

# Collaborative understanding of disciplinary correlations using a low-fidelity physics based aerospace toolkit

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Richard-Gregor Becker

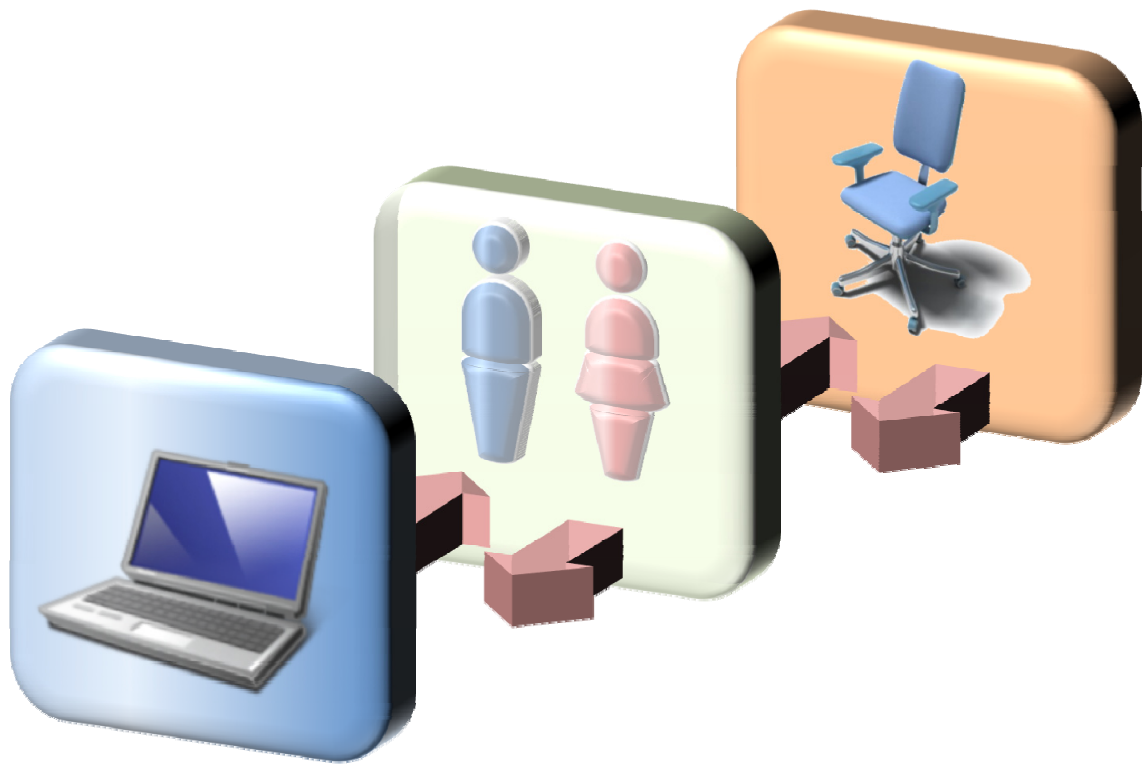
Björn Nagel

<http://ewade2013.AircraftDesign.org>  
<http://dx.doi.org/10.5281/zenodo.546610>

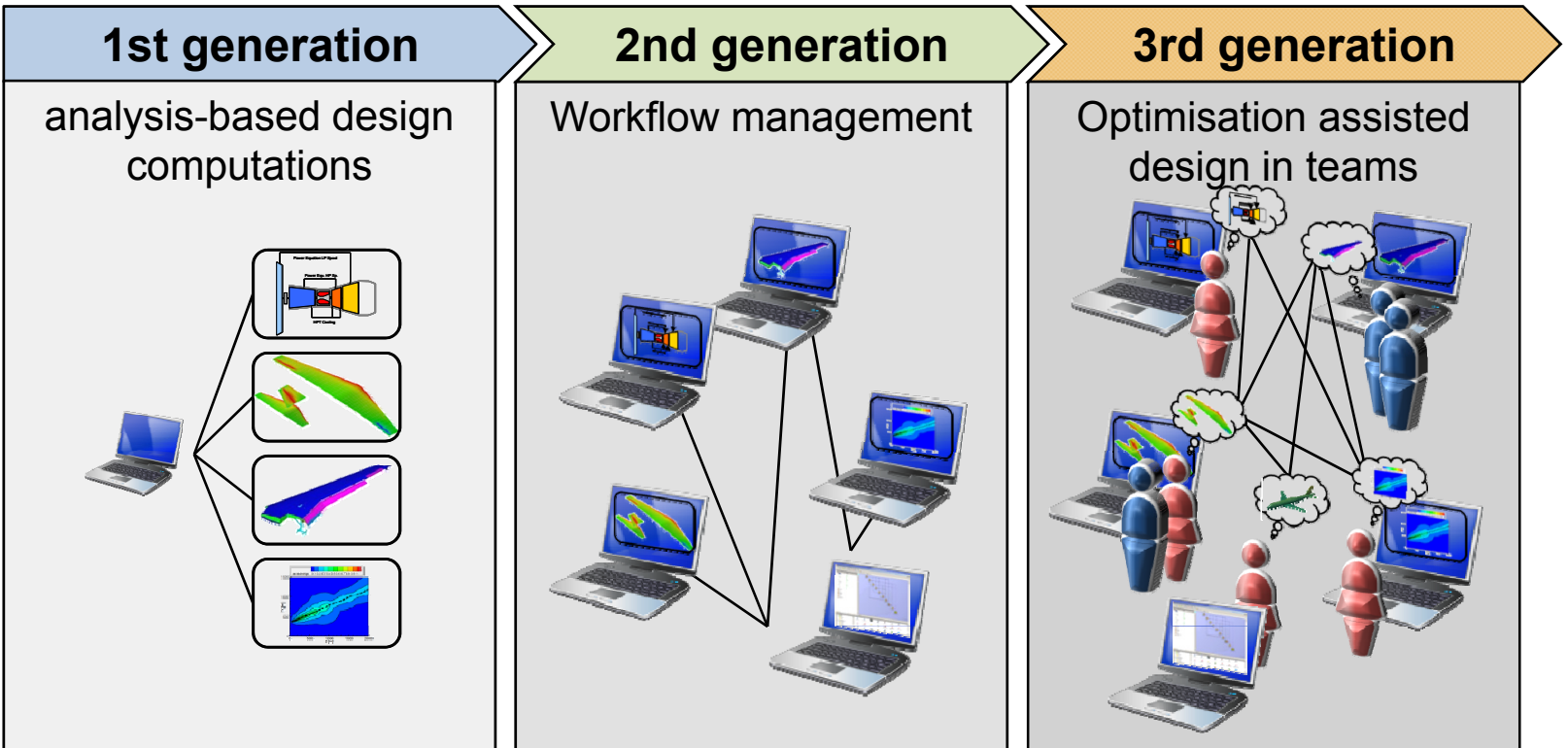
4<sup>th</sup> CEAS Air & Space Conference  
16<sup>th</sup>-19<sup>th</sup> September 2013  
Linköping



