CEAS TCAD

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

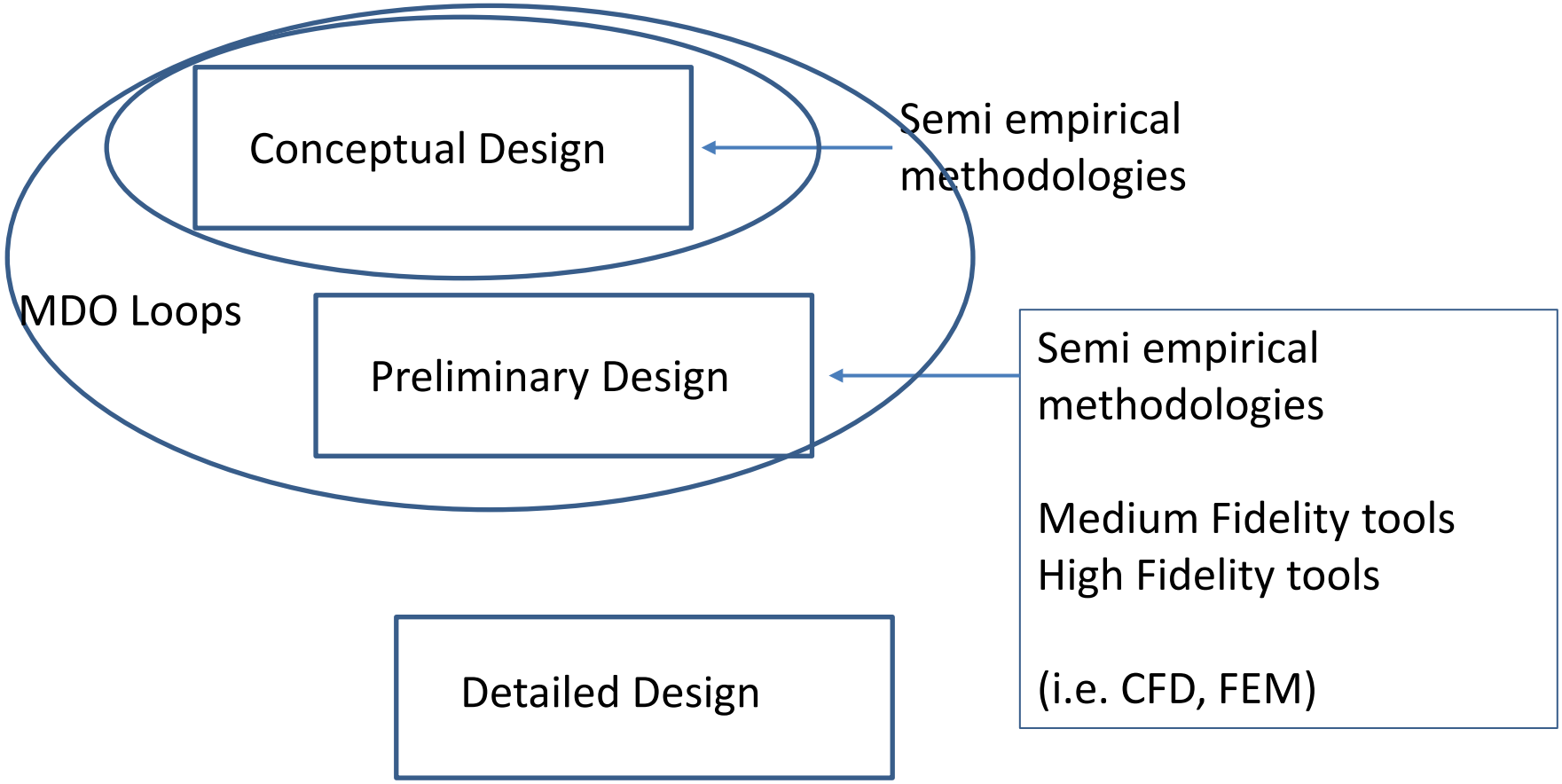
DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

