An Outlook on DLR's SBW activities

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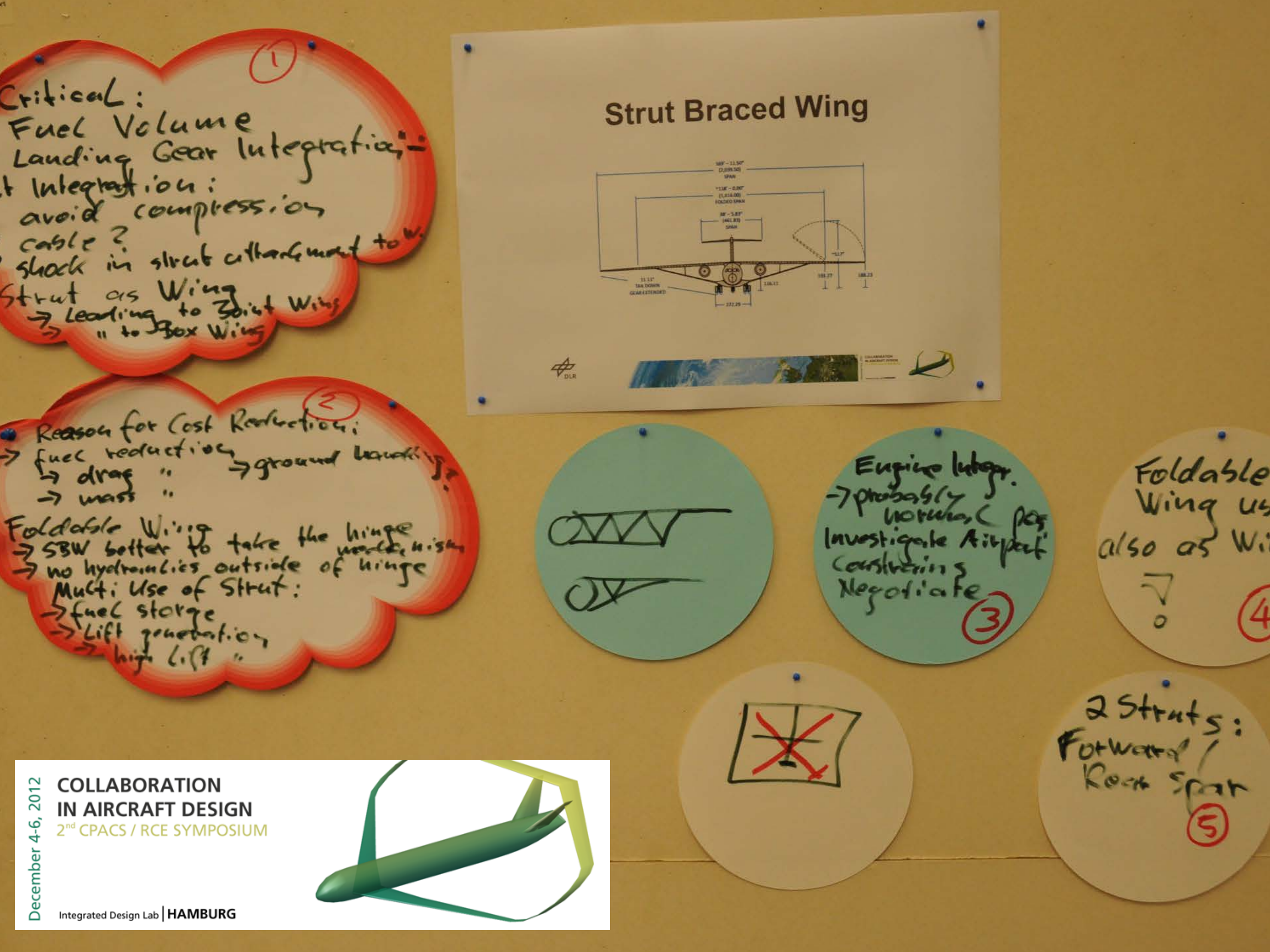
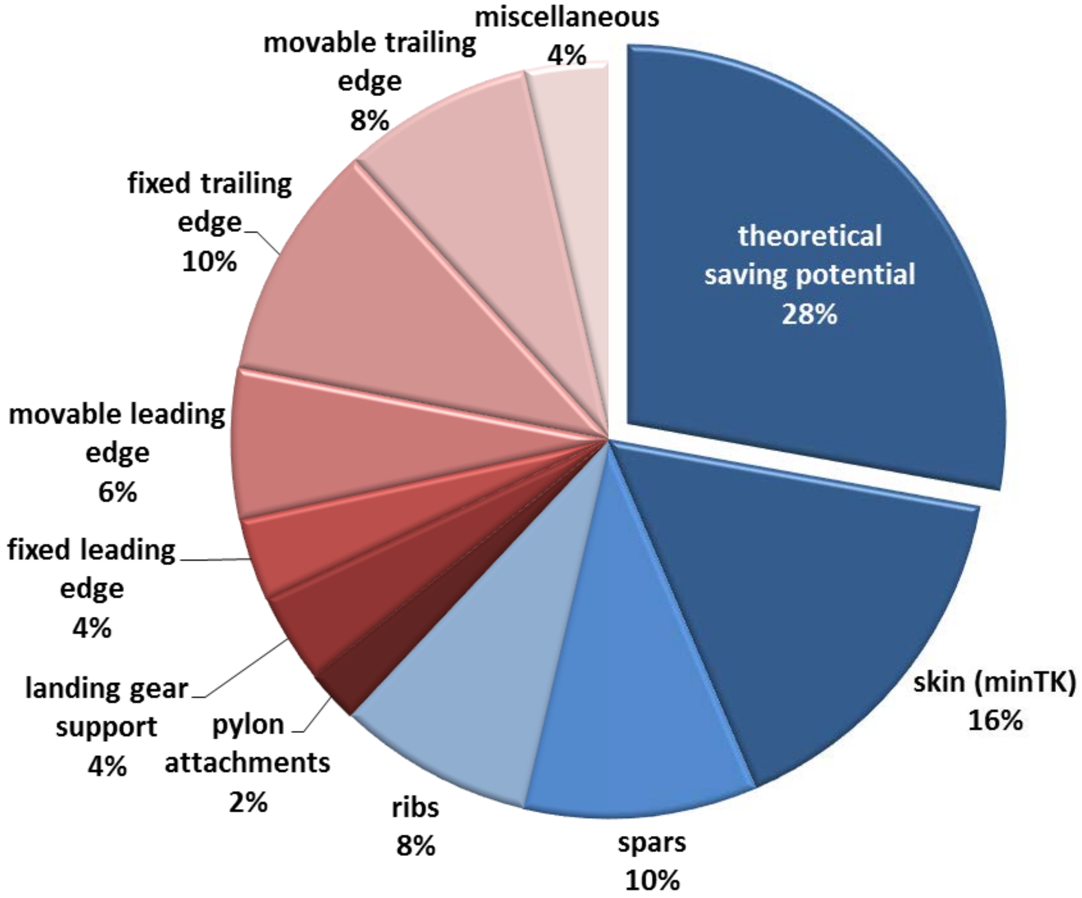
DLR


Strut Braced Wing
DLR
Critical:
Fuel Volume
Landing Gear Integration
Integration:
avoid compression
cable ?
shock in strut attachment to W.
Strut as Wing
→ Leading to Joint Wing
→ " to Box Wing
Reason for Cost Reduction:
→ fuel reduction
→ drag "
→ mass "
→ ground handling ?
Foldable Wing
→ SBW better to take the hinge mechanism
→ no hydraulics outside of hinge
Multi Use of Strut:
→ fuel storage
→ Lift generation
→ high lift "
Engine Integr.
→ probably normal pos.
Investigate Airport Constrains
Negotiate
Foldable Wing also as Wi
2 Struts:
Forward / Rear Spar
COLLABORATION
IN AIRCRAFT DESIGN
2nd CPACS / RCE SYMPOSIUM
December 4-6, 2012
Integrated Design Lab | HAMBURG