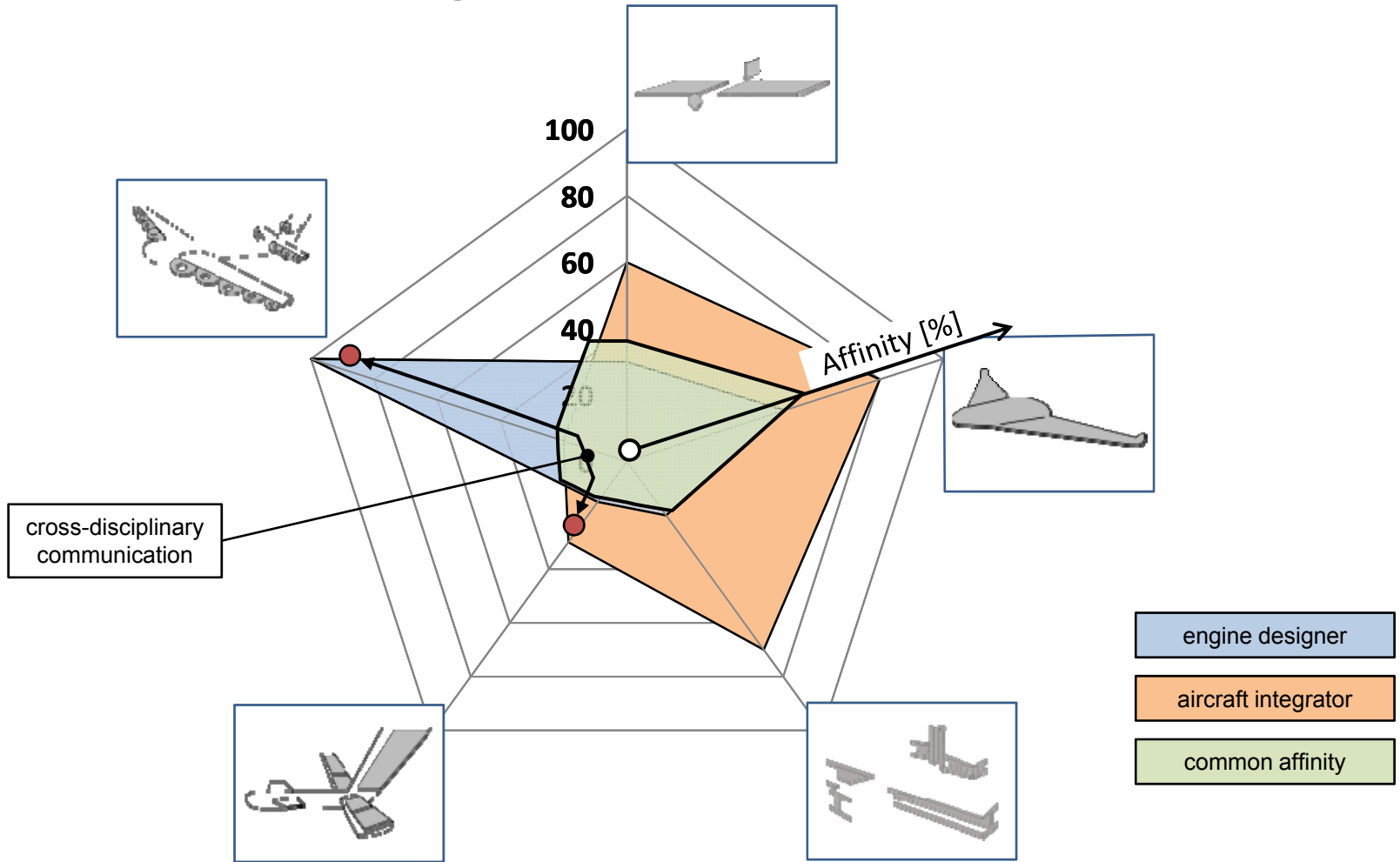
Knowledge for Tomorrow



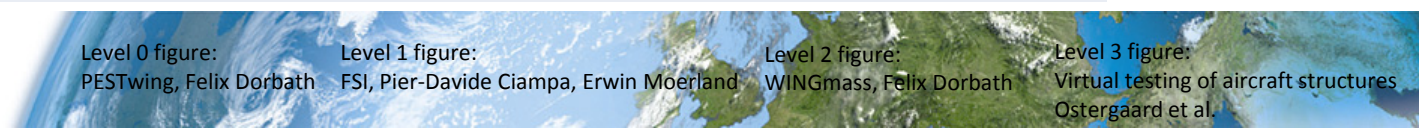
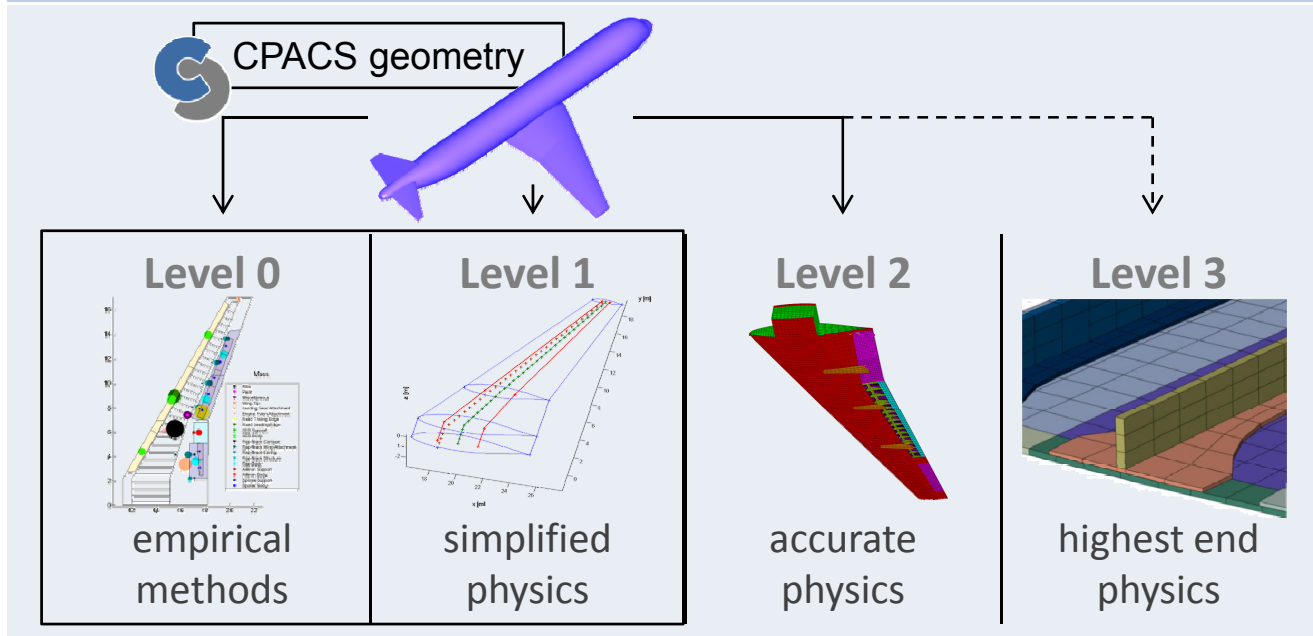
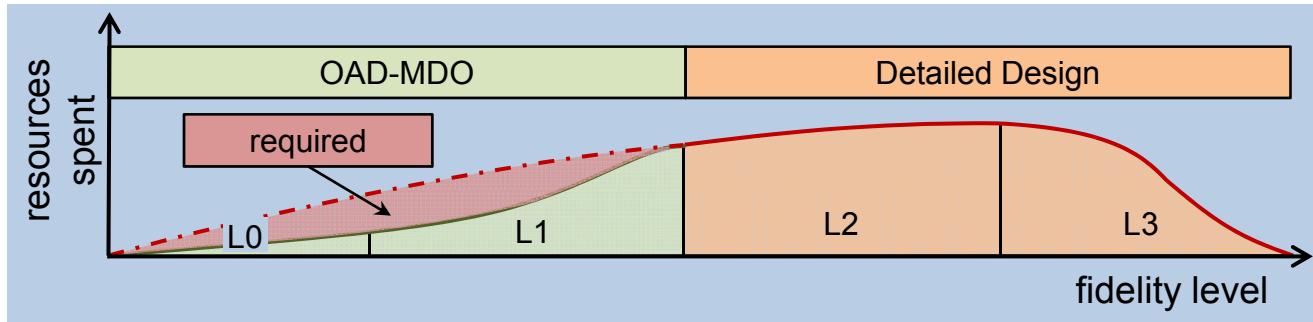
# Advancements in MDO