SEZIONE INGEGNERIA AEROSPAZIALE

About possible European Project on Methods and Tools

Fabrizio Nicolosi

Aircraft Design Phases

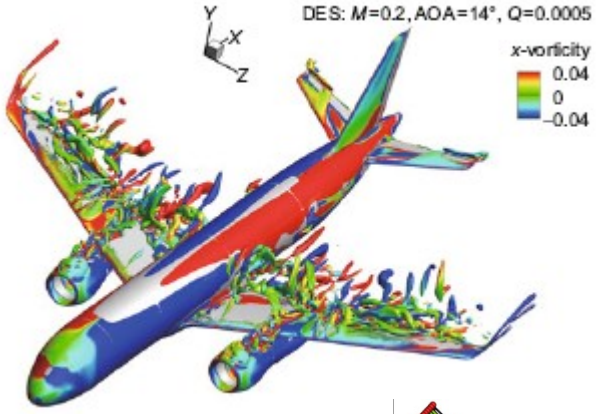


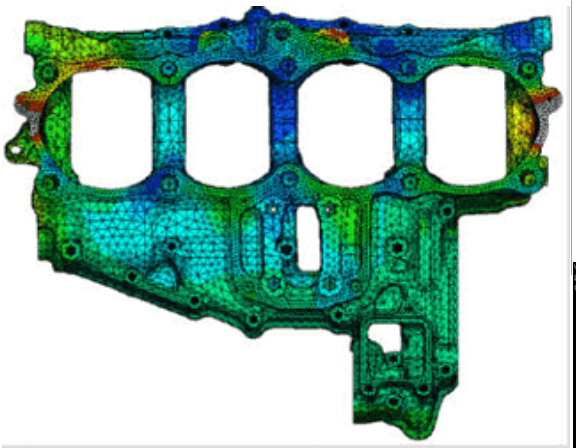
Aircraft Design Process

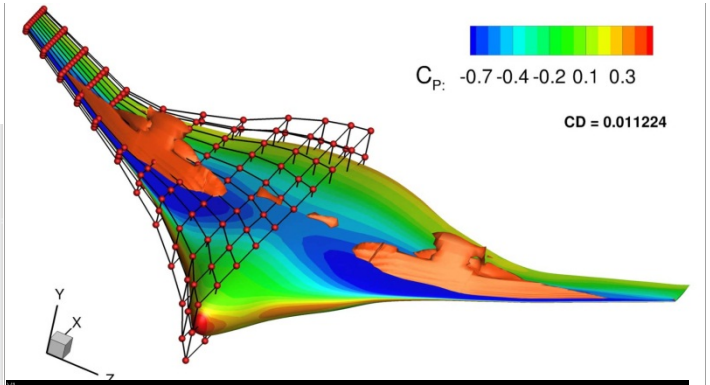
New and Better airplanes needs ***better TOOLS***

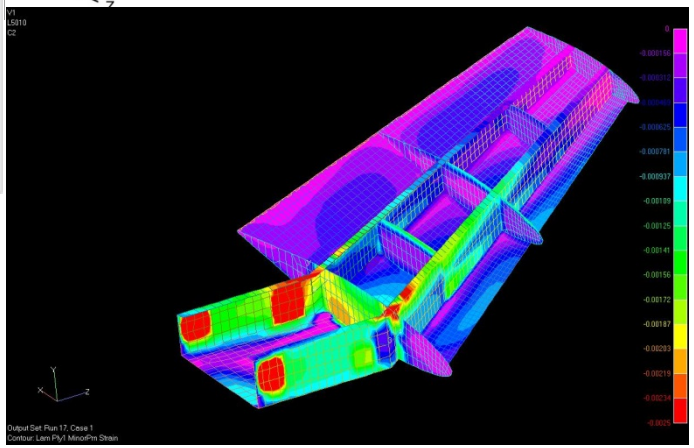
Aircraft Design Process

Better tools :
CFD RANS , FEM,..