Mass distribution D150



ONERA Strut Braced Wing

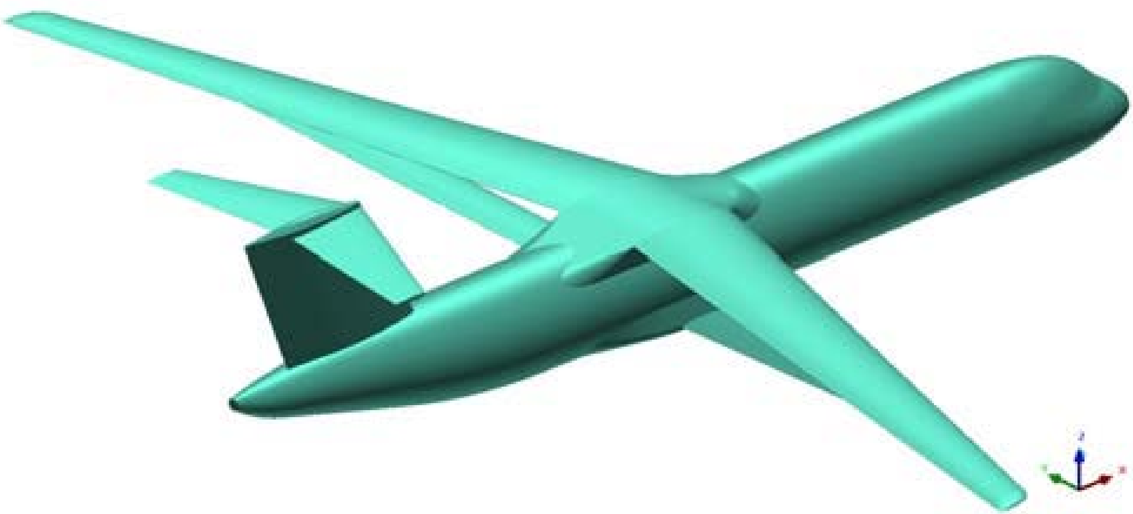
- Wing reference area
  122.4 m^2 → 160 m^2