# Cross-disciplinary communication



# Low-level toolkit



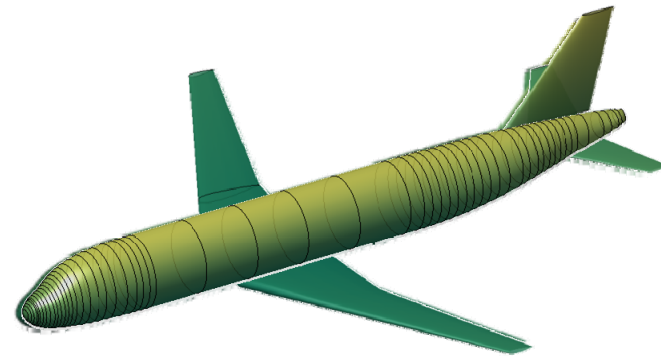
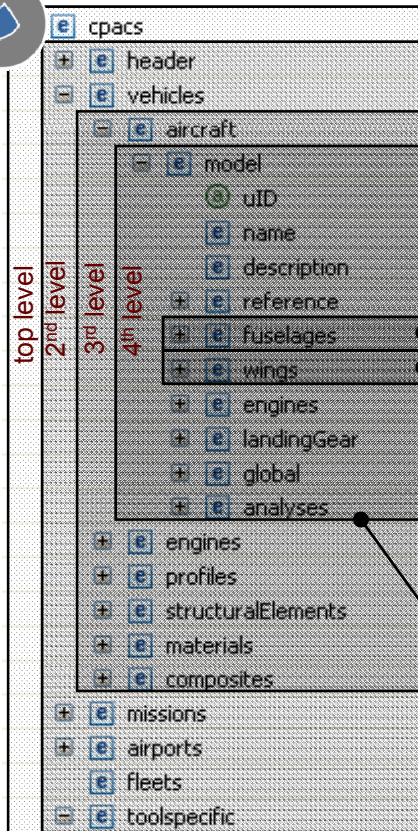
Level 0 figure:  
PESTwing, Felix Dorbath

Level 1 figure:  
FSI, Pier-Davide Ciampa, Erwin Moerland

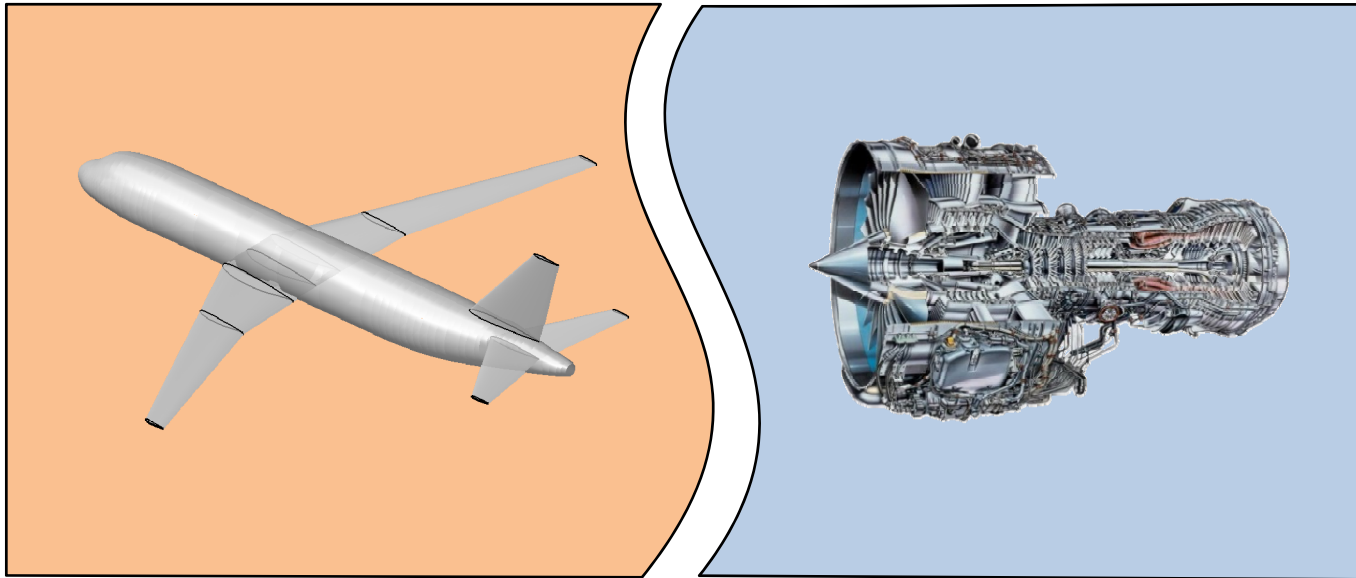
Level 2 figure:  
WINGmass, Felix Dorbath

Level 3 figure:  
Virtual testing of aircraft structures  
Ostergaard et al.

