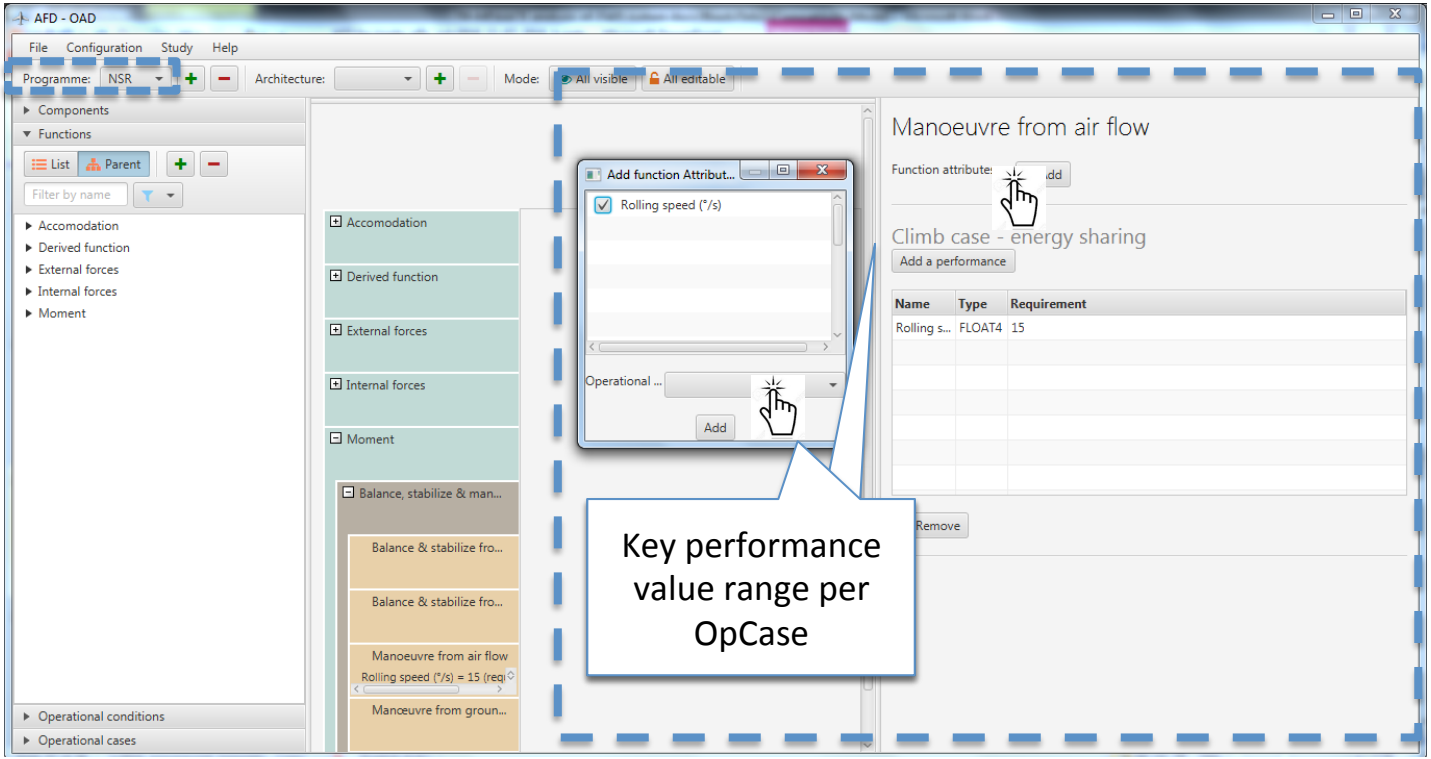
Performance values dependent on OpCases

# Specification : Sizing operational