- Aspect ratio
  9.6 → 16

- Wing thickness
  13% → 10%

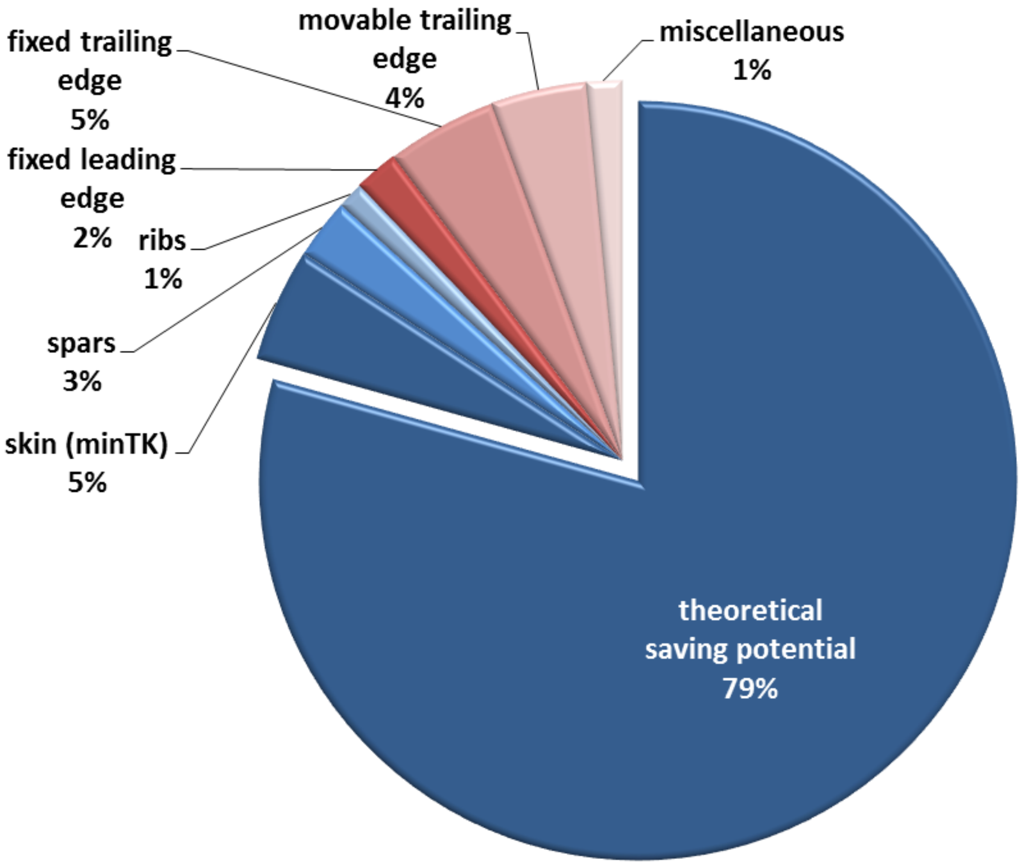
- MTOM
  77000kg → 78000

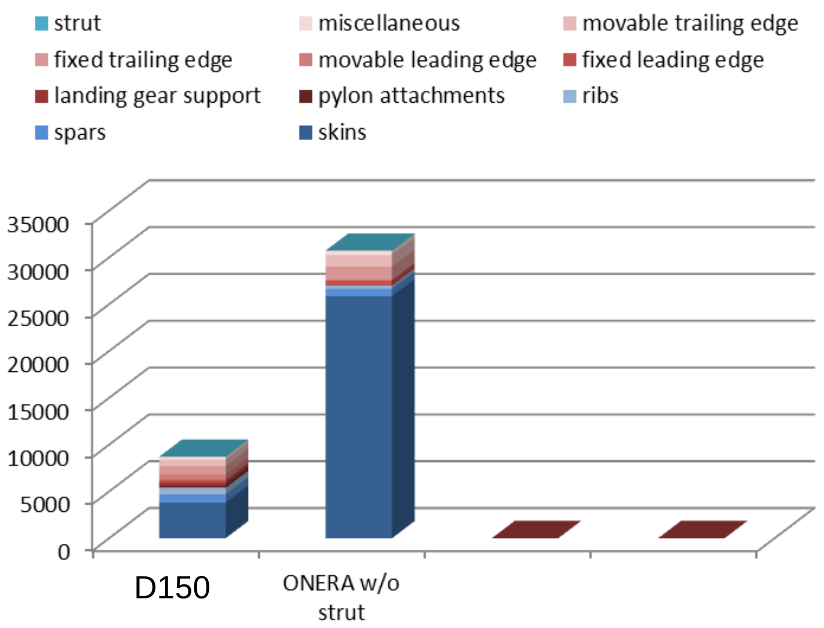
- Cruise Mach
  0.78 → 0.75



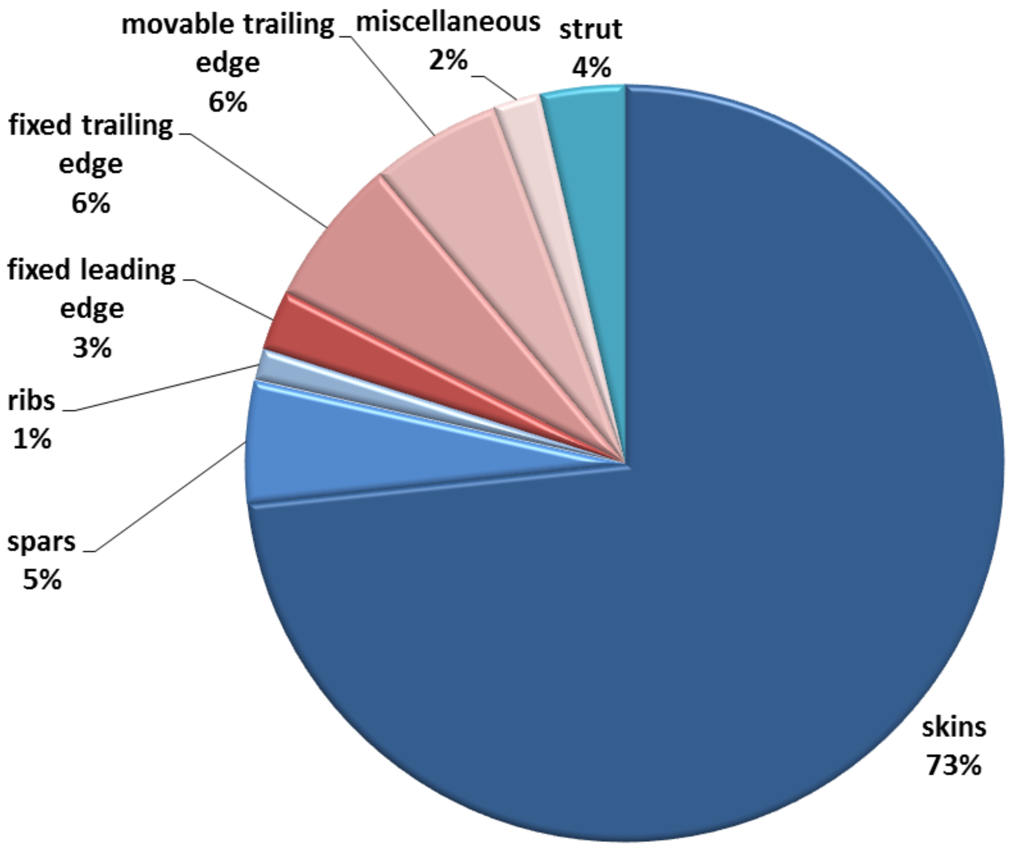
Mass distribution Albatros

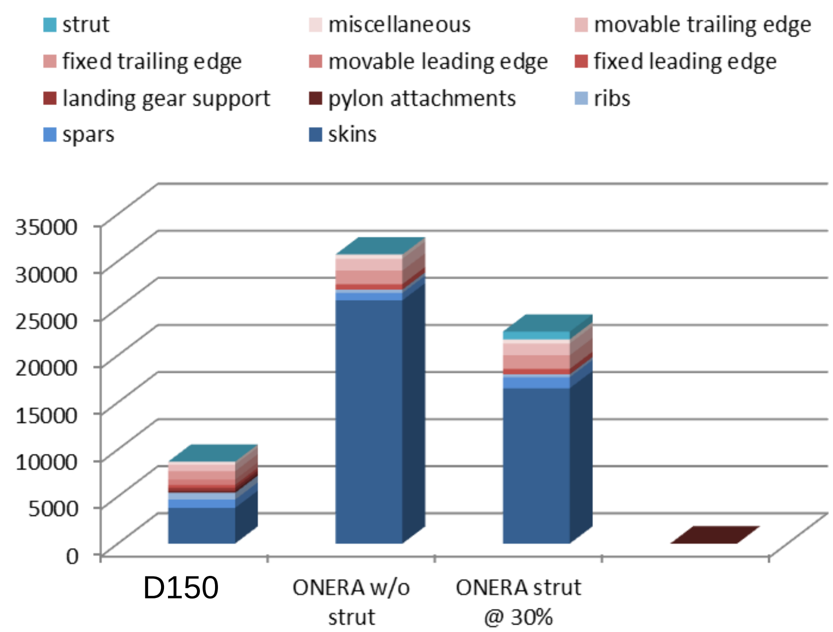
without strut



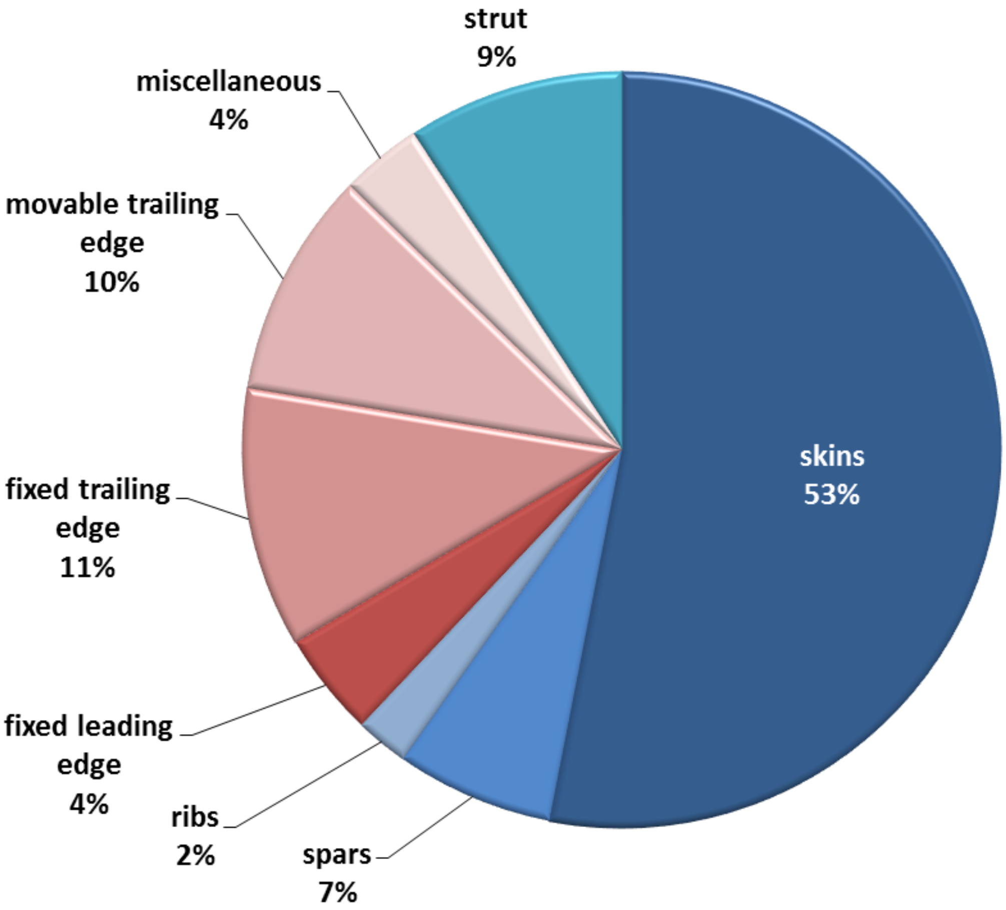


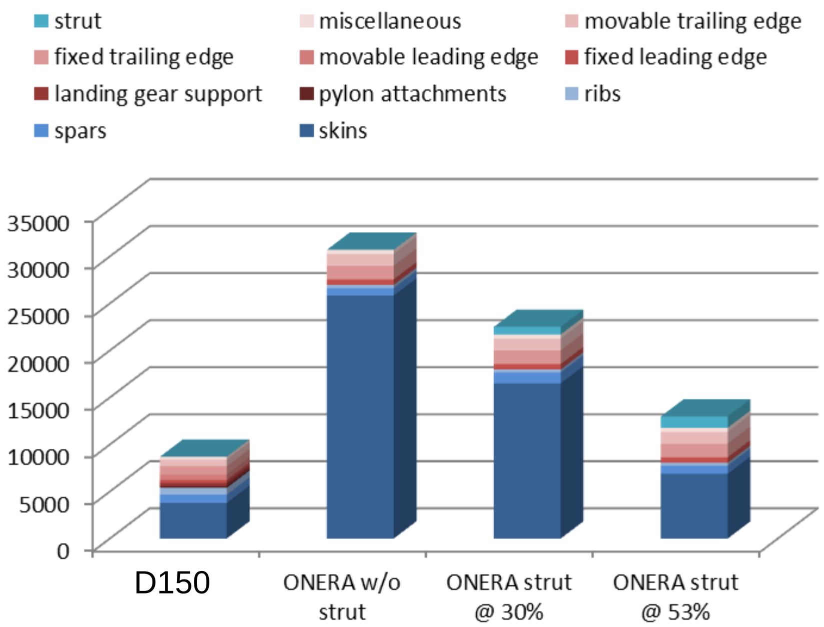
Mass distribution Albatros
strut @ 30% span