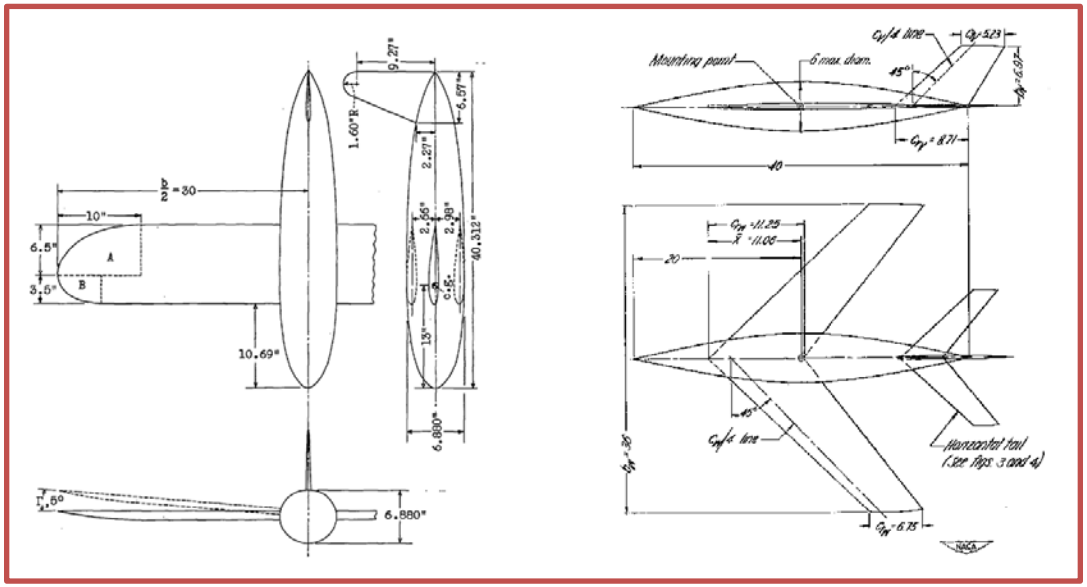




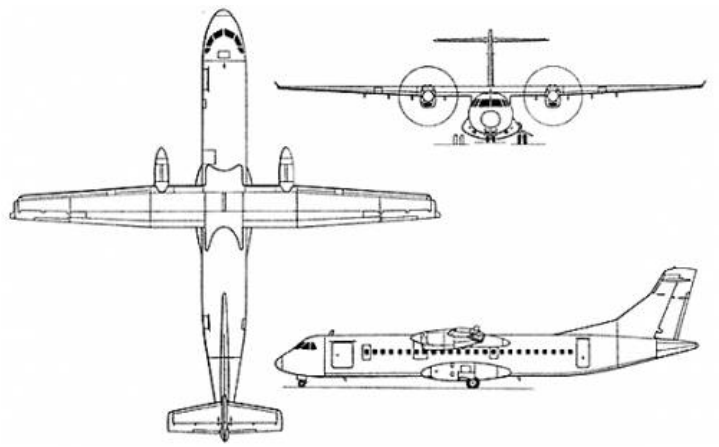


But, if we want to explore many different solutions ?

Semi-empirical methodologies (DATCOM, ESDU..)



NACA Reports (DATCOM base)



Regional turboprop

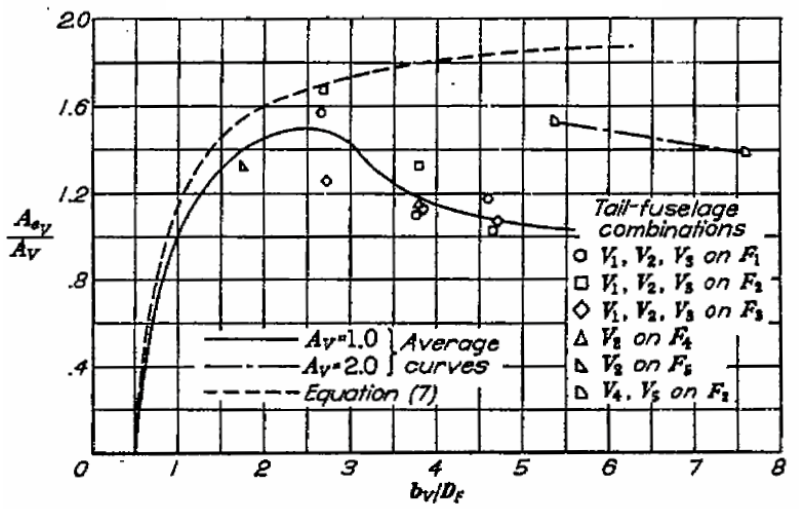
NACA geometries vs actual transport airplanes