cases



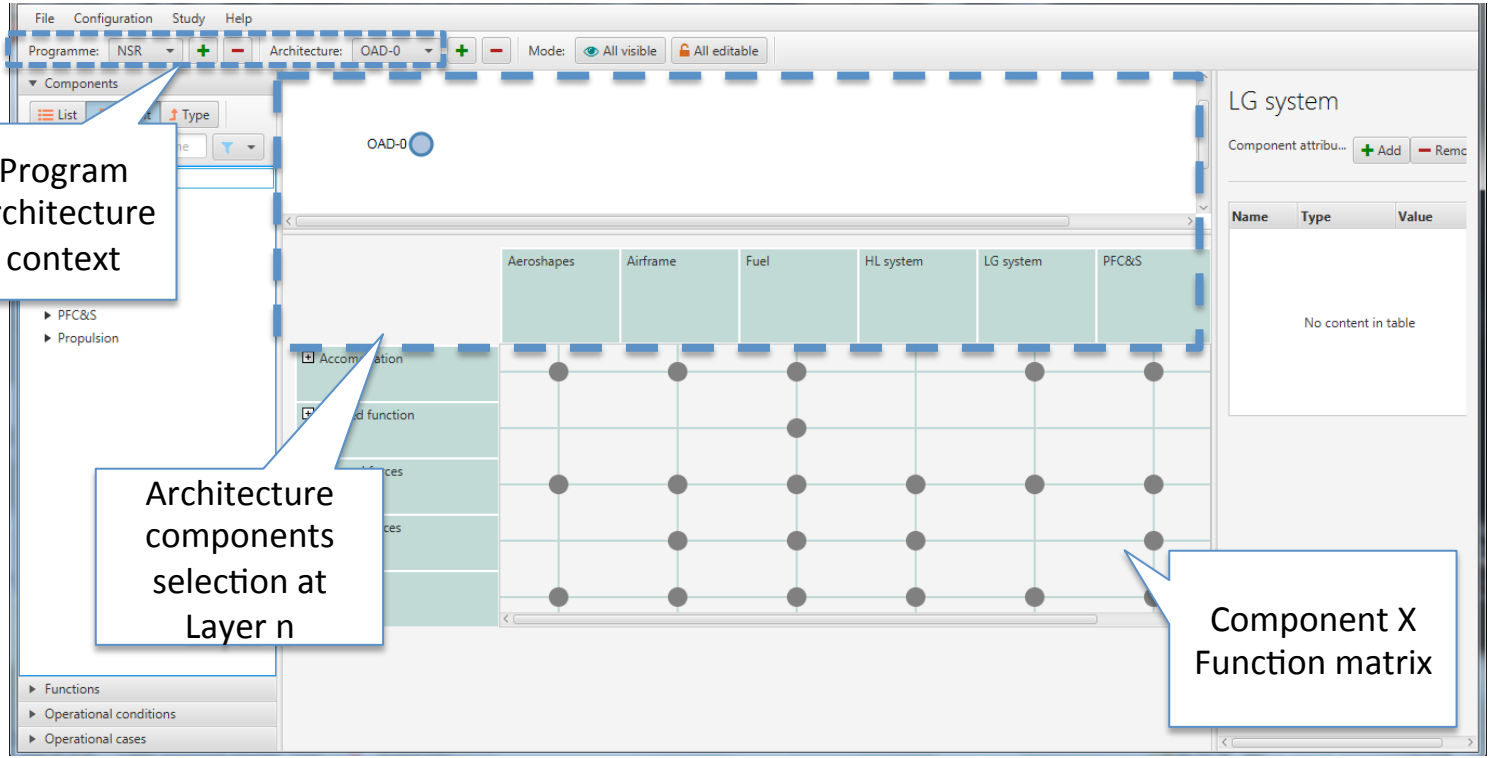

OpCase = set of selected OpCond attributes (possibly valued)