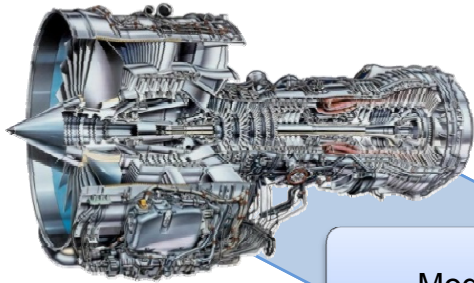
# Common Parametric Aircraft Configuration Scheme - CPACS



# Interactive aircraft and engine design



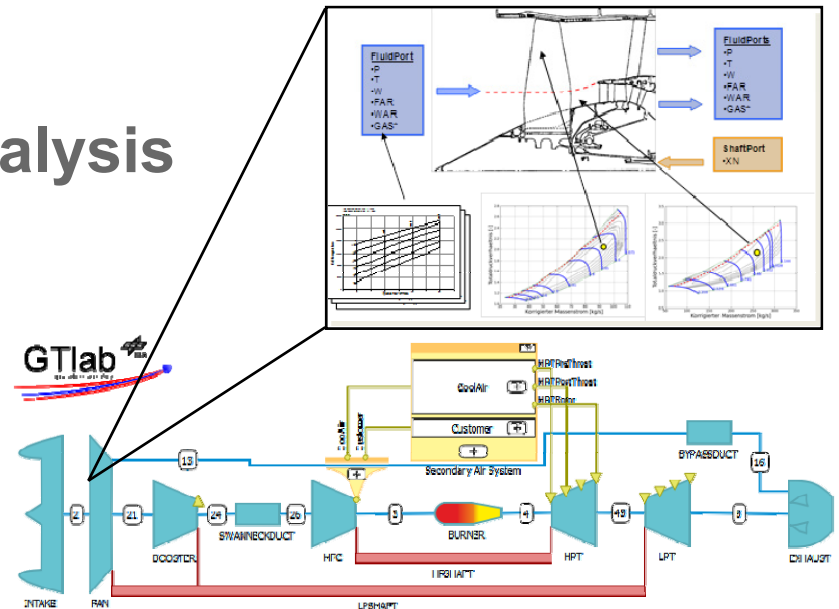
# Engine data for aircraft analysis



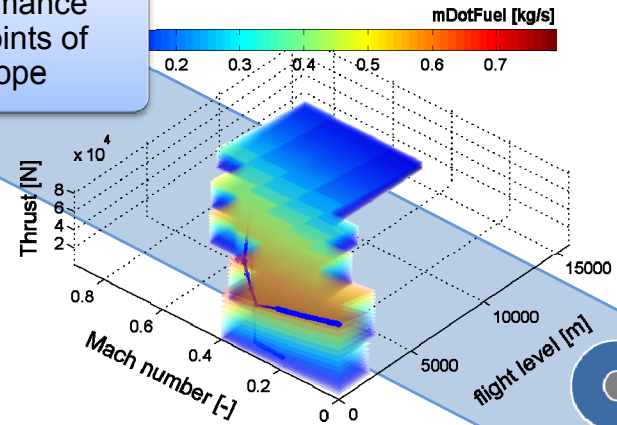
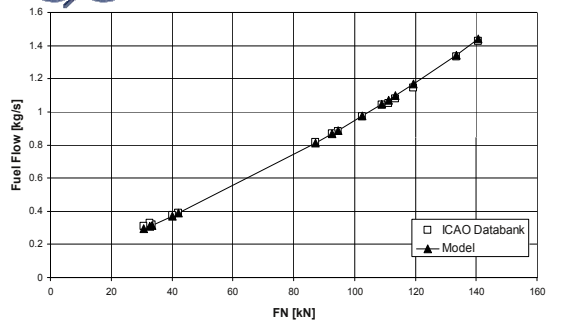
Modular engine component modelling

Model validation against ICAO certification data

Engine performance for discrete points of flight envelope



Fuel Consumption at different Power Settings

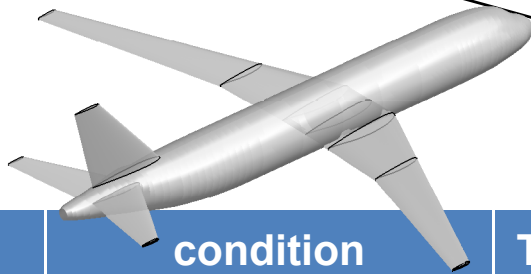
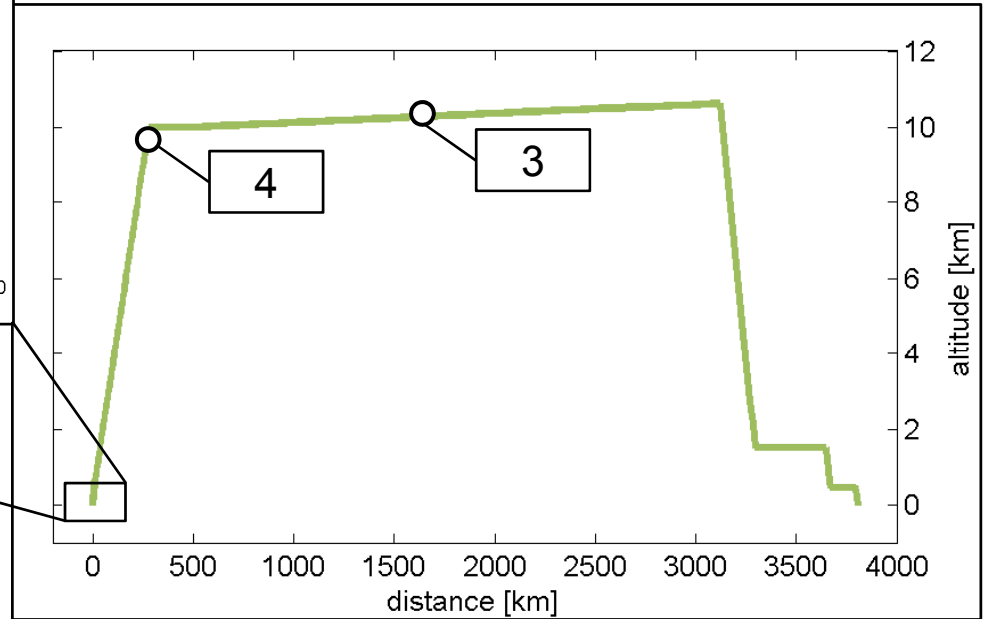
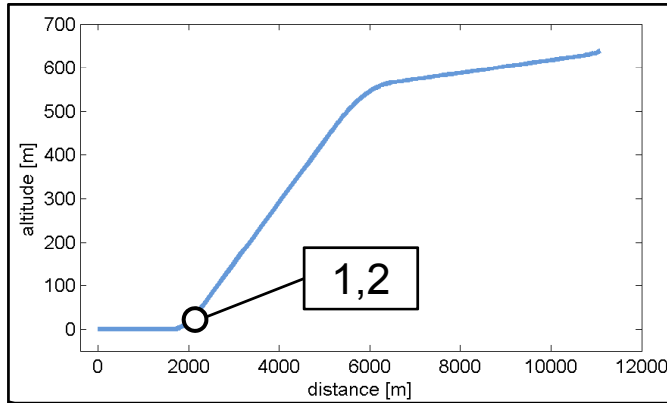


