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Short Range Reference Aircraft CeRAS

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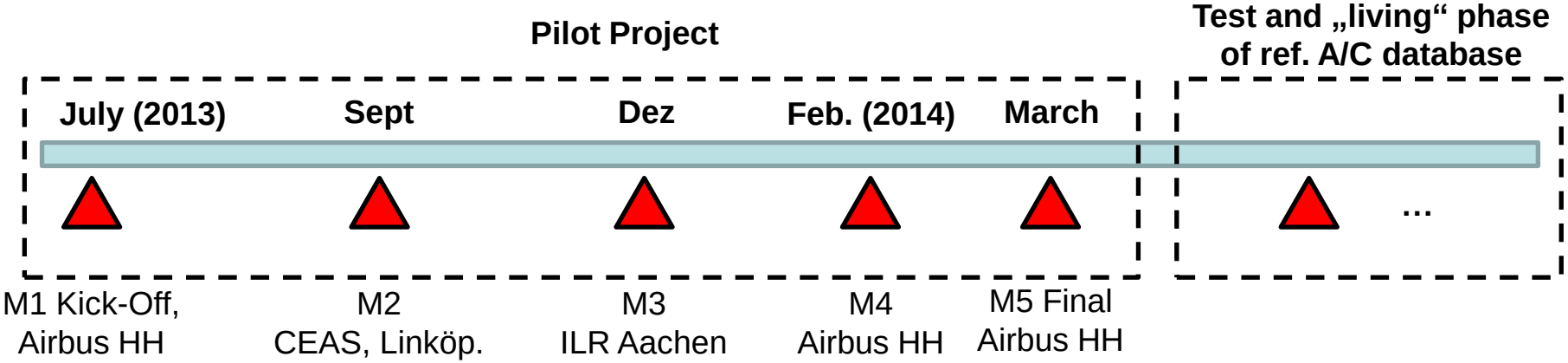
Problem statement, motivation & objectives

Problems in common practice:

- Limited availability of consistent reference A/C data for research community
- Restricted data authorization from industry
- Repeated/redundant definition processes
  → consumes cost & resources + makes comparability difficult

Objective: **Central Reference A/C Data System for Research Community → CeRAS**

Pilot Project at ILR, RWTH Aachen University
sponsored by Airbus, cooperation with FPO Hamburg



User group and advantages of CeRAS

Advantages for different users in research community:

Research institutes and universities	Industry, e.g. Airbus:
Quick download of reference A/C with much more detailed data	Reduction of data authorization processes
Usage as baseline A/C in research projects (OAD, technology evaluation)	Referencing to central ref. A/C database towards external partners
Usage for calibration of own platforms and tools → higher quality of external methods and results	- Smarter use of external data (quality assurance, reliability, consistency) - Capability development (e.g. for ref. database)

CeRAS: Requirements

Requirements:

- Complete, consistent & unique description of reference A/C parameter and units
- Standardized data & process for creation of new reference a/c (V&V process)
- Common standard for data exchange in research community
- Compatibility of different reference A/C versions
- Long-term goal: Extensibility of reference a/c system by additional ref. A/C, depth (e.g. component level) & width (towards overall air transport system)

→ **Open-Source Reference Database and V&V environment**

CeRAS: First Reference Aircraft?

Which Reference Aircraft? → Conventional short range A/C

… **why?!** Everyone has an aircraft design for a short range configuration!

… **but:** different versions, data, methods available with different accuracy, validity

→ unique version and definitions required agreed by Airbus & research community

→ Good starting point to set up a standardized database upload and download process and enable method calibration and data comparison

→ **Doesn't lead to a new or better short range configuration … just to a consistent, agreed, validated and reliable dataset!**

CSR-01

(CeRAS Short Range – Version 01)