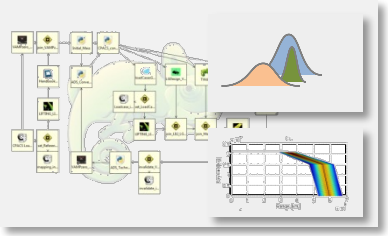


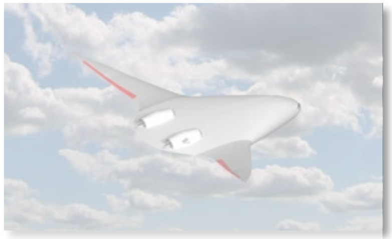
Mass distribution Albatros
strut @ 53%

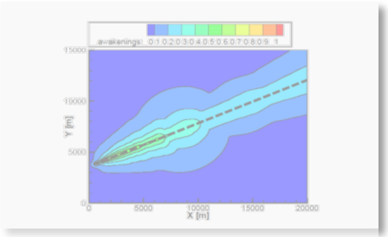




FrEACs: Future Enhanced Aircraft Configurations

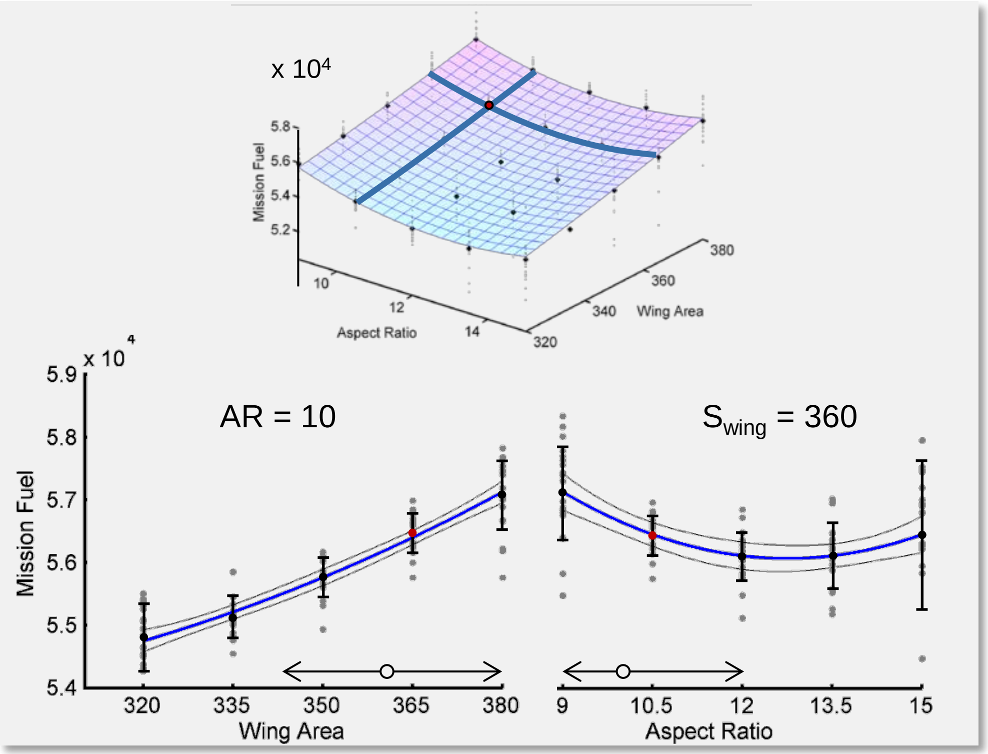




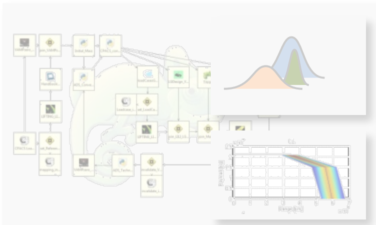


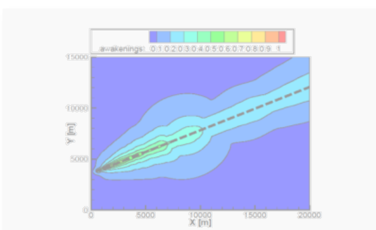
1

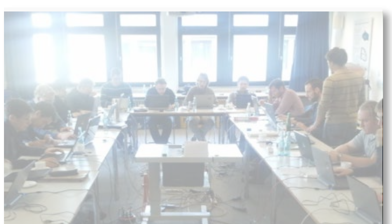
Level of confidence in the design process