V2500 Engine – Source: Pratt&Whitney





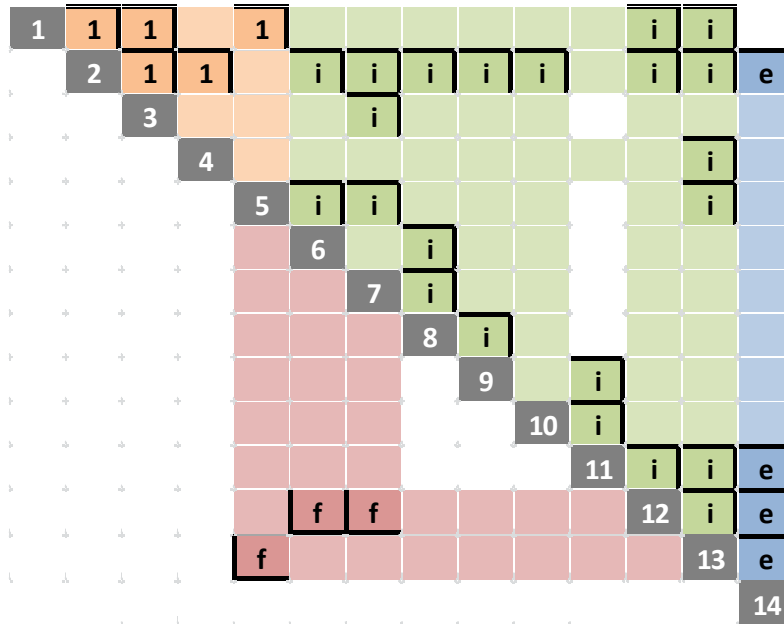
# Aircraft data for engine layout



	condition	$T_{req}$ [kN]	$T_{del}$ [kN]	alt [m]	Mach [-]	$\alpha$ [deg]	$\gamma$ [deg]
1	one engine inoperative	82.4	80.9	64	0.23	9.4	2.4
2	end of field	78.3	78.3	45	0.26	8.0	8.0
3	mid cruise	19.9	19.9	$10.4 \cdot 10^3$	0.78	4.1	$\sim 0$
4	top of climb	27.0	27.0	$10.0 \cdot 10^3$	0.78	3.6	1.1



# Combined a/c & engine design – N2 Chart

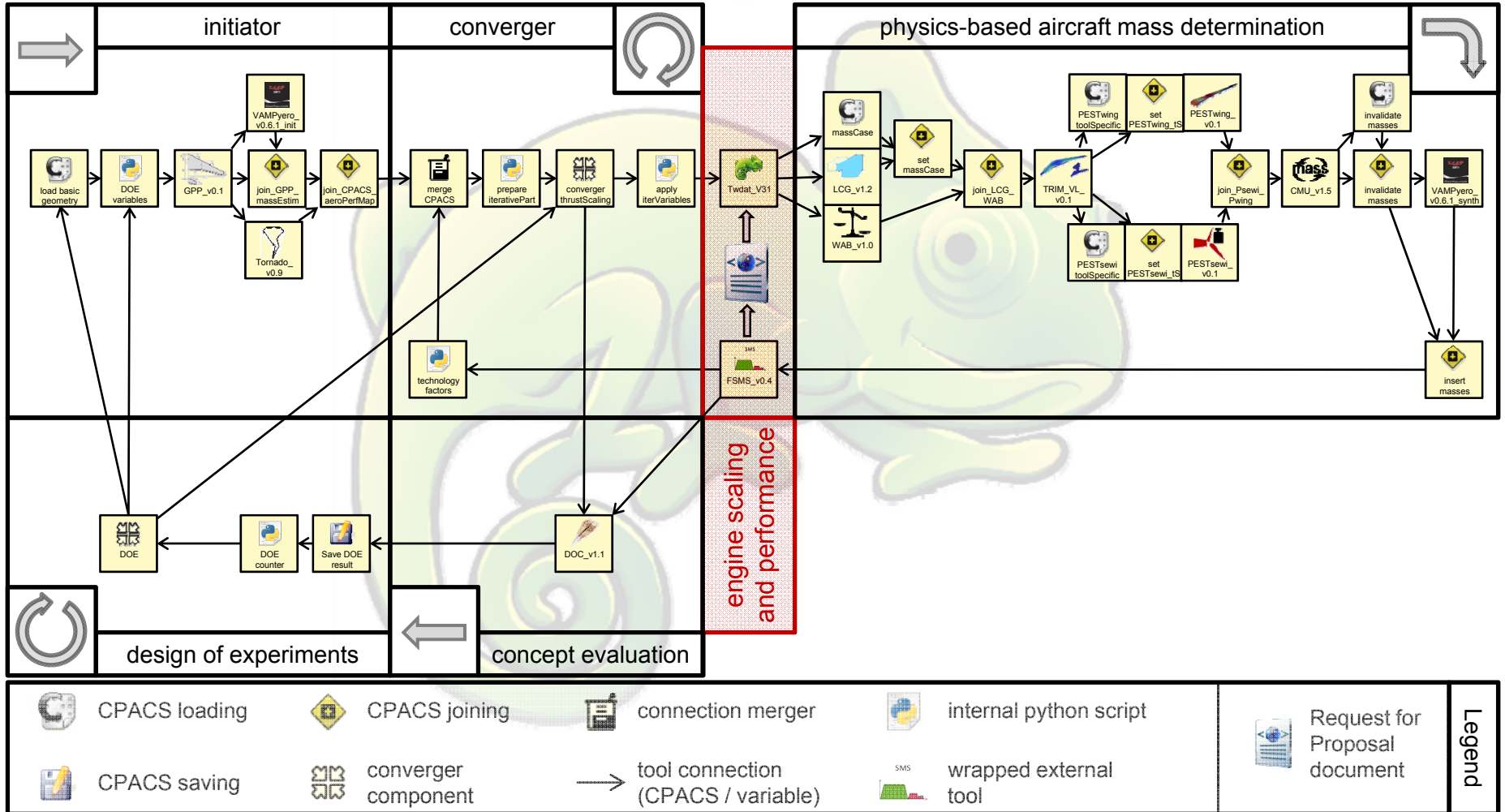


#	purpose	tool
1	TLAR & basic aircraft geometry	user input
2	geometry variation	GPP
3	mass initialisation	VAMPzero
4	aerodynamic performance map	Tornado
5	engine mass & performance map	TWDat
6	loadCase determination	LCG
7	weight and balance	WandB
8	spanwise loading	TRIM_VL
9	wing primary mass	PESTwing
10	wing secondary mass	PESTsewi
11	mass tree update	CMU
12	aircraft mass synthesis	VAMPzero
13	fuel mass and engine scaling	FSMS
14	direct operating costs	DOC