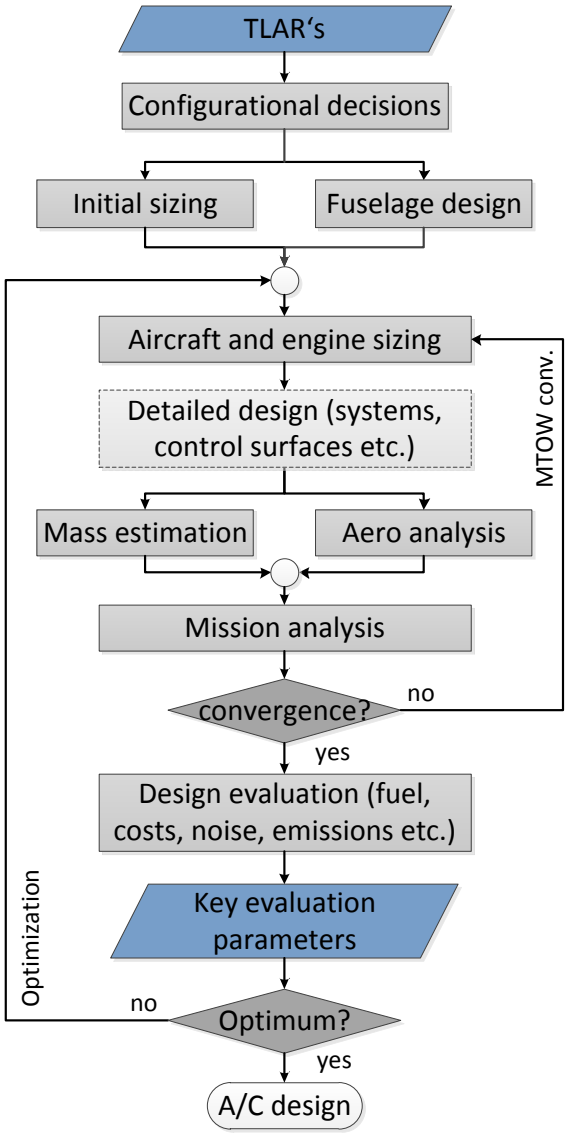
Overview of Design Approach for CSR-01

Design Approach:

- CSR-01: CeRAS Short Range A/C
- ILR Multidisciplinary Integrated Conceptual Aircraft Design and Optimization (MICADO*) aircraft software platform applied

Application of MICADO useful for:

- Generation of complete and consistent OAD datasets
- Quick generation of sizing sensitivities → usage by partners without own design tools
- Compatibility with common standards: CPACS, Airbus "readability"



*K. Risse, E. Anton, T. Lammering, K. Franz, R. Hoenschemeyer. *An Integrated Environment for Preliminary Aircraft Design and Optimization.* In 8th AIAA Multidisciplinary Design Optimization Specialist Conference, 2012

CSR-01: Starting point and approach

Data specified by Airbus:

- MTOW = 77000 kg
- S_{ref} = 122,4 m^2
- Engines: 2 x V2527-A5
- SLST = 26500 lb

		Aircraft Characteristics	
		WV010	WV011
Maximum Takeoff Weight (MTOW)	Kilograms	77 000	75 500
	Pounds	169 756	166 449
Maximum Landing Weight (MLW)	Kilograms	64 500	66 000
	Pounds	142 198	145 505
Maximum Zero Fuel Weight (MZFW)	Kilograms	61 000	62 500
	Pounds	134 482	137 789

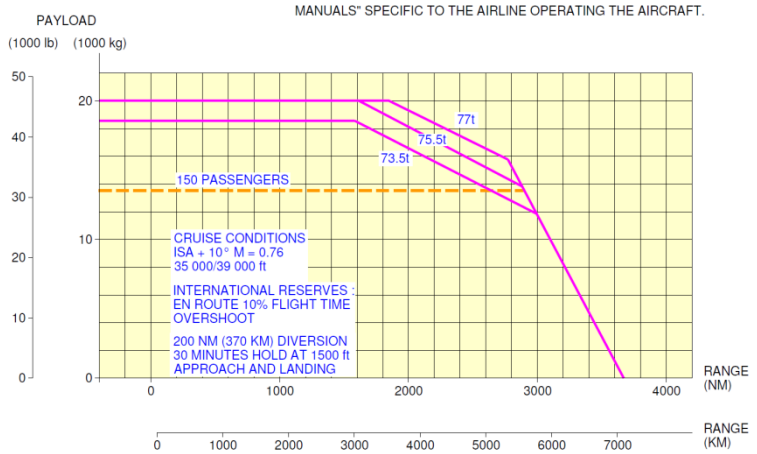
[Airbus, "A320 Aircraft Characteristics Airport and Maintenance Planning", 2012]

