

On the need for a reference aircraft to support (collaborative) aircraft design

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**Chair of Flight
Performance and
Propulsion**



Analysis tool validation

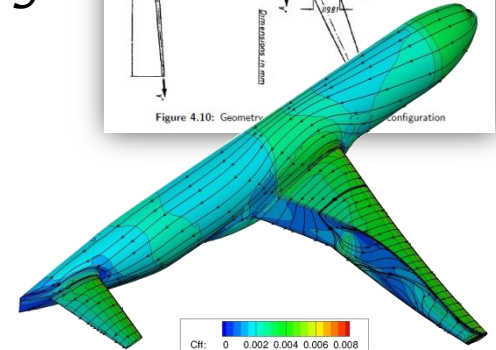
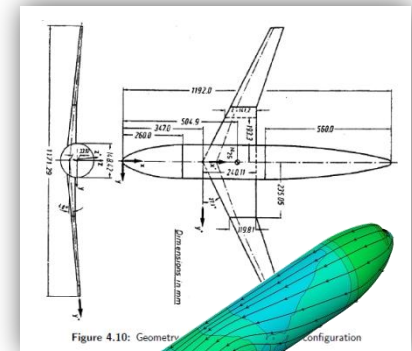
How do we validate our analysis tools?

- For **aerodynamics**:
 - NACA/NASA reports
 - DLR and NASA reference models from the Drag Prediction Workshops (DLR-F4/F5)
 - Drag polars and coefficients from *Aerodynamic Design of Transport Aircraft*, by E.Obert
 - ...
 - Internal confidential material

<http://aaac.larc.nasa.gov/tsab/cfdlarc/aiaa-dpw/Workshop2/DLR-F6-geom.html>

<http://aaac.larc.nasa.gov/tsab/cfdlarc/aiaa-dpw/Workshop5/DPW5-geom.html>

B. Tinling and W. Kolk, *The effects of Mach number and Reynolds number on the aerodynamic characteristics of several 12-percent thick wings having 35 degrees of sweepback and various amounts of camber*, National Advisory Committee for Aeronautics, 1951.



Analysis tool validation

How do we validate our analysis tools?

- For component **weight estimation**

Table 1

Comparative study of some class II & 1/2 weight estimation methods. Wing weight estimation error computed as a percentage of the actual wing weight.

Aircraft	Error of wing weight estimation (%)					
	AdAstra [32]	Torenbeek [35]	van Dijk [32]	WP15 [32]	Macci [20]	PDCYL [1]
A300-600R	4.7	-	4.6	-0.2	12	-
A310-300	-7.2	-	-4.0	-0.3	-	-
A320-100	-7.0	-	-6.1	-8.3	-4.6	-
A330-300	0.1	-	-12.9	-12.7	-	-
A340-300	-1.4	1.2	-2.4	-5.9	-2.8	-
A380-800	22.6	-	8.5	0.4	-	-
B737-200	-	-	-	-	-17.5	-7.6
B747-100	-	1.9	-	-	-3.5	4.1
B747-200	29.4	-	15.6	22.0	-1.8	-
B747-400	55.5	-	38.9	12.4	-	-
B777-200	16.2	-	10.8	16.1	-	-
DC-8	-	-	-	-	-	-
MD-11	-	-	-	-	-	-7.9
MD-83	-	-	-	-	-	-31.1
L-1011	-	-	-	-	-	-6.3
Fokker 100	-	-3.8	-	-	-	-
Cessna Citation II	-	3.8	-	-	-	-