# Specification: Functional requirements




expected performances per OpCase

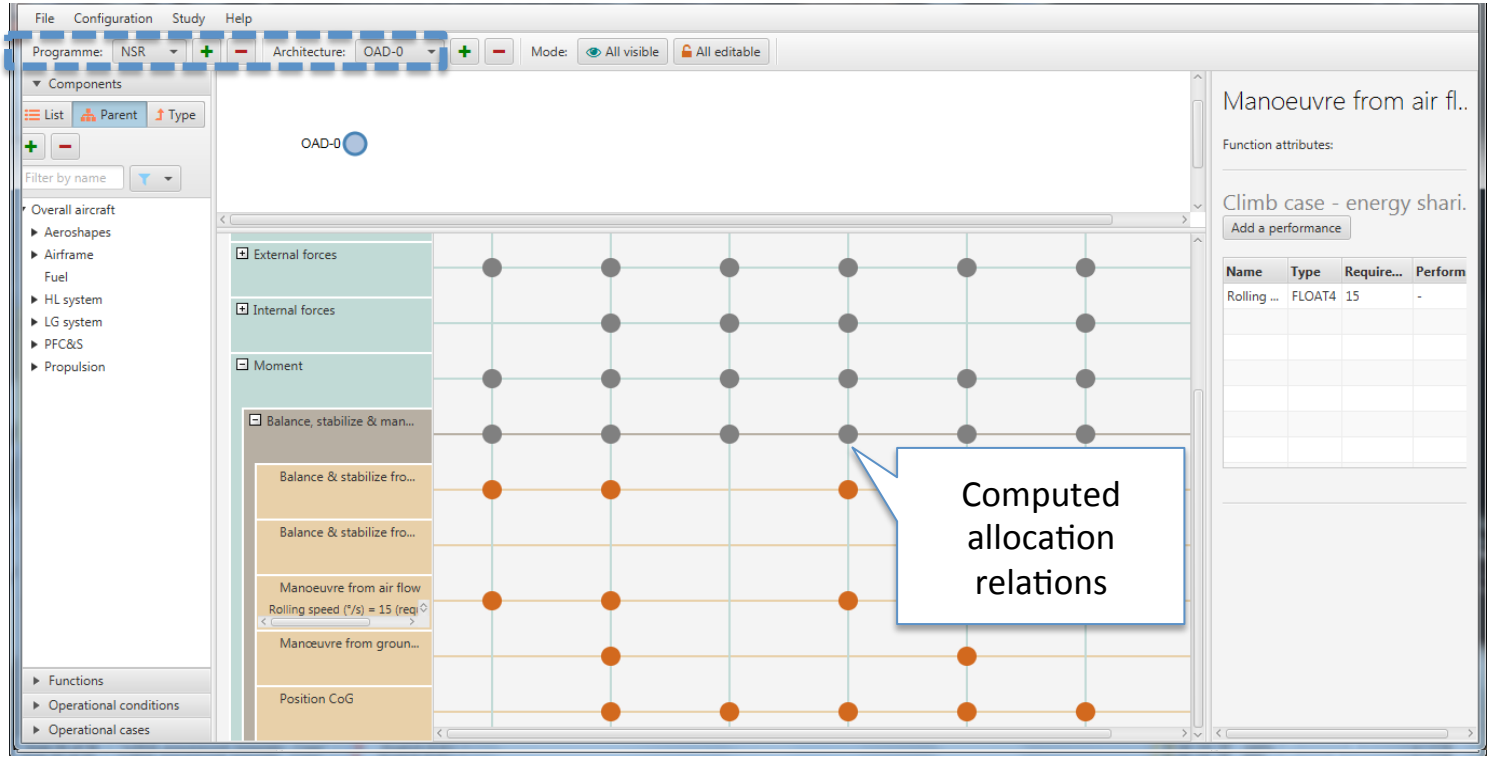
# Architecture: Component X Function matrix