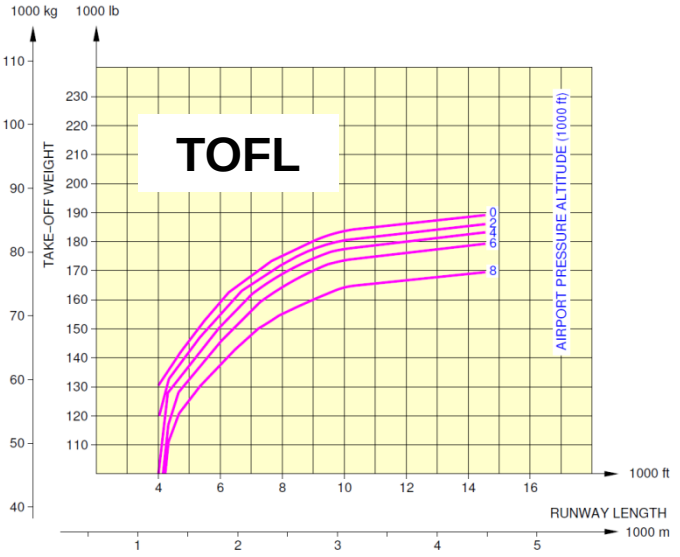
Derived data:

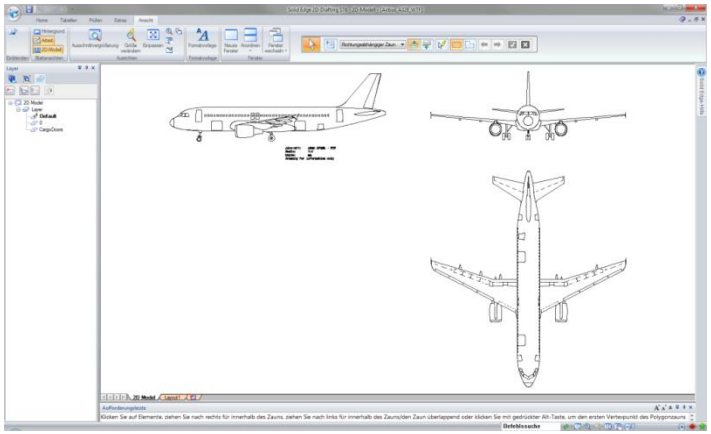
- Geometry from CAD 3-view, design masses from Airbus AC Characteristics
- TLARs and Key AC characteristics (e.g. design masses) derived from public available sources, e.g. Airbus AC Characteristics

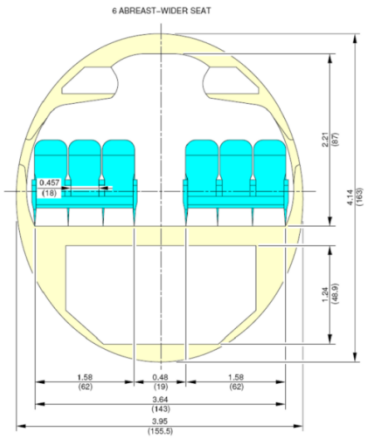
Creation of consistent OAD reference data by using ILR MICADO software