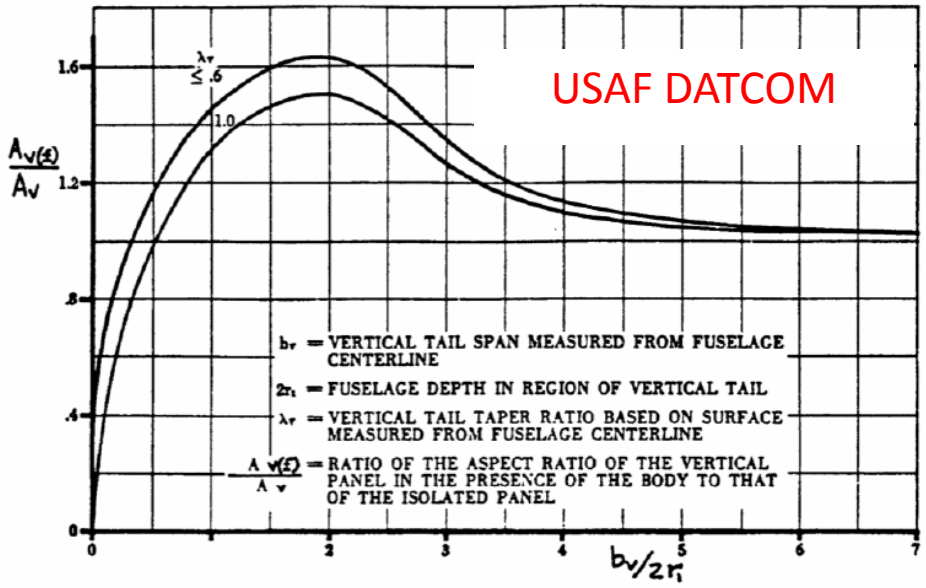
Even more difficult the application for new configurations (BWB,..)

Mutual aerodynamic interference effects are not represented

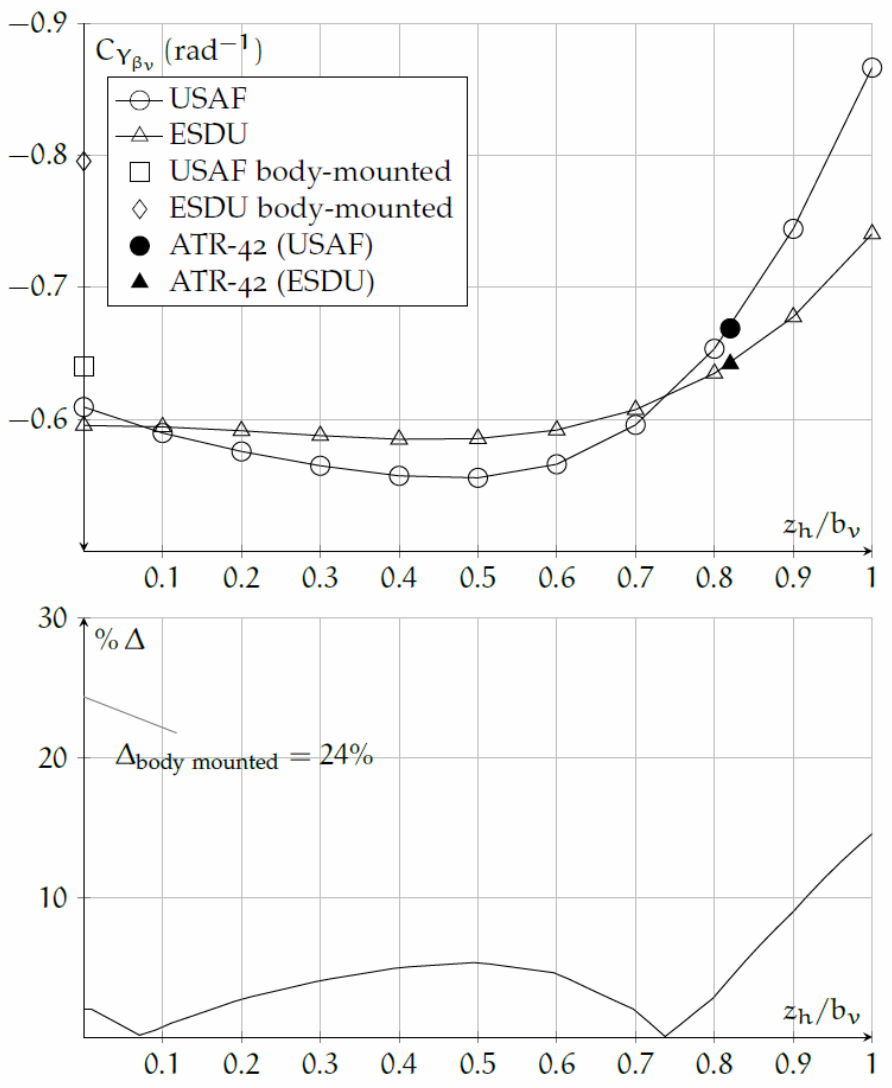
An example … Vertical tail aerodynamics (dir. Stability)