FrEACs: Future Enhanced Aircraft Configurations

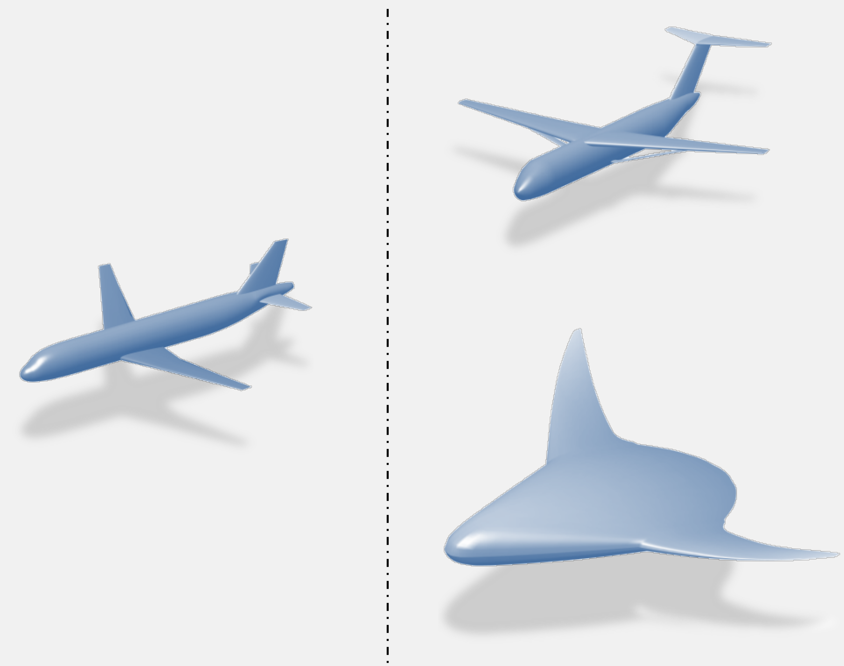




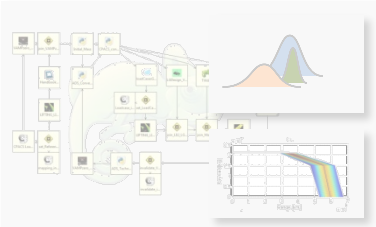


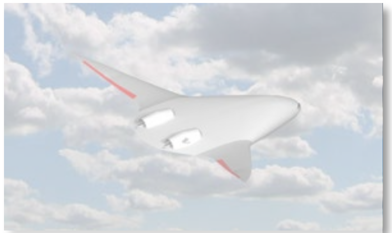
2

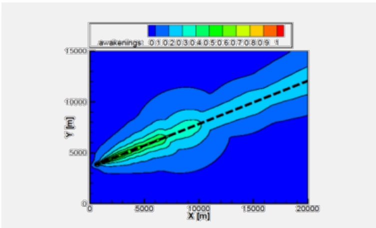
Unconventional configurations



FrEACs: Future Enhanced Aircraft Configurations

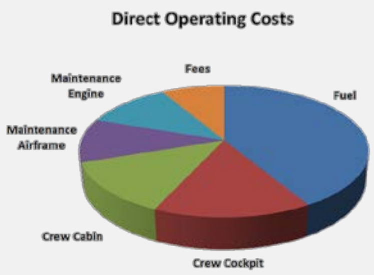


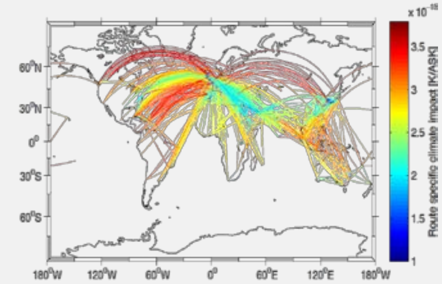


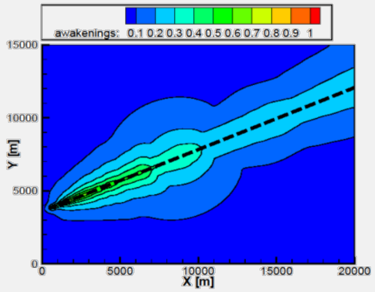


3

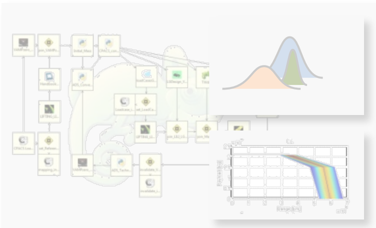
Assessment of environmental impact

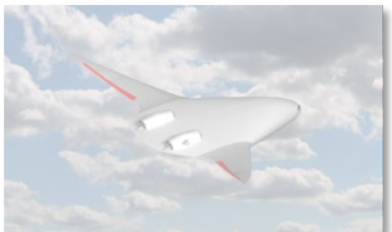


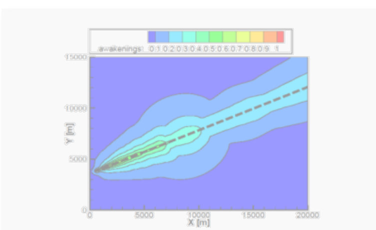




FrEACs: Future Enhanced Aircraft Configurations

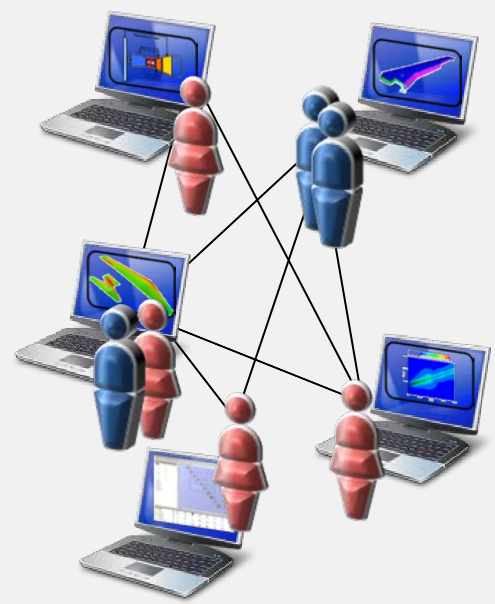


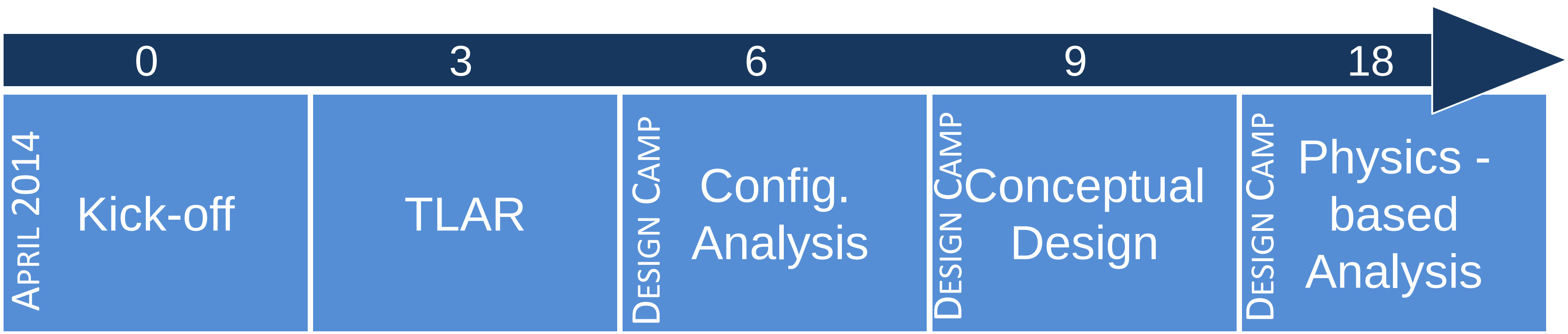




4

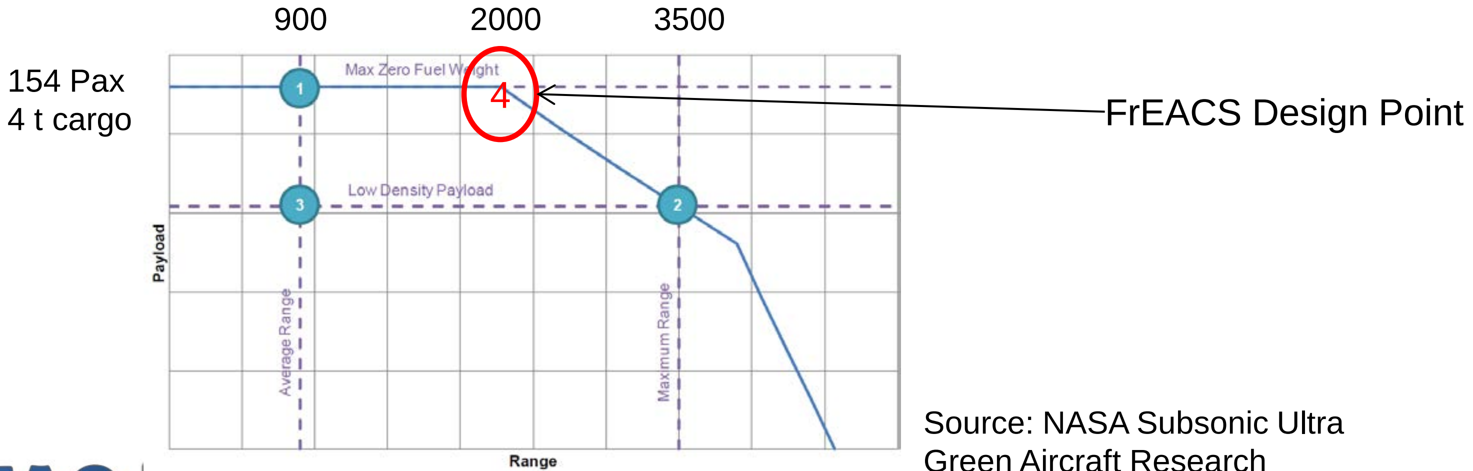
Holistic design process




0
3
6
9
18
April 2014
Kick-off
TLAR
Design Camp
Config. Analysis
Design Camp
Conceptual Design
Design Camp
Physics - based Analysis