CSR-01: Plausibility checks against public data







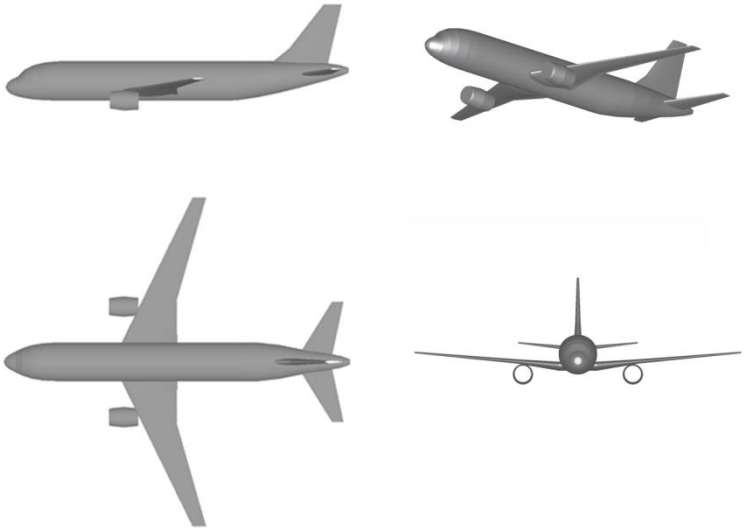


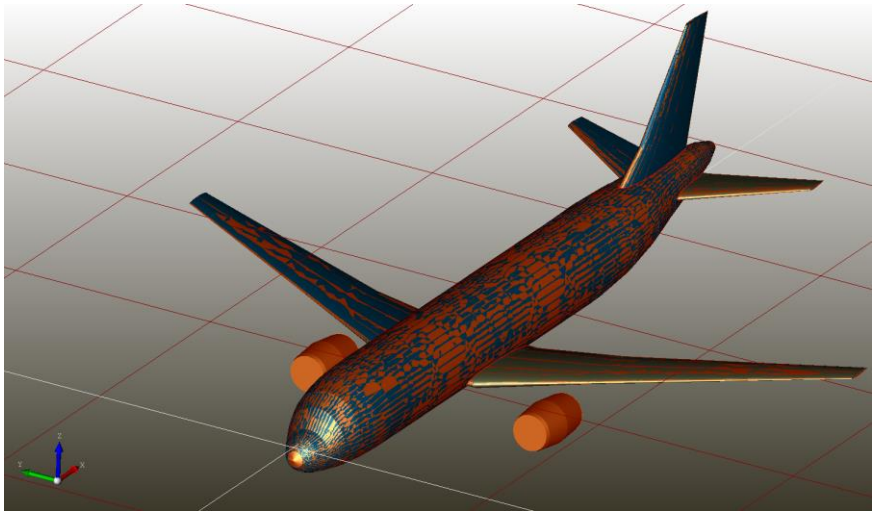
[Airbus, "A320 Aircraft Characteristics Airport and Maintenance Planning", 2012]

Comparison with CPACS geometry

Comparison with CPACS geometry data standard

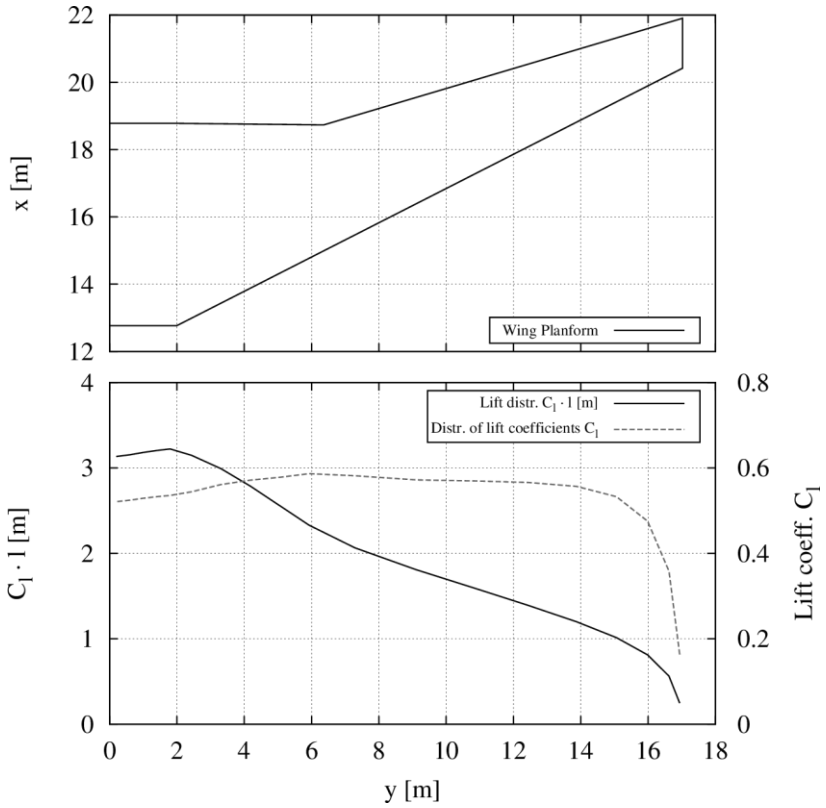
- Automated export of watertight .stp file from MICADO XML
- Automatic generation of CPACS XML file from MICADO XML
- Comparison of MICADO .stp file and CPACS XML file using DLR TIGL Viewer