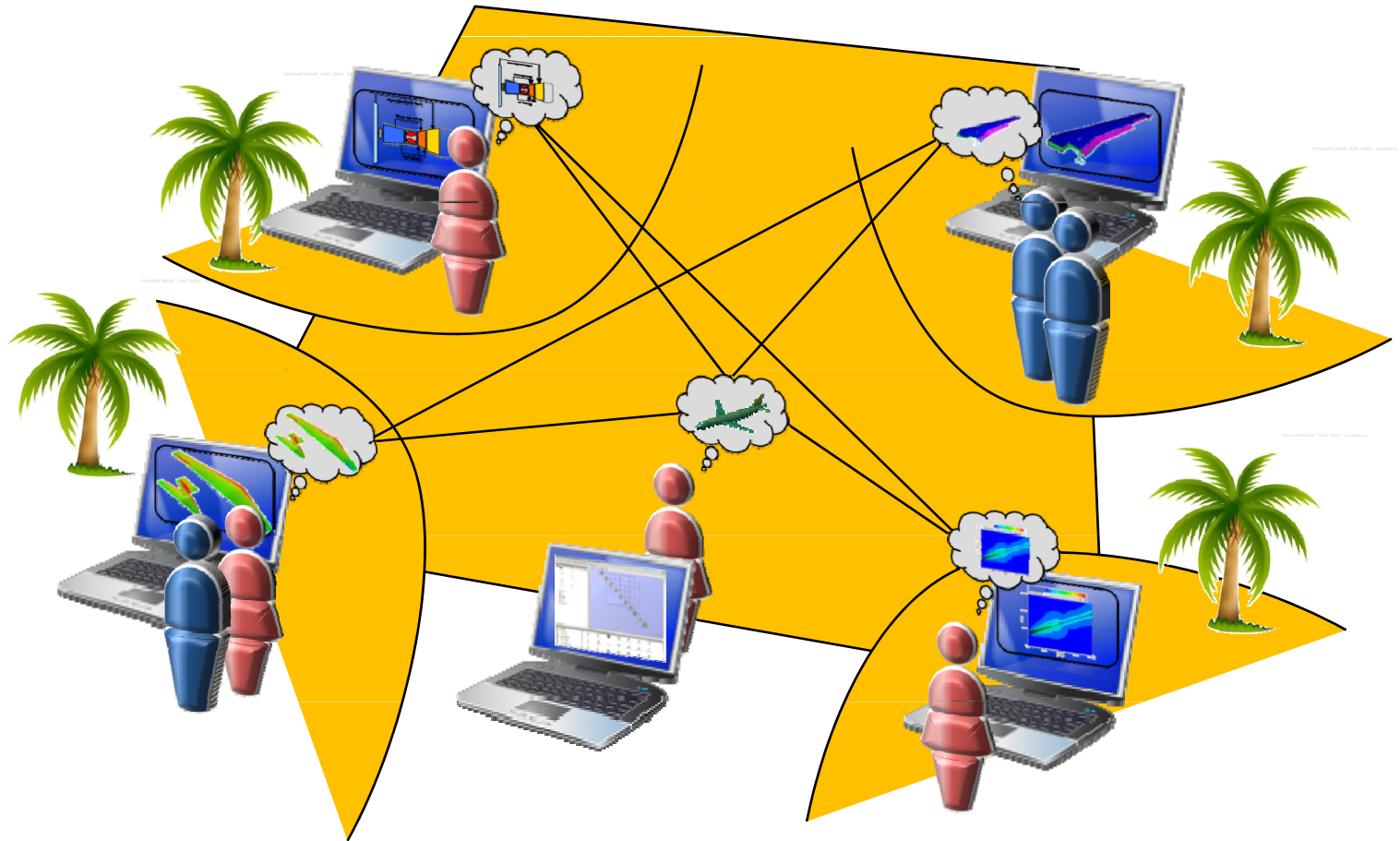
- 1 connection in initialisation phase
- i input connection in interative phase
- f feedback connection in iterative phase
- e connection in evaluation phase