That architecture Component is sized for…

That architecture Component contributes to…

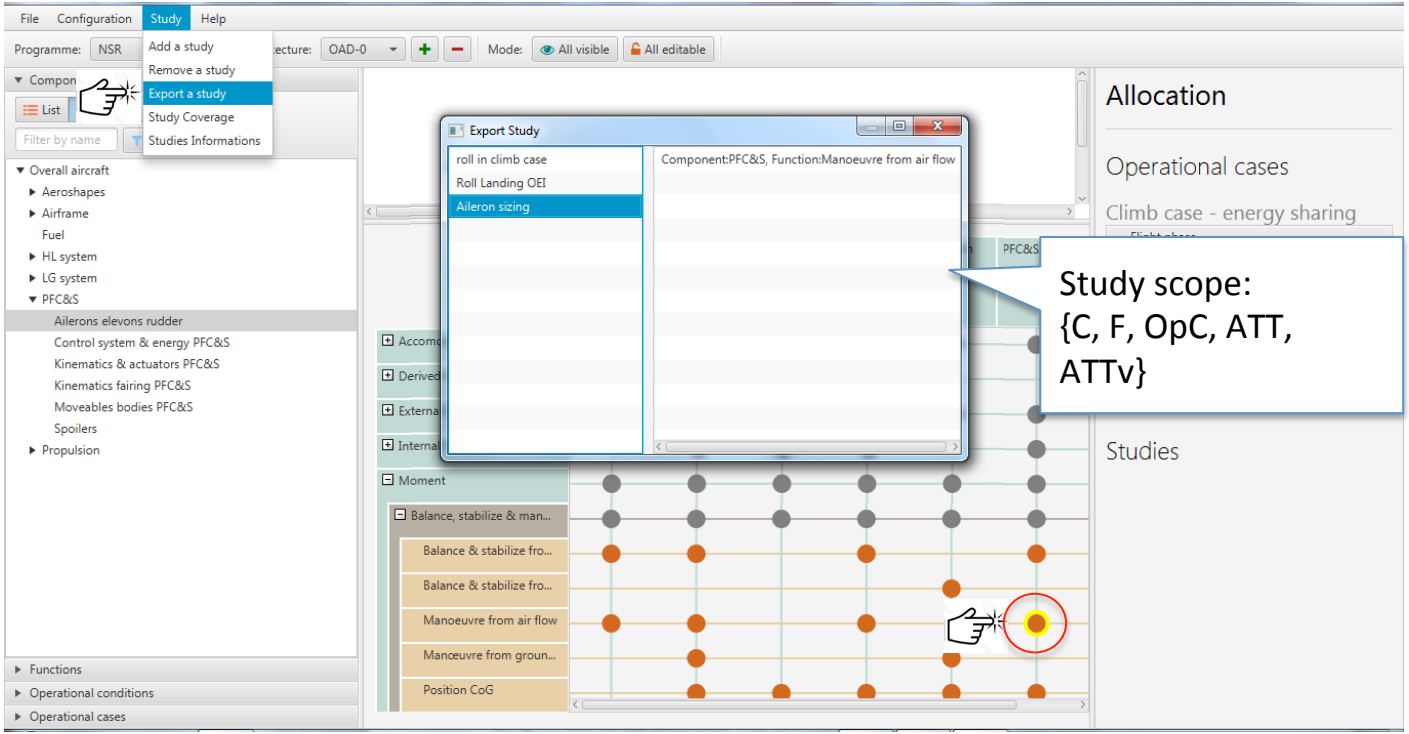
# Architecture: Component X Function matrix