CSR-01: Wing geometry and aerodynamics

CSR-01: C_l and lift distribution



Comparison for Do 728 [DLR-AS]

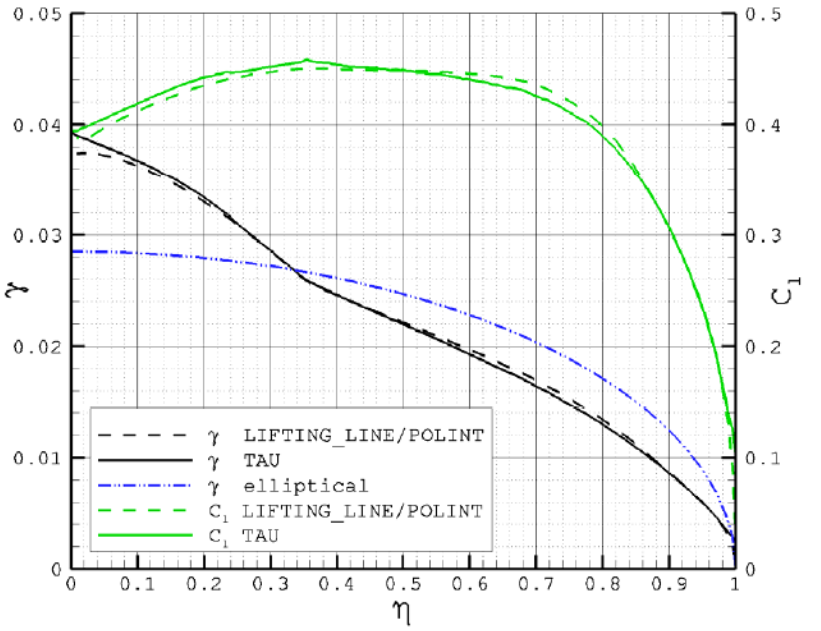


Figure 22. Do 728 wing: circulation distribution and lift coefficient distribution, Ma=0.78.

[Liersch, C., Wunderlich, T., "A Fast Aerodynamic Tool for Preliminary Aircraft Design", ISSMO, AIAA, 2008]

CSR-01: Verification of performance data

Climb performance data
(from BR to ICA, @ MTOW=77to, ISA)

- Time [min]: **24.6** (25.5)*
- BF [kg]: **1917** (1988)
- Range [NM]: **155** (160)

* **MICADO value** (from climb table)