TLAR Values

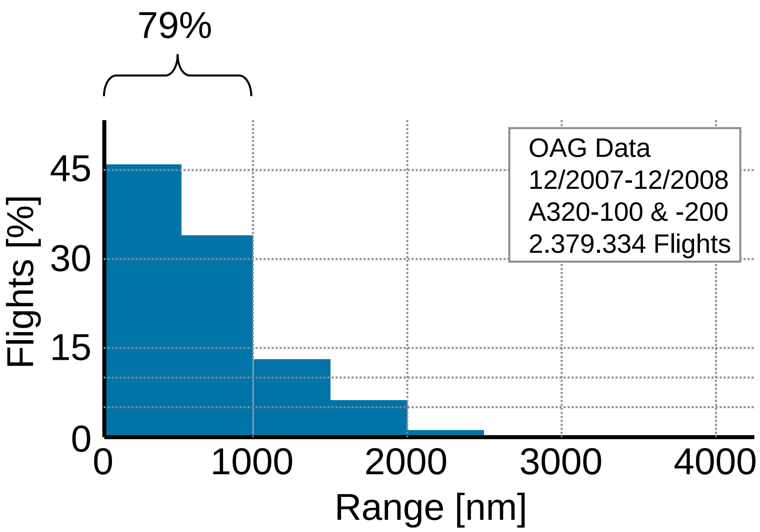
Category	Name	Unit	Description	Operator	SBW	Reason / Explanation
payload	**#Pax**	**[-]**	**number of passengers**	**=**	**154 (single class layout , 95 [kg] per passenger)**	• **Boeing CMO 2030 Aircraft Fleet Information** • **Mean Value for Mid-Range Aircraft** • **Airbus Global Market Forecast states similar values**
	m_{cargo}	[t]	amount of cargo	=	4	• A320 payload 18.6 t • NACRE payload is 180pax → 17.1t • Using cargo from payload of A320



Source: NASA Subsonic Ultra Green Aircraft Research

TLAR Values

Category	Name	Unit	Description	Operator	SBW	
payload	#Pax	[-]	number of passengers	=	154 (single class layout , 95 [kg] per passenger)	
	m_{cargo}	[t]	amount of cargo	=	4	
range	**range capability**	**[nm]**	**maximum range (at given payload capacity)**	**>**	**2000**	**79% of actual A320-Flights are less than 1000nm [OAG Data 12/2007-12/2008]**



TLAR Values

Category	Name	Unit	Description	Operator	SBW	Reason / Explanation
airport compatibility	ICAO Class		airport class (only max. airport box dimensions and max. landing gear wheel track taken into account)		ICAO Code C	
	b	**[m]**	**maximum wing span**	**<**	**36**	**ICAO Code C**
	t_{wheel}	[m]	maximum wheel track width	<	9	ICAO Code C (6-9)
	runway loading	-	maximum loading of the runway for rigid pavements cat. A	<	50	Typical value of B737 and A320 for rigid pavement subclass A
	TOFL	**[m]**	**take-off field length (@MTOW, SL, ISA + 15deg)**	**<**	**2100**	**TOFL: 75% of airports have TOFL > 2072m (all airports with DME(distance measurement equipment) CAT 1)**

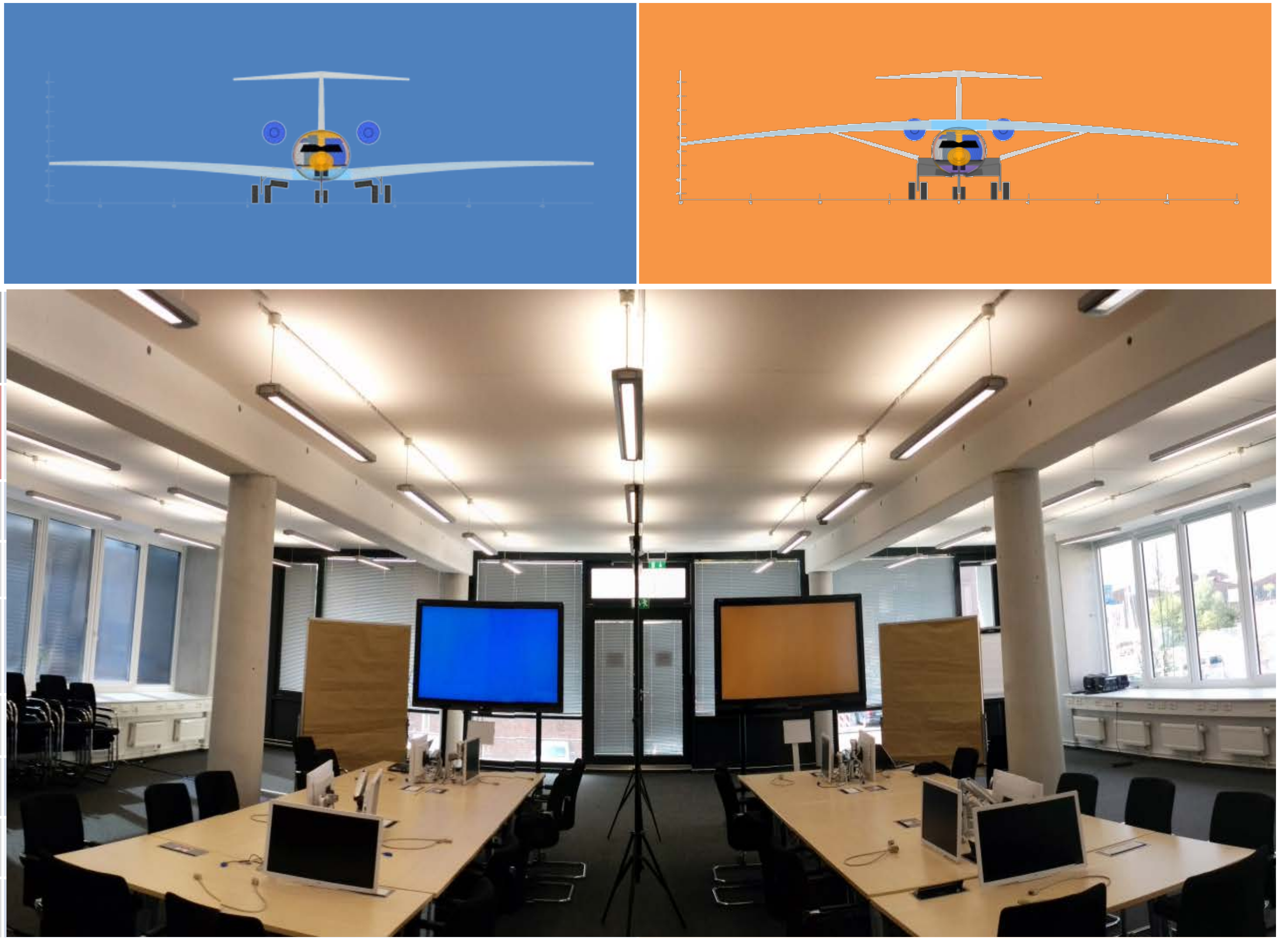
TLAR Values

Category	Name	Unit	Description	Operator	SBW	Reason / Explanation

performance targets	M	[-]	Mach number in cruise at ICA	=	**0.72**	• NACRE 0.74 – 0.76
						• NASA N+3 Aircraft Concepts and Designs:
						    • 0.7 suggested by Boeing Current Market Outlook
						    • Also used 0.74
						• ONERA 0.75
						• Airbus LDA (Low Drag Aircraft)
						    • M0.75 @ 20° sweep
						    • M0.75 @ 16° sweep
						    • M0.74 @ 7° sweep
						• Lamair 0.78 @ ICA 10.500 m
						• Often outcome of optimization process