NACA Report 1049





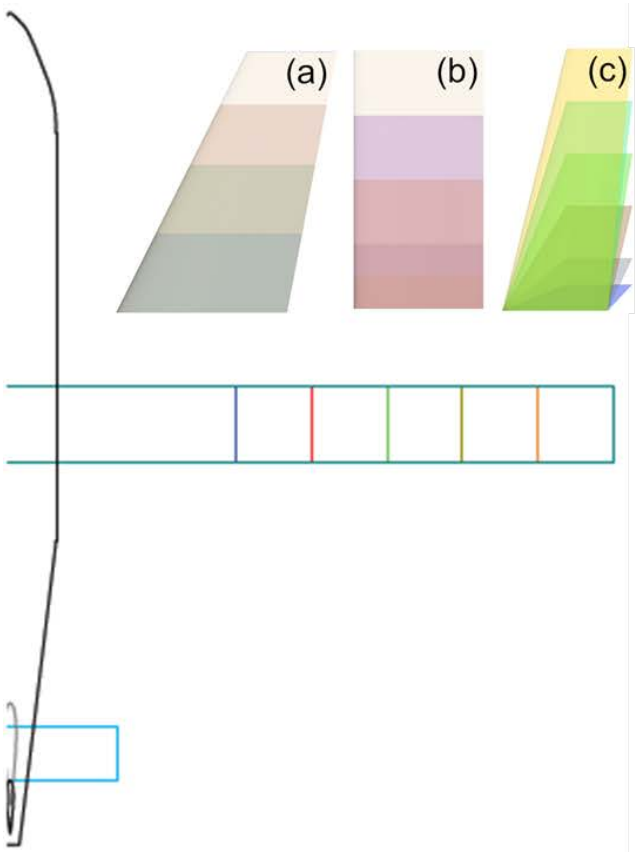
DATCOM vs ESDU comparison

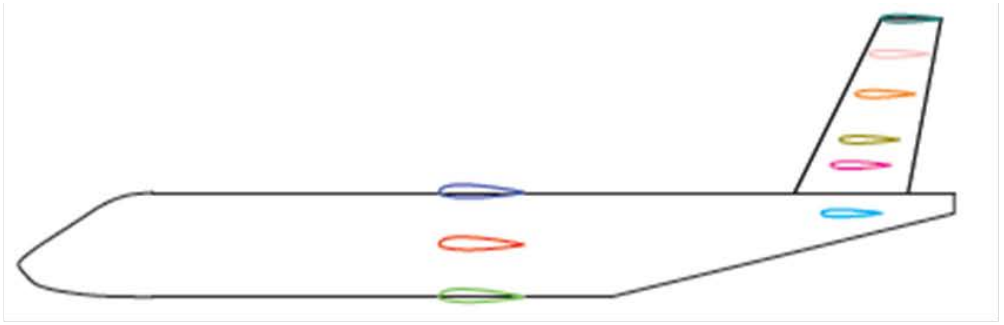


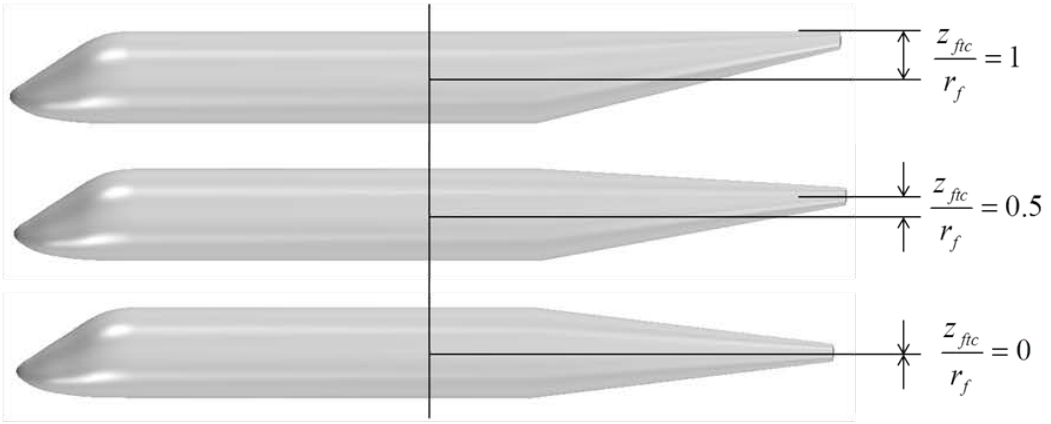
Can we build new reliable semi-empirical methods ?