A319/320/321 FLIGHT CREW OPERATING MANUAL	IN FLIGHT PERFORMANCE CLIMB	3.05.10 SEQ 120	P 3 REV 25

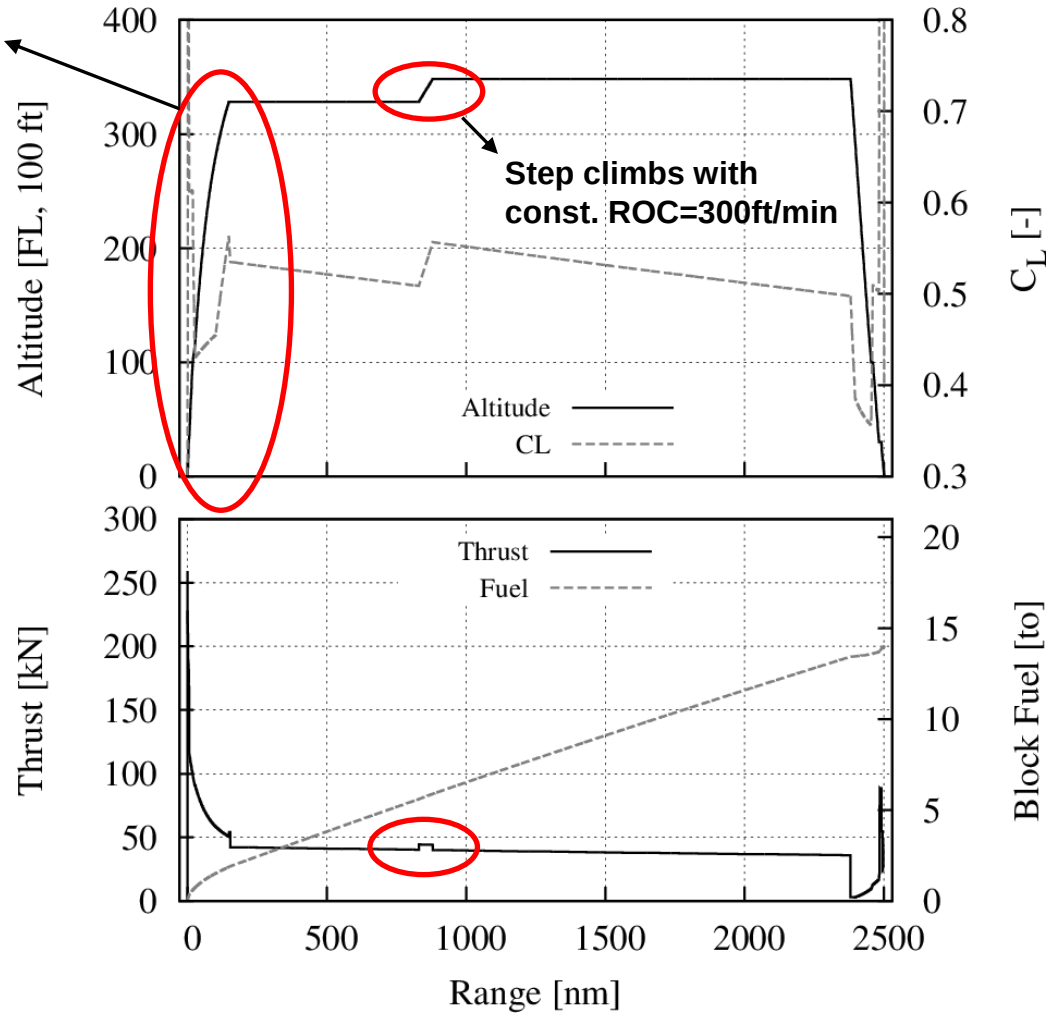
CLIMB - 250KT/300KT/M.78

MAX. CLIMB THRUST
NORMAL AIR CONDITIONING
ANTI-ICING OFF

ISA
CG=33.0%

FROM BRAKE RELEASE
TIME (MIN) FUEL (KG)
DISTANCE (NM) TAS (KT)

FL	WEIGHT AT BRAKE RELEASE (1000KG) 66	68	70	72	74	76	78
390							
370	24 1748 152 385	25 1851 163 387	27 1966 175 389	29 2096 190 391			
350	21 1619 132 377	22 1703 140 378	24 1794 149 380	25 1892 158 381	26 2000 169 383	28 2121 182 385	30 2258 196 388
330	19 1515 117 369	20 1589 124 370	21 1668 131 371	22 1751 138 373	23 1840 146 374	25 1935 155 376	26 2040 165 378
310	17 1419 104 361	18 1486 110 362	19 1556 115 363	20 1629 121 364	21 1706 128 365	22 1788 135 366	23 1876 142 368
290	16 1322 92 350	16 1382 96 351	17 1444 101 352	18 1510 106 353	19 1578 111 354	20 1649 117 355	21 1725 123 356



[Airbus, "Getting to Grips with Aircraft Performance", 2002]

CSR-01: Creation of sizing tables (example)

Creation of off-design and resizing sensitivities:

- Quick generation of sizing sensitivities using MICADO
  → usage by partners without own design tools
- Generation of complete and consistent OAD datasets for resizing sensitivities
  → derivation of 1 % tables

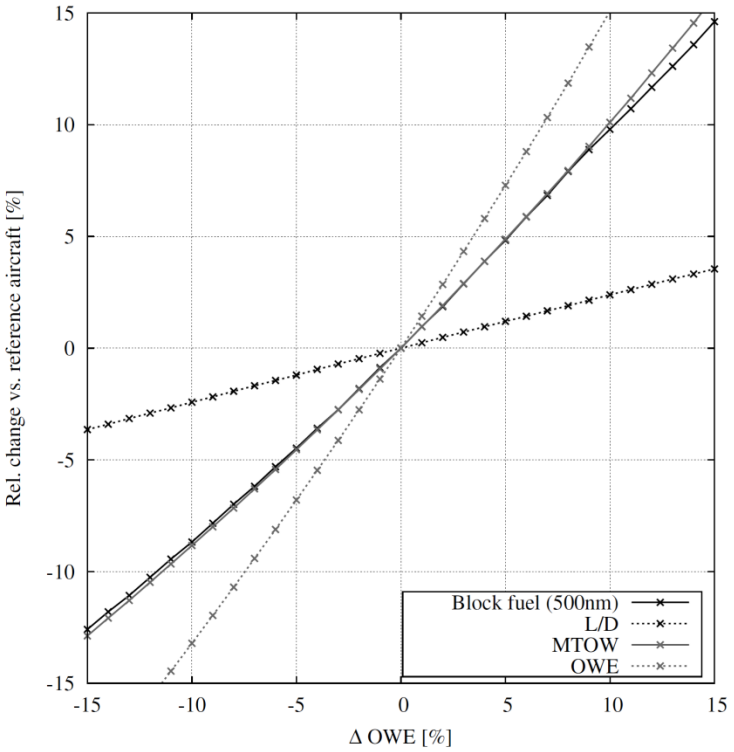


Table: Resizing sensitivities (1% tables)

Parameter	ΔOWE 1 %	ΔC_D 1 %	ΔSFC 1 %
wing area	0.95%	0.28%	0.34%
horizontal tail area	1.45%	0.43%	0.53%
vertical tail area	1.37%	0.42%	0.50%
SLST (per Engine)	0.95%	0.29%	0.34%
MTOW	0.96%	0.29%	0.35%
MZFW	0.97%	0.08%	0.10%
MLW	0.82%	0.25%	0.30%
OWE	1.43%	0.12%	0.14%
wing mass	5.93%	0.21%	0.24%
Block fuel @ SPP design mission	0.79%	1.03%	1.20%
Block fuel @ SPP study mission	0.96%	0.74%	1.10%

CeRAS online

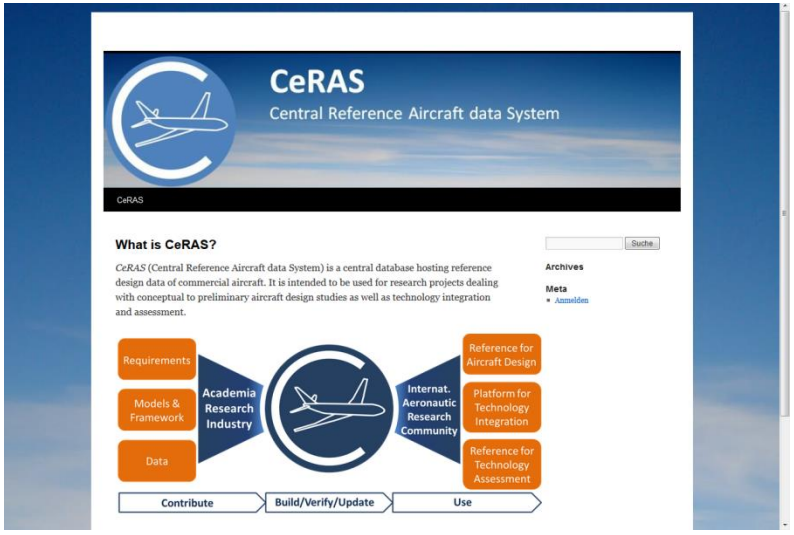
Presentation of reference data in the world wide web:

All reference data is stored and distributed by an internal server within the ILR. The server can be reached via

http://ceras.ilr.rwth-aachen.de/

Main characteristics:

- Accessibility and extensibility by a larger research and industrial community
- Complete, consistent and unique description of ref. A/C on OAD level
- Common standards for data exchange between industry and research partners



Where is CeRAS used so far?