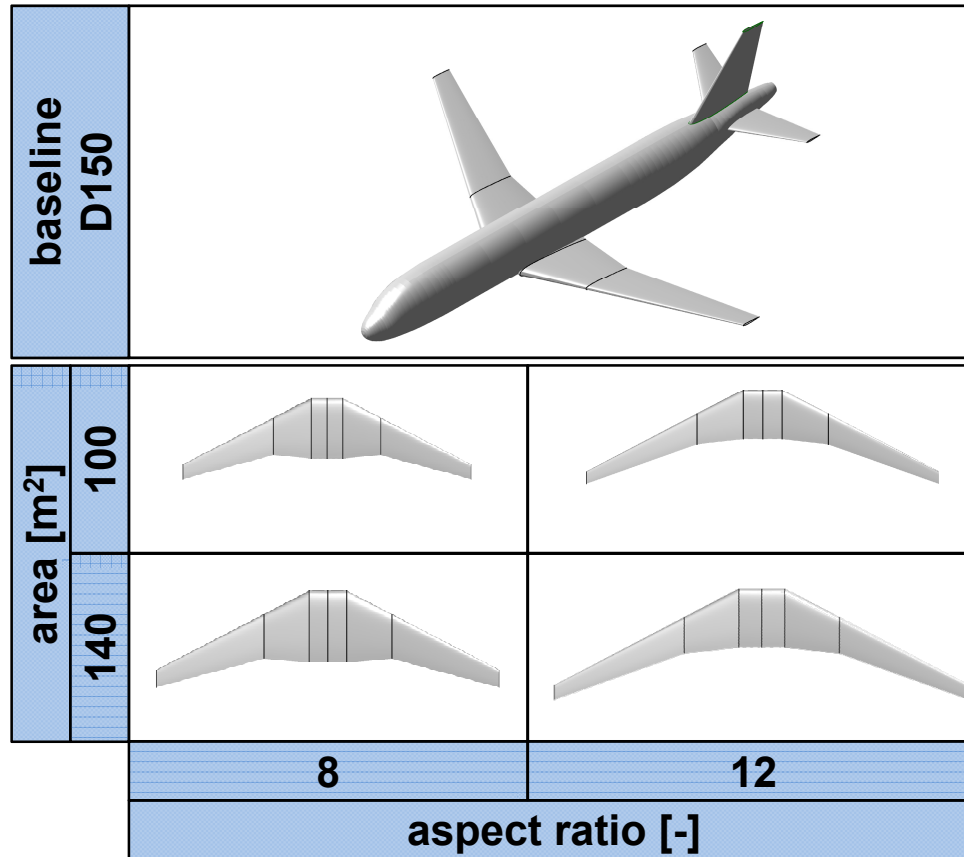
# Workflow in for CPACS



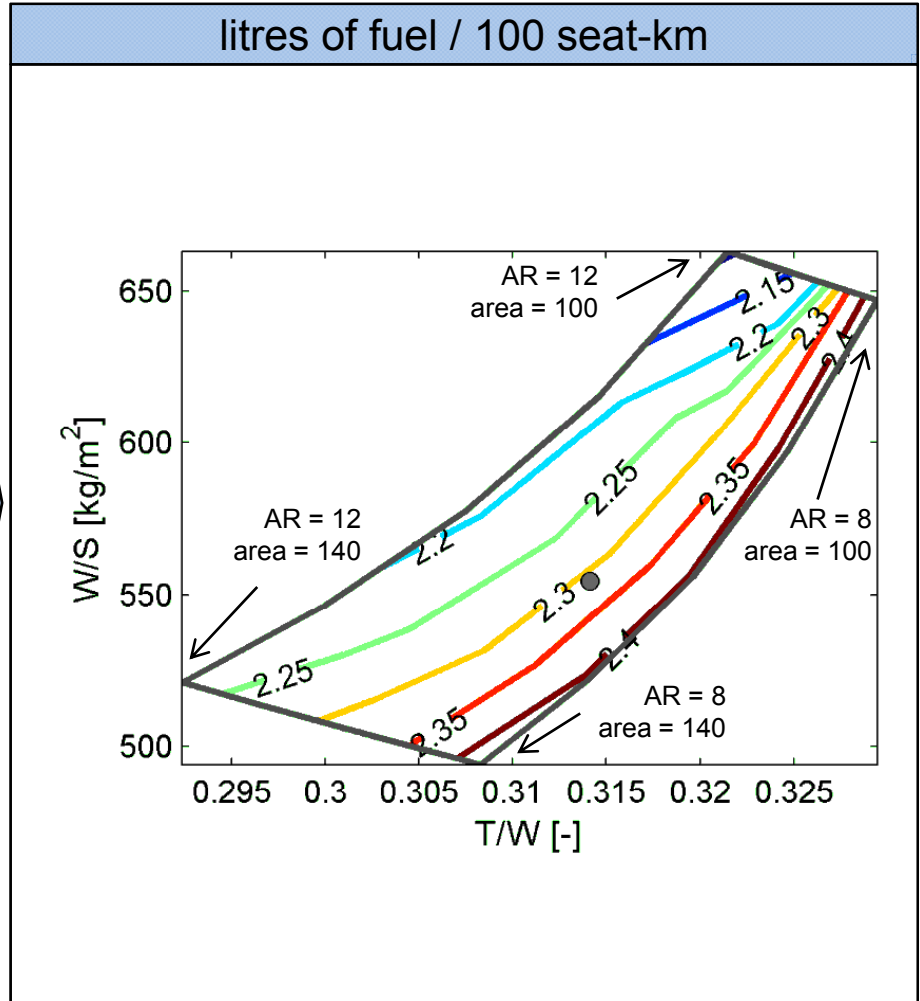
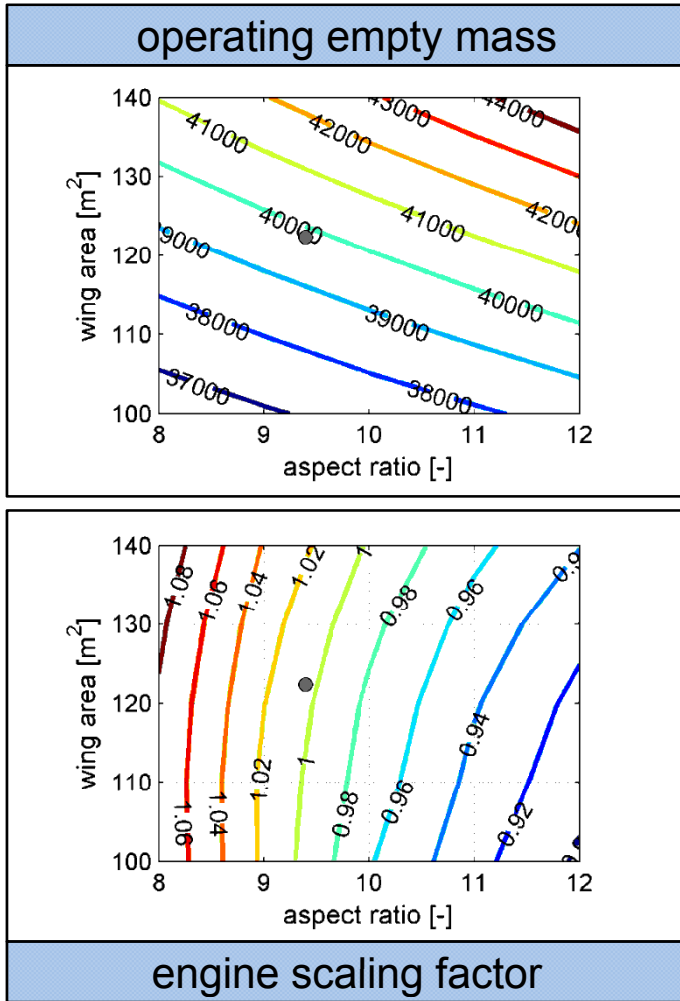
# Design for collaboration