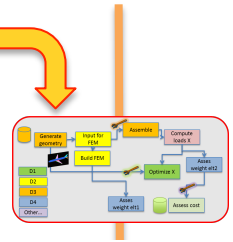



That architecture Component is sized for…

That architecture Component contributes to…

# Export Study scope requirements

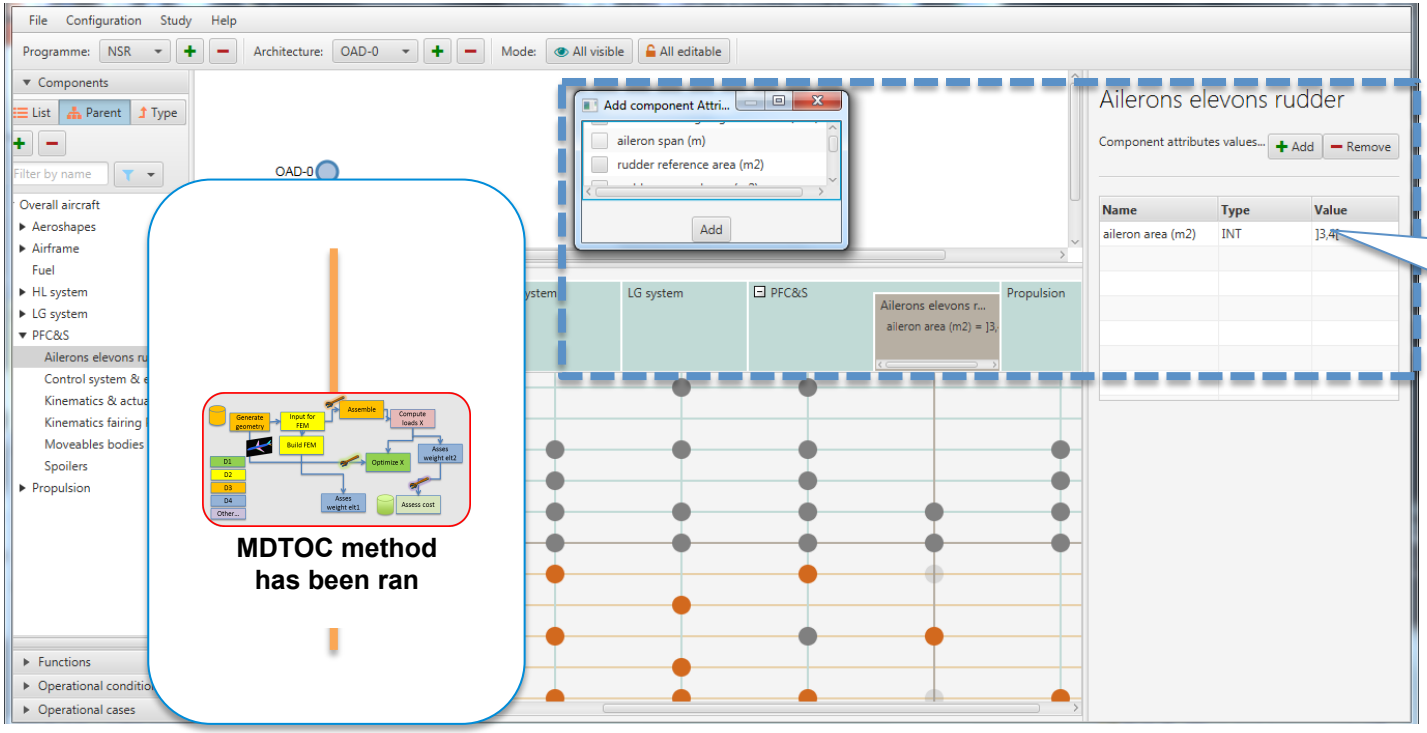


**Scope Requirement for a MDTOC method**

# Import attribute estimated values

(Static, discrete as in DBD)
Links to figures, models…

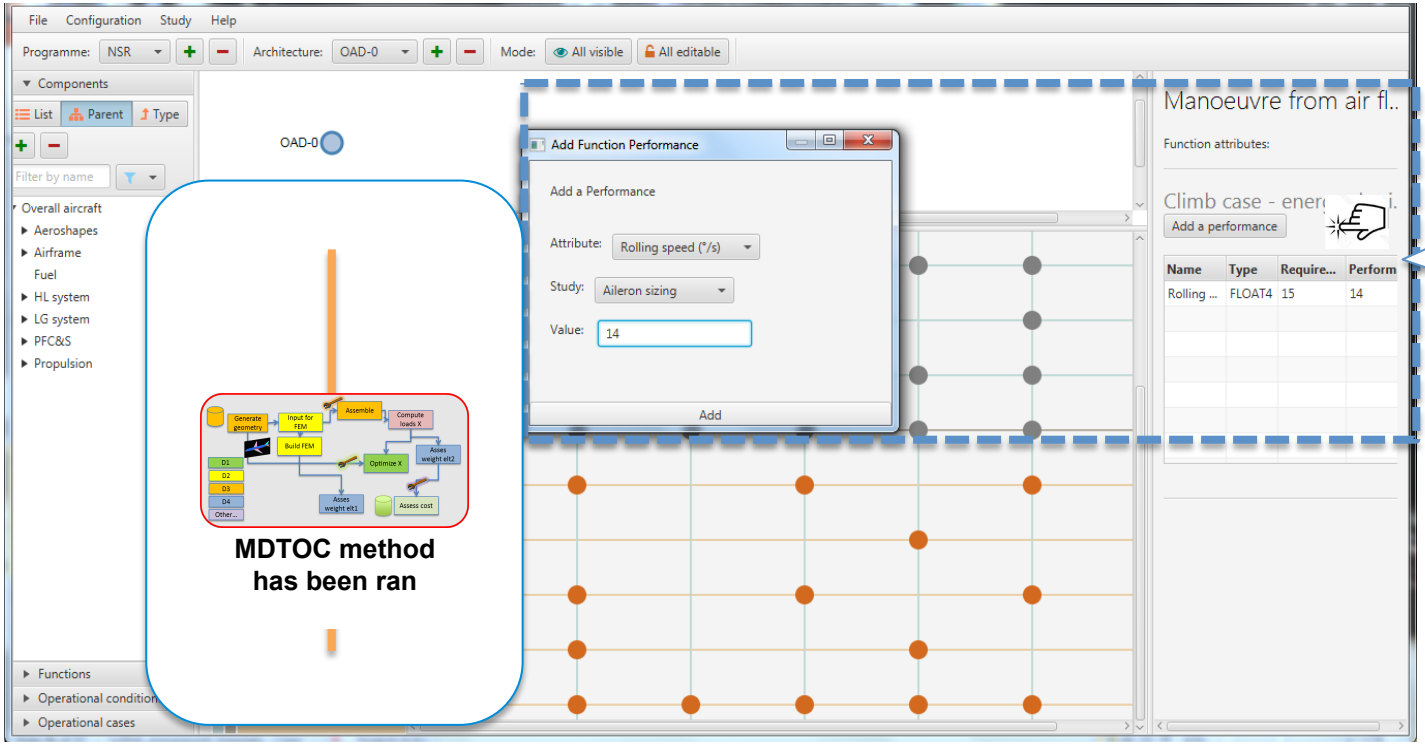



Component CL1
Key characteristic
sized in Study

**CL1**

- Key characteristics
- Estimated values
- Uncertainty defined

# Import attribute estimated values

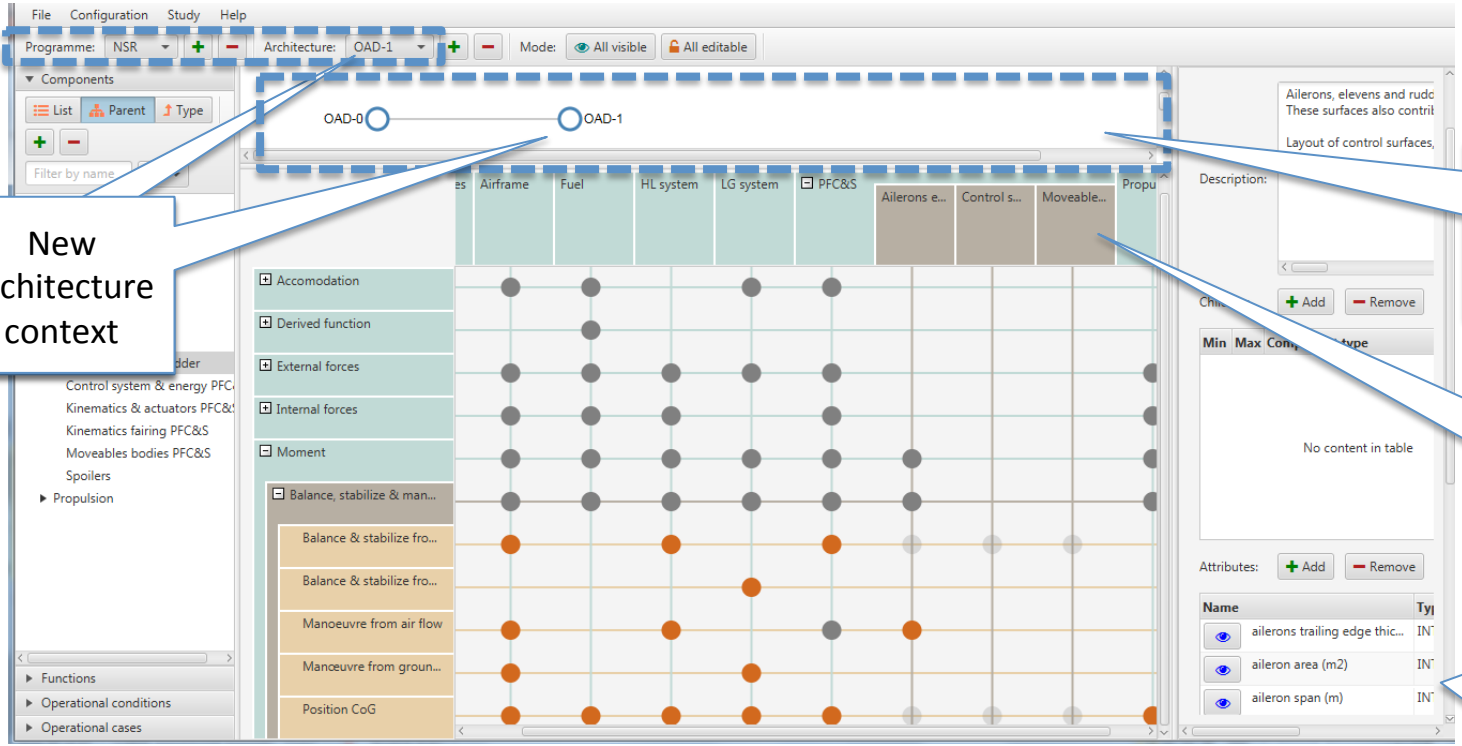