(What is usually low-fidelity… maybe can be rebuild and assessed as a FAST, RELIABLE "high-fidelity" tool !)

An example … Parametric modeling of Vertical tail and fuselage…





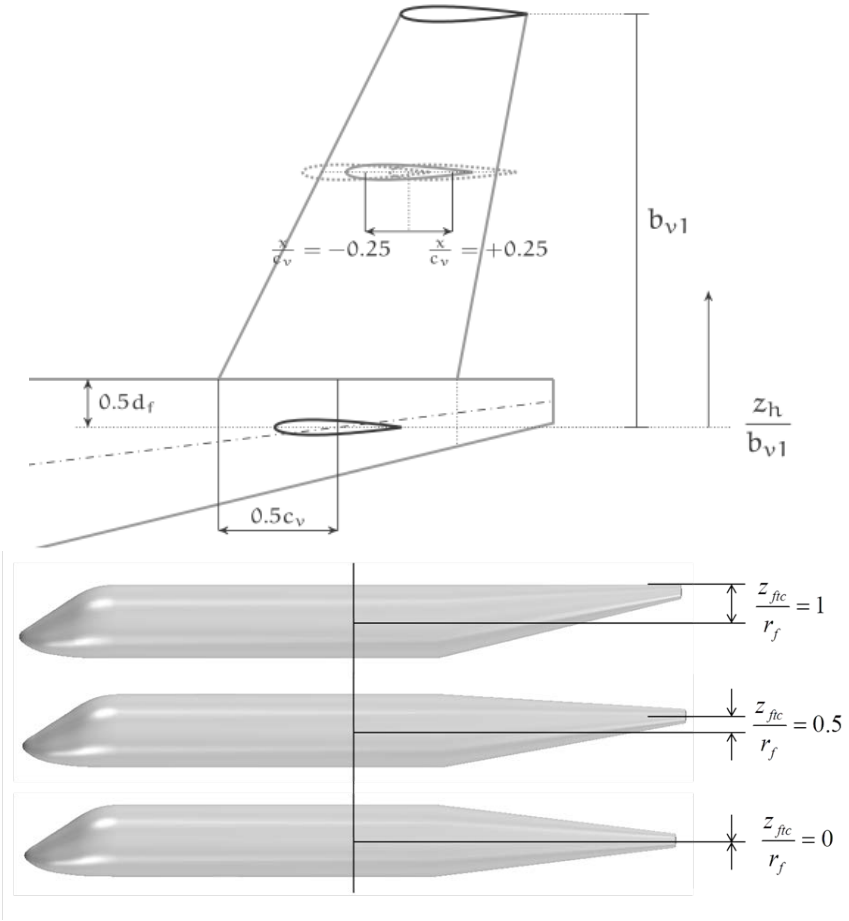


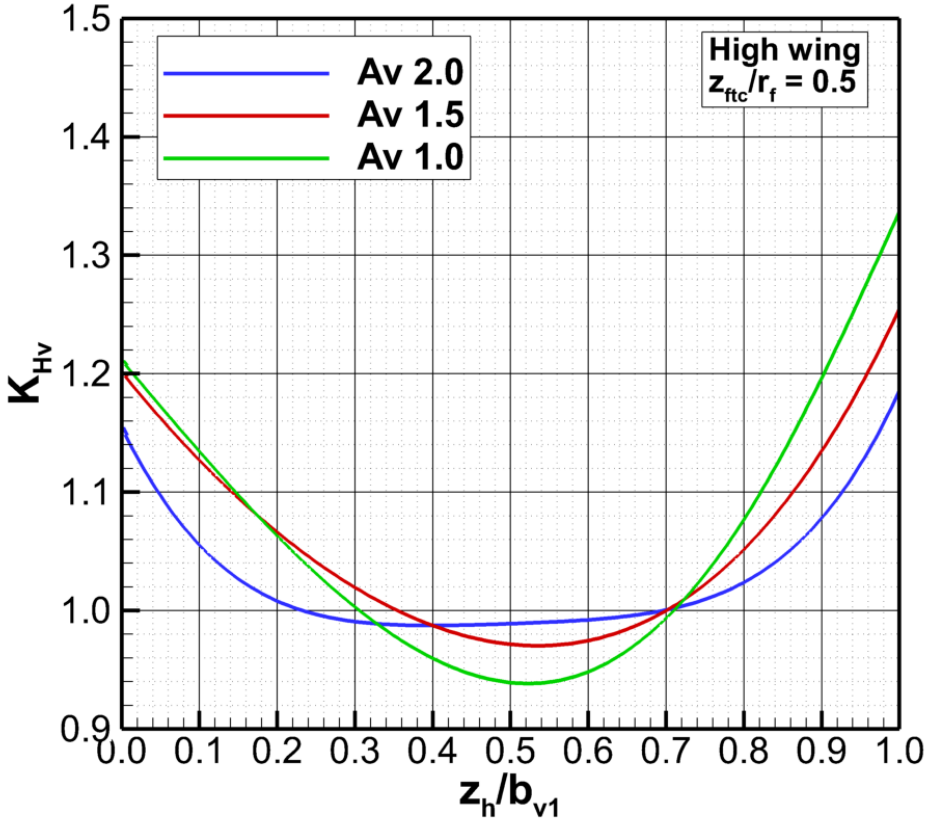
aerodynamic interference effects among aircraft components has been investigated on hundreds of configurations