Required effort for continuing CeRAS support

Creation of additional reference aircraft:

- Agreement on reference aircraft
- Agreement on TLARs and key aircraft characteristics
- Collection of reference data
- Aircraft design with MICADO (according to all TLARs and specifications)
- Verification with user group (including Airbus)
- Final design
- Upload to homepage w.r.t. CeRAS standards, styles, processes, …

Technical maintenance and administration of CeRAS homepage

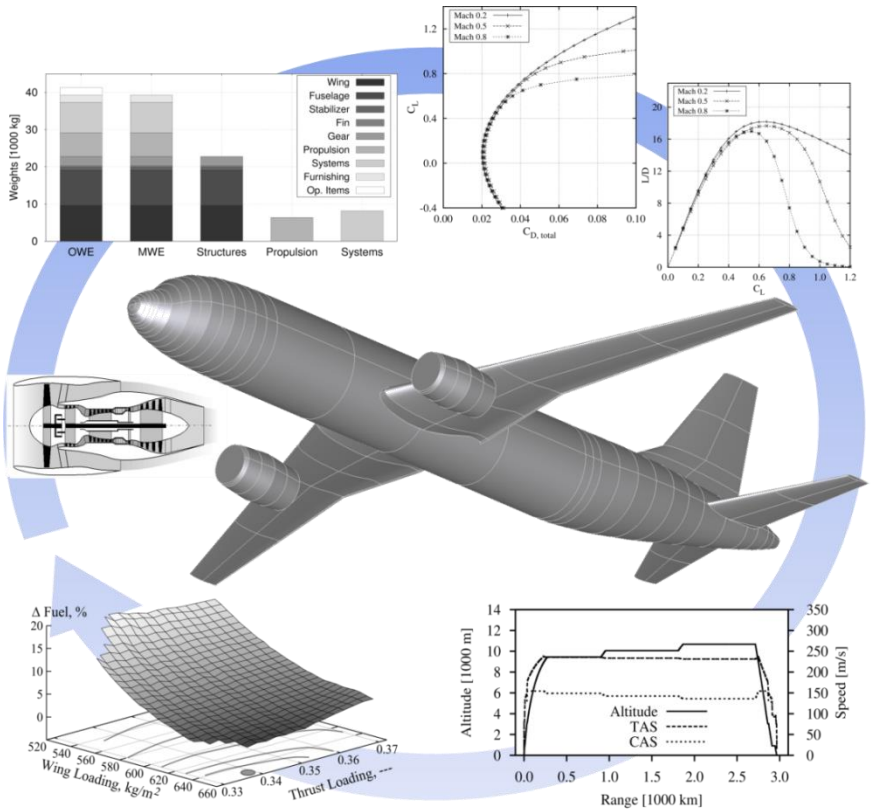
- Feedback from user group (contents, styles, feature requests, errors, …)
- Update of design data
- Communication with RWTH IT Center
- Security standards (update of software components, …)
- Hardware maintenance
- Guarantee of permanent homepage access

Summary and next steps

- **Reference a/c database (CeRAS) for research community created:**
  - Sponsored by Airbus in a half year pilot project
  - First reference a/c designed → CSR-01 (research version)
  - Standardized data and processes defined for usage of database
  - Homepage on internal server → V&V environment for research community

- **Next steps:**
  - Agreement on long range aircraft (e.g. Airbus A330, Boeing B777, …)
  - Meeting with research community for discussion of CeRAS homepage (Meeting location?, participants?)
  - “list of experts”
  - Make CeRAS detectable by Google
  - **Use and enhancement of CeRAS in national and international research projects**

Thank you for your attention!



Questions?

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