DESIGN CAMP Configuration Analysis

- Operators
- Prozess Integration
- Aerodynamic
- Structures/Aeroelastic
- Engines
- Mission
- Systems
- Landing Gear
- Assessment

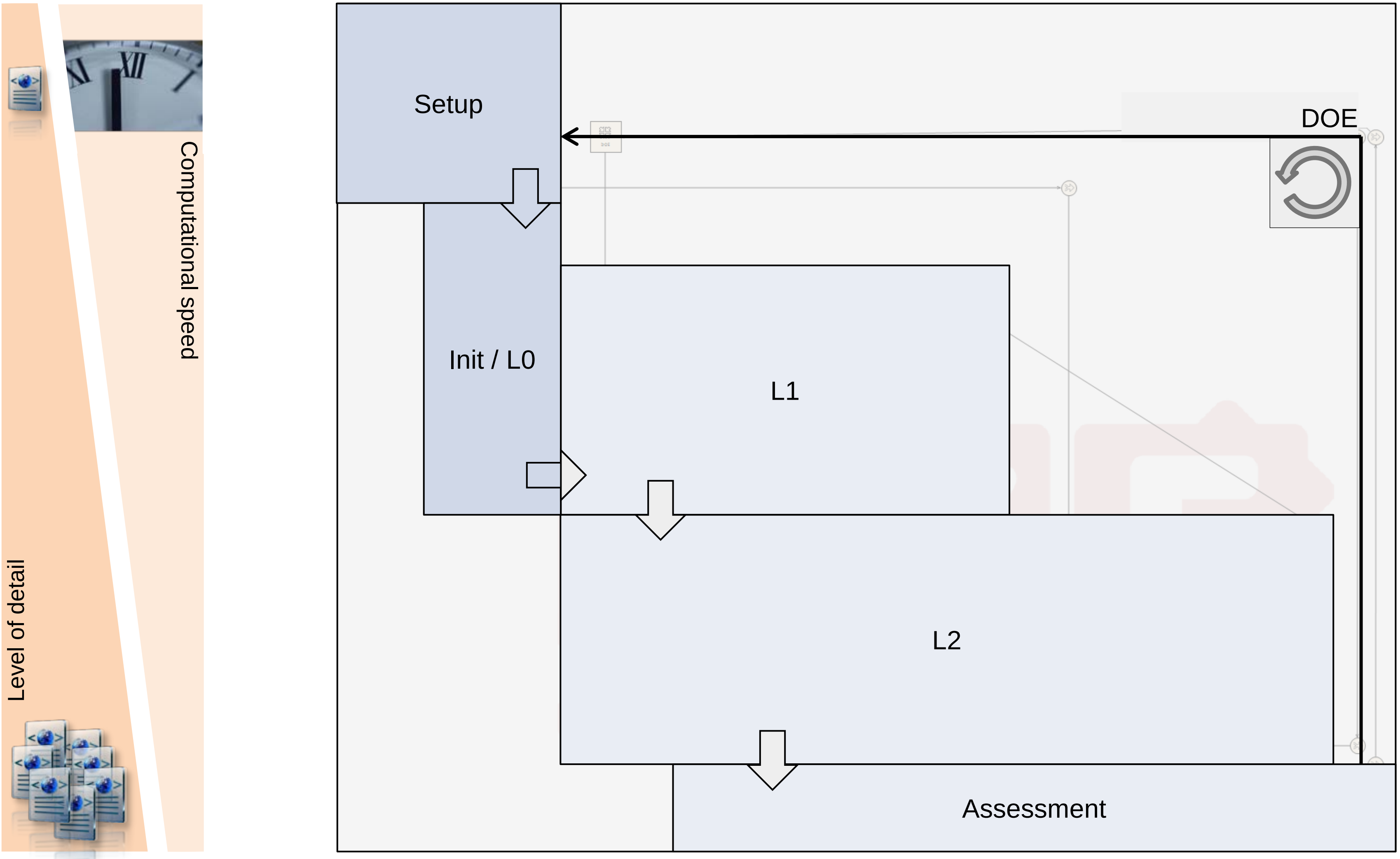


1	connection in initialisation phase
i	input connection in interative phase
f	feedback connection in iterative phase
e	connection in evaluation phase

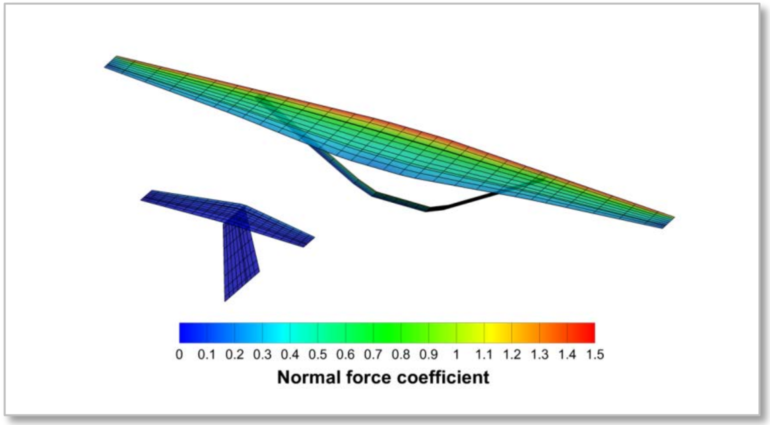
Dependencies - N2 Chart

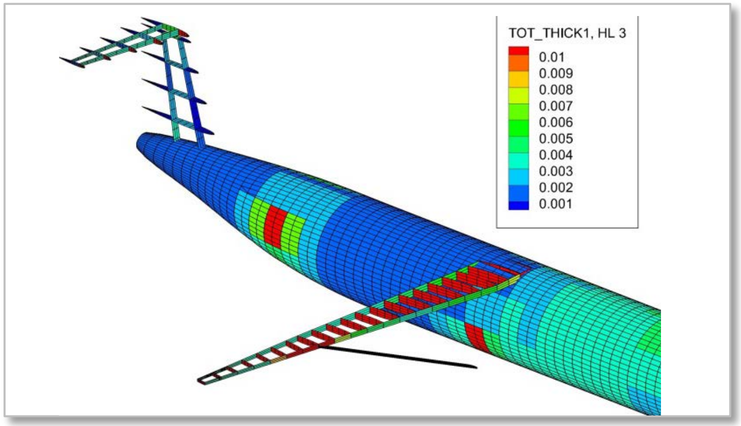
TLAR			TLAR								
	FuCD		Fuselage, Payload				Secondary mass fuselage, payload	Payload		Secondary mass fuselage, payload	
		TWDat	Engine mass and SFC					Engine mass and SFC		Engine mass and SFC	
			VAMPzero	Geometry	Structures, Geometry	Geometry	Structures, Geometry, Mass Breakdown	Mass-Breakdown	Control Surfaces	Mass-Breakdown	
				Liftingline & Handbook-Aero			Aero Loads	Aero Performance			
					PESTsewi		Secondary wing mass			Secondary wing mass	
						WingMass Surrogate				Primary mass wing	
							DELiS			Primary mass aircraft	
		Engine scaling	Trip Fuel					**FSMS**			Trip Fuel
									Paradise	System Design	
			Mass-Breakdown							**CMU**	