# Aircraft parameter analysis



# Transfer functions for interaction

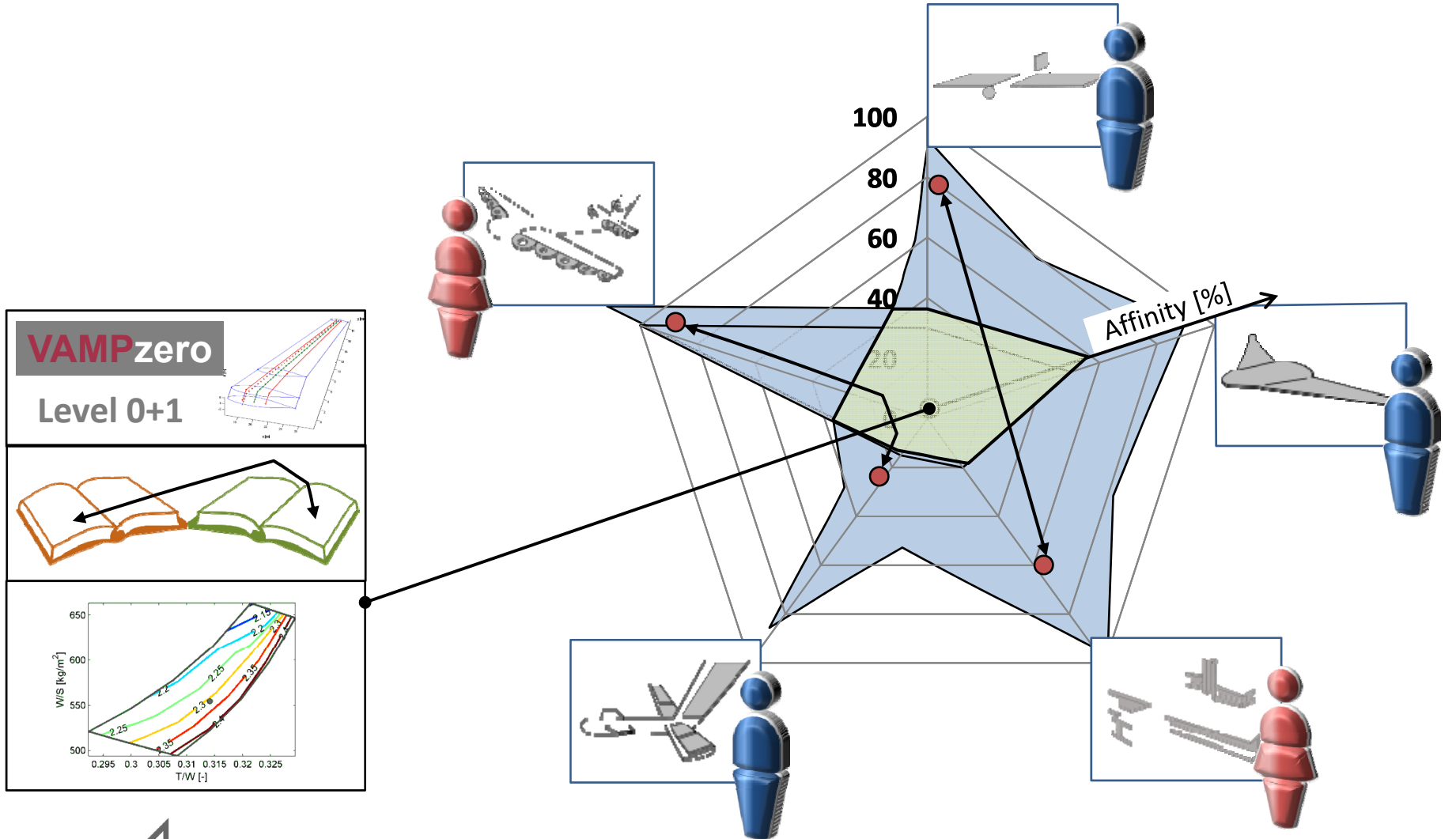


## Conclusion

- Build up of low-level toolkit
- Initial application: combining a/c and engine predesign
- Modularly applicable components & attitude change
- Translate knowledge between team members having various backgrounds
- Clear and streamlined communication, combined implicit and explicit knowledge

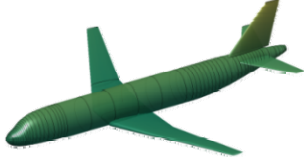

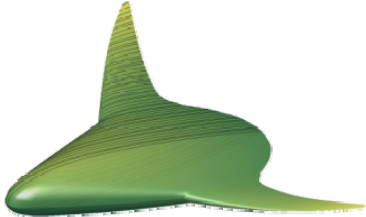
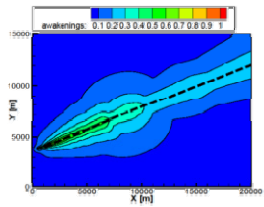
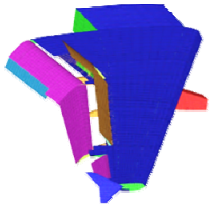
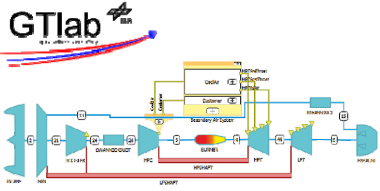
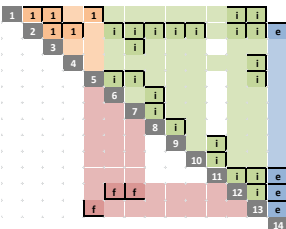
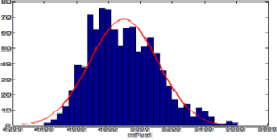



# Conclusion



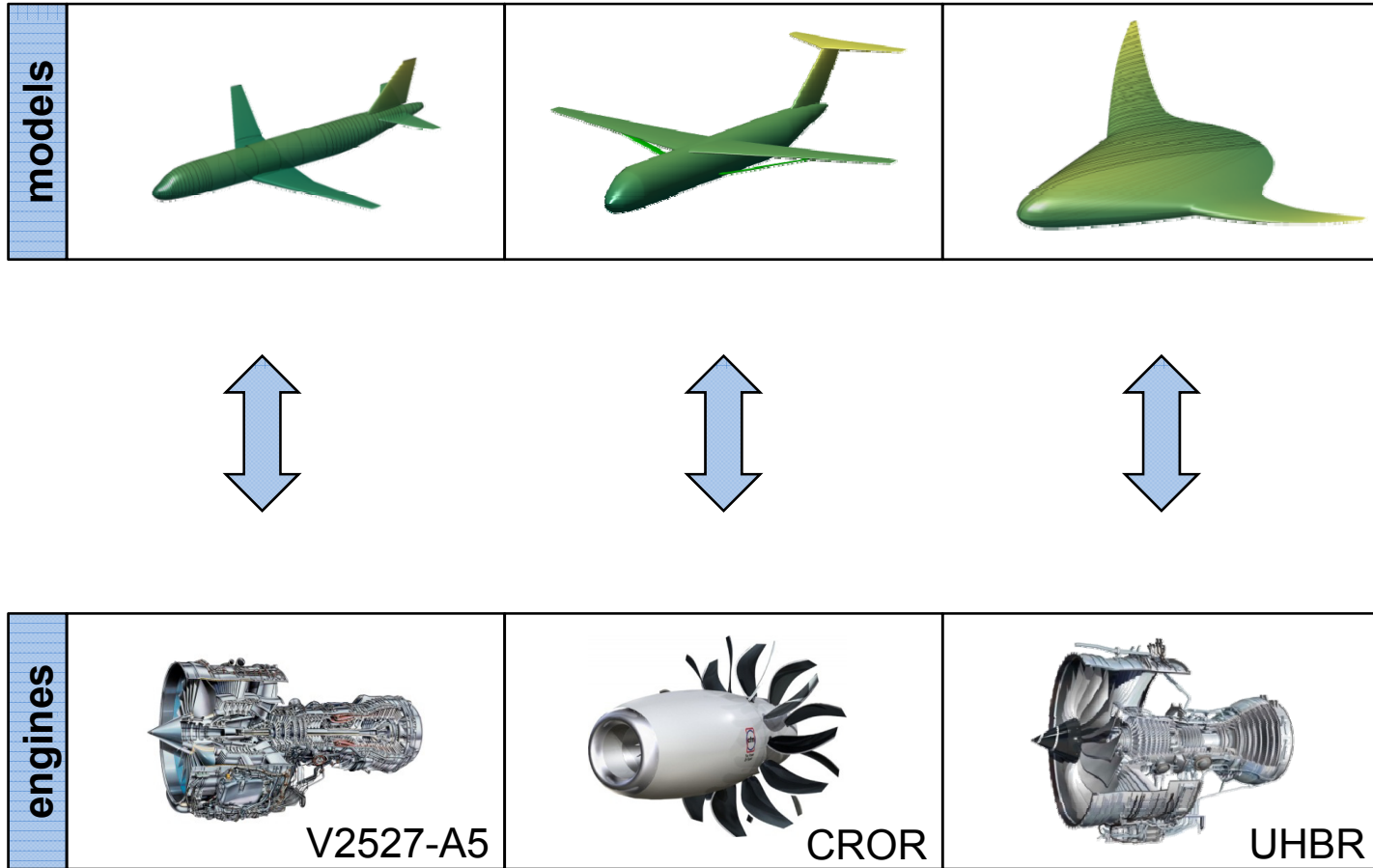


# Outlook

<b>models</b>			
<b>tools</b>			
<b>integration</b>			



# Outlook



# Design/Fidelity Level Transfer Functions