Can we build new reliable semi-empirical methods ?

(What is usually low-fidelity… maybe can be rebuild and assessed as a FAST, RELIABLE "high-fidelity" tool !)

NEW SEMI-EMPIRICAL BUILT THROUGH CFD





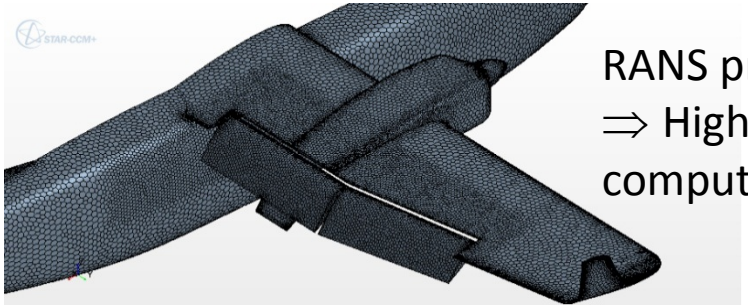
9 charts

Can we build new reliable semi-empirical methods ?

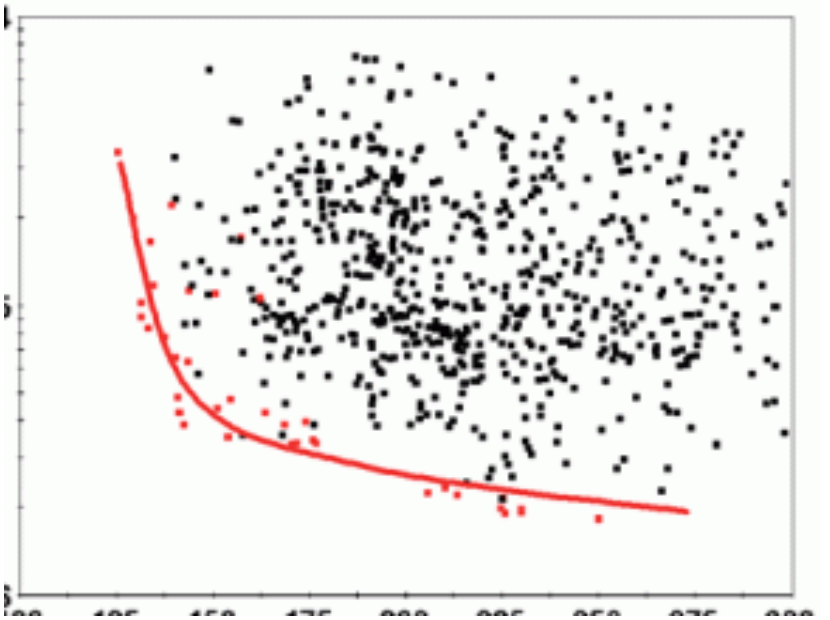
Another important example concerning aerodynamics:

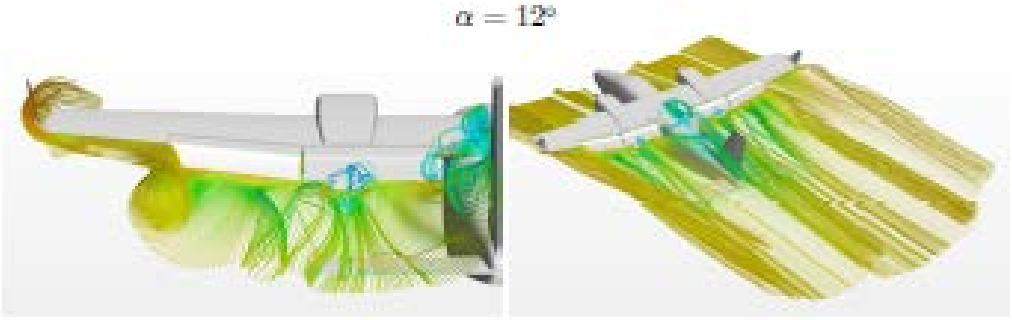
- Aircraft CLmax estimation (is crucial for wing design)
- Even more difficult for high-lift configuration (flap and slat)

For Pareto-Frontier MDO we need to consider
and to evaluate thousands of different solutions…
=> A Fast tool is needed !



RANS prediction
$\Rightarrow$ High
computational efforts





NEW SEMI-EMPIRICAL BUILT THROUGH CFD !
(Maybe we can consider "only" 100 different cases…)

Can we build new reliable semi-empirical methods ?

Estimation of 3-D aircraft clean CLmax:

CLmax= Kwing * Kfus* Ktail * (Clmax)

Coefficients estimated through CFD with calculations performed :
40 different wings combined with
4 different fuselage diam.
4 different tail size

With HIGH-LIFT SYSTEM:

Estimated through hundreds CFD RANS
On parametric high-lift systrem configuration

$$\Delta CL_{max} = K_c * K_s * K_d \quad \Delta Cl_{max}$$

Chord ext span ext deflection

WE NEED TO UNDERSTAND THE PHYSICS OF THE PROBLEM
TO SET-UP RIGHT PARAMETRIC ANALYSIS (and RIGHT COEFFICIENTS)

A NEW DATCOM ?

AERODYNAMICS

- Parasite Drag → Investigating and modeling drag sources like excrescences, gap, cooling (GA)
- Induced drag (oswald) → New method to estimate "e" A fast approach for winglet effectiveness prediction ?
- Downwash
- H tail and V tail effectiveness
- Max lift coefficient
- High-lift devices
- Landing gear

STRUCTURES

- Wing parametric structural description
- Fuselage
- …..
- Landing gear

WEIGHTS

- Wing weight prediction
- Fuselage
- …..

Help from Industry ?

But also other disciplines involved :

SYSTEMS, AEROELASTICITY, PROPULSION (ENGINE MODEL), FLIGHT DYNAMICS and FLIGHT Qualities, **DOC**

WHAT ABOUT A RESEARCH PROJECT ?

WP1 – **Parametric representation and shape modeling** (for shapes, structures, systems, elastic items…) How many ?... Which geometrical parameters….

WP2 – **Application of high fidelity systems (CFD, FEM, etc) to set-up new semi-empirical fast and reliable tools** (surrogate models).

⇒ Use of some data and experience coming from Industry

⇒ Set-up of some medium-fidelity tools (for example coupling 2-D NS data with wing lifting line analysis)

WP3 – **Experimental Validation through parametric testing**

(Some WT tests, Structural tests, Aeroelastic tests…)

⇒ Validation also through the application of high-fidelity numerical tools

=> Comparison with classical old methodology

WP4 – Example of applications

Aerodynamic – drag
Aerodynamic – stability
…
Structures
Weight
Systems
Engines….

Aerodynamic – drag
Aerodynamic – stability
…
Structures
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Aerodynamic – drag
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DIFFERENT Configurations

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2 Years , or 30 months

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WP4 – Example of applications

1 Year or 20 months

WHAT ABOUT A RESEARCH PROJECT ?