Function Key performance per OpCase estimated values in Study

**CL1**

- Key characteristics
- Estimated values
- Uncertainty defined

# Refine architecture at next CL n+1



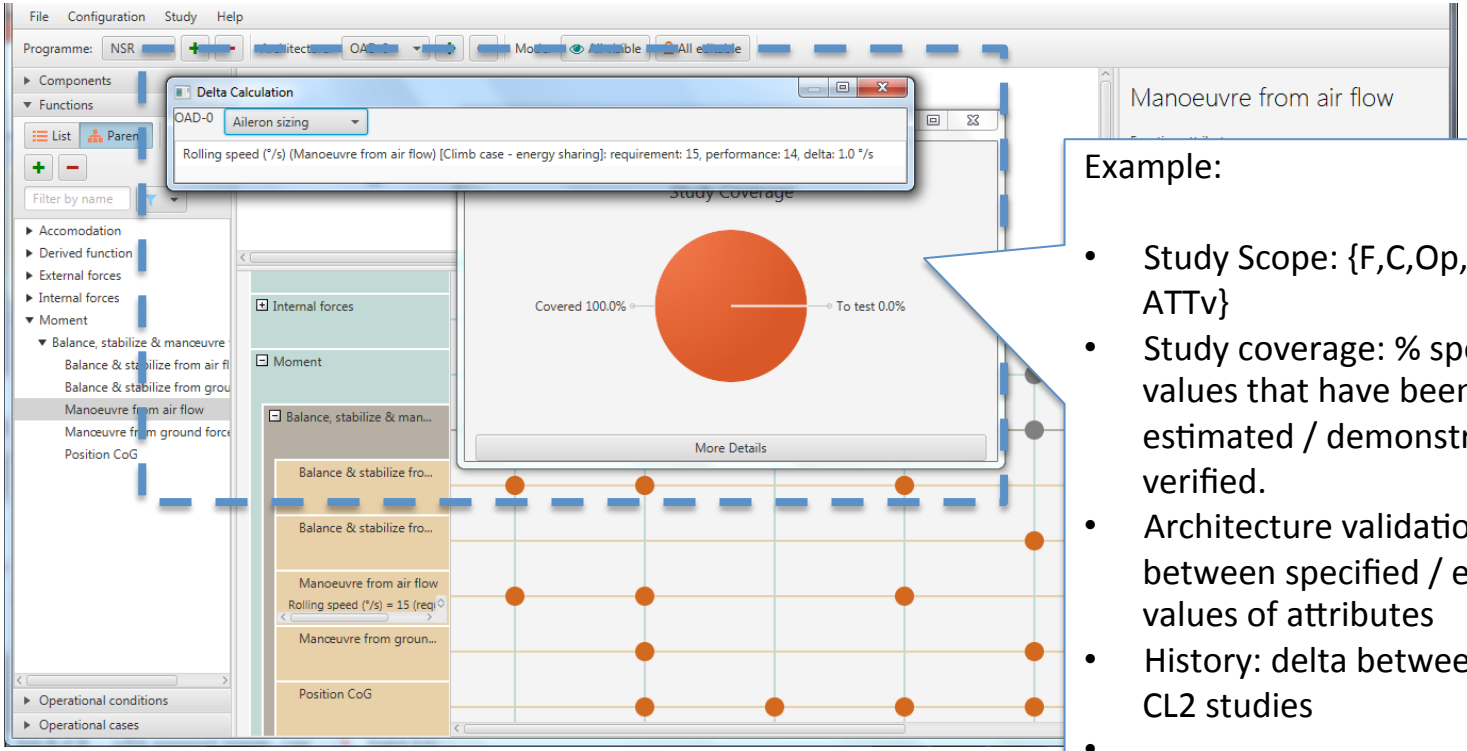

New architecture context

Inherited architecture at CL n+1

Add Components

New Component attributes

# History, progress possible KPIs




Example:

- Study Scope: {F,C,Op,ATT, ATTv}
- Study coverage: % specified values that have been estimated / demonstrated / verified.
- Architecture validation: delta between specified / estimated values of attributes
- History: delta between CL1 / CL2 studies
- …

# SUMMARY

# Parting thoughts



## Reusable knowledge, reproducible processes…

- product development layer / architect organization
- MDTOC methods (~automatize)
- Function breakdown
- Component libraries
- …

Process optimization

## Flexibility

- New technology == new Component subtypes, with new characteristics
- Key attributes list open
- OpCases definitions

## Potential

- A rich Attribute model for architecture convergence
- Opportunity for applying data analytics method / relevant dash-board, monitoring views for the architects
- Information integration with requirements as a potential

# Parting thoughts


| | | |
|---|---|---|
| E | ICT | Provide the IT infrastructure |
| M | Methods | Manage consistent dictionaries, architecture knowledge…. |
| E | Architect | Define the component overall virtual architecture. Launch, coordinate and drumbeat MDTO studies |
| E | MDTOC leader, M&S | Define the component trade-off capability, M&S means and granularity of the demonstrated values |
| E | Designers | Run studies and give back information on parts impacted by the change (replaced and introduced) |


thank
you!