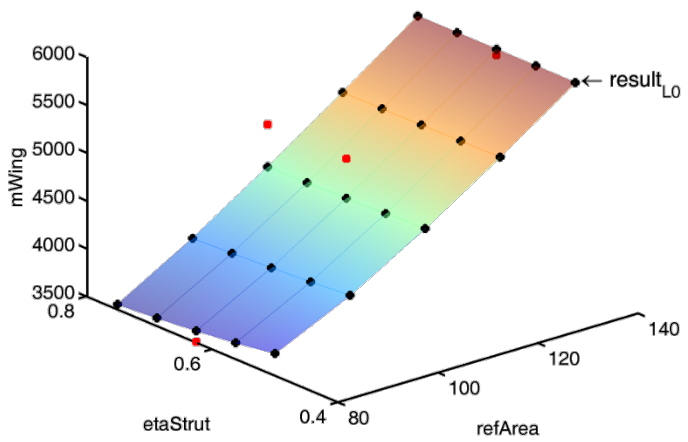
Workflow Principle

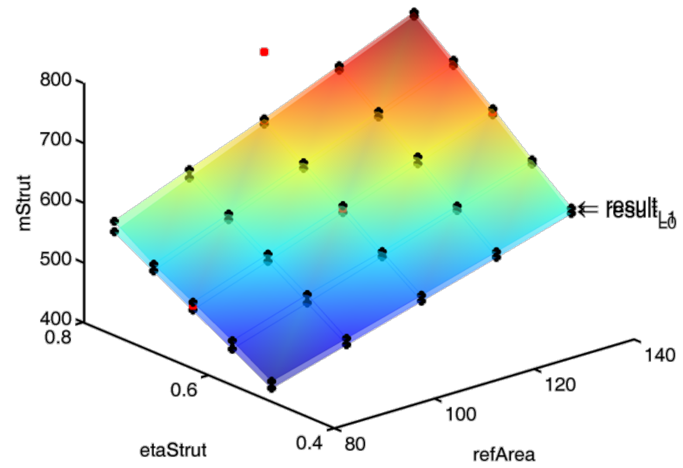


Results: Team Orange









DESIGN CAMP Conceptual Design

DESIGN CAMP Conceptual Design

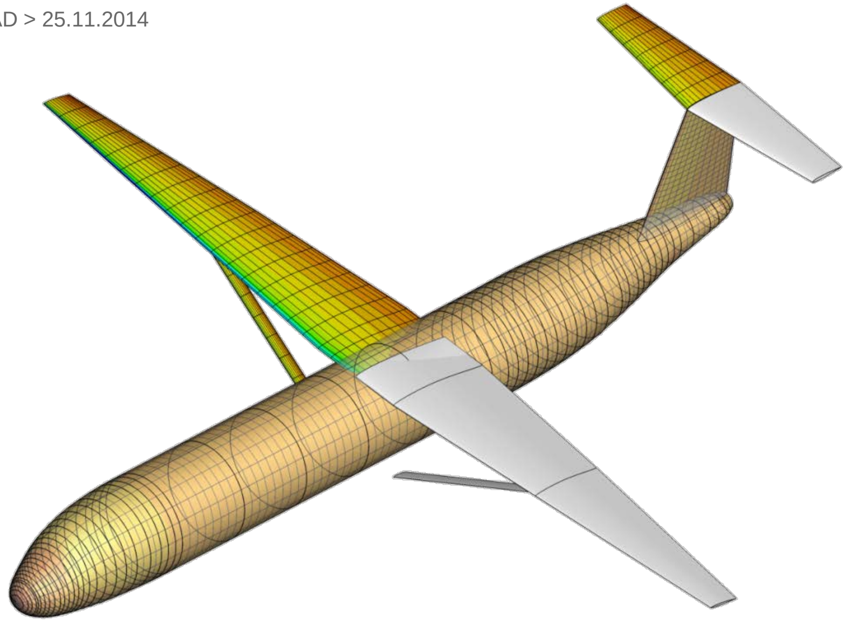
- Evaluate design alternatives
- Limited to conceptual design knowledge
- Target function becomes significant
- Technology vetos

		Trade-off criteria								
		Fuel Efficiency	Maintainability	Design Complexity	Capacity	Noise	Turnaround	Mission Flexibility	"Wildcard"	Score
Weight factor		70%	20%	18%	16%	10%	10%	3%	5%	152%
Configuration: Engine(Pusher) on Wing	Landing Gear on Wing	Reason 2	0	0	0	0	0	0	0	1,4
Engine(Pusher) on Wing	Landing Gear on Engine	Reason 1	0	0	0	0	0	0	0	0,7
	Landing Gear on Engine	Reason 0	0	0	0	0	0	0	0	0
Engine on Tail	Landing Gear on Fuselage	Reason -2	0	0	0	0	0	0	0	-1,4
Engine on Tail	Landing Gear on Wing	Reason 0	0	0	0	0	0	0	0	0
Wildcard	Wildcard	Reason 0	0	0	0	0	0	0	0	0

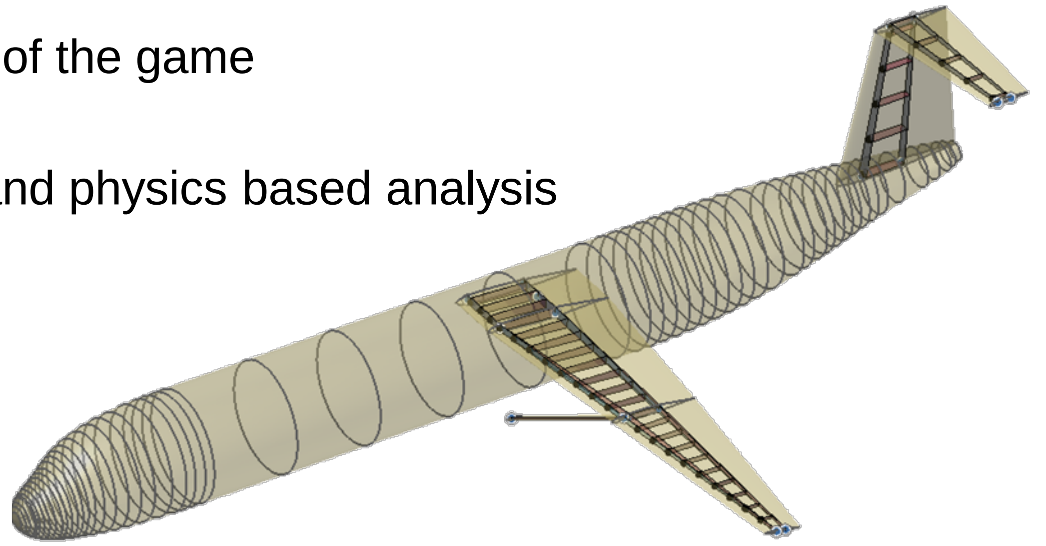
Legend:

2	major Improvements
1	minor Improvements
0	Comparable to D150
-1	minor Drawbacks
-2	major Drawbacks (obvious Killer)

Conclusion & Outlook



- Conceptual design phase
  - Preliminary results
- Combined engine and aircraft development
- 36m span boundary limits the design significantly
- Target function changes the name of the game
- Looking forward to design freeze and physics based analysis

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Thank you for your attention!