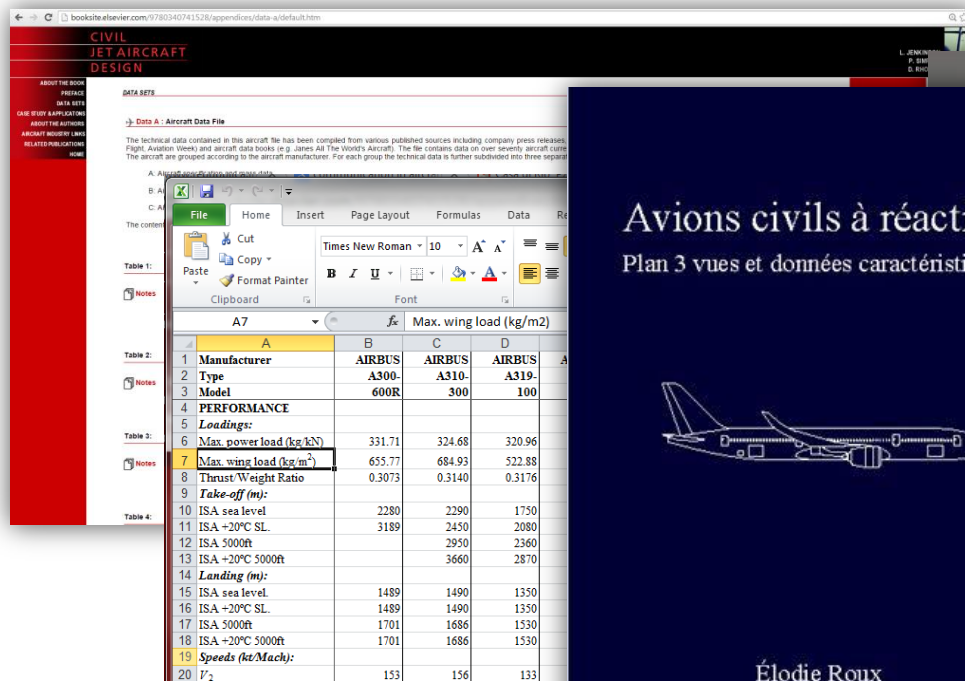
Available data extremely scarce (dependency on unknown loads, allowables, design criteria, weigh components definition...)



Design tool validation

How do we evaluate our DESIGN tools?

- We can **verify** them (are they able to synthesize a design?)



The screenshot shows a web browser displaying a technical data file for aircraft design. The file is titled "Data A - Aircraft Data File" and contains technical data for three aircraft models: Airbus A300-600R, Airbus A310-300, and Airbus A319-100. The data is organized into tables, with the first table showing basic aircraft information and the subsequent tables showing performance data. The data is presented in a structured format, with columns for aircraft model, manufacturer, type, model, and various performance metrics.

	A	B	C	D
1 Manufacturer	AIRBUS	AIRBUS	AIRBUS	
2 Type	A300-	A310-	A319-	
3 Model	600R	300	100	
4 PERFORMANCE				
5 Loadings:				
6 Max. power load (kg/kN)	331.71	324.68	320.96	
7 Max. wing load (kg/m ²)	655.77	684.93	522.88	
8 Thrust/Weight Ratio	0.3073	0.3140	0.3176	
9 Take-off (m):				
10 ISA sea level	2280	2290	1750	
11 ISA +20°C SL	3189	2450	2080	
12 ISA 5000ft		2950	2360	
13 ISA +20°C 5000ft		3660	2870	
14 Landing (m):				
15 ISA sea level	1489	1490	1350	
16 ISA +20°C SL	1489	1490	1350	
17 ISA 5000ft	1701	1686	1530	
18 ISA +20°C 5000ft	1701	1686	1530	
19 Speeds (kt/Mach):				
20 V ₂	153	156	133	

Jenkinson's data collection (Civil
<http://booksite.elsevier.com/9780>

Avions civils à réaction
Plan 3 vues et données caractéristiques



Élodie Roux



[a/default.htm](http://booksite.elsevier.com/9780)



Need for a reference aircraft

- **TLAR** (including special constraints)
- Detailed **geometry**
 - Airfoils
 - Structural layout
- **Weights**
 - Weight components (wing, tailplanes, systems, etc...)
- Detailed **performance** data
 - L/D_{\max} , L/D_{cruise} , $C_{L\text{cruise}}$, CL_{TO} , CL_{LA} , C_D , polars (trimmed, flapped, landing gear down)
 - Climb and TO&Landing
 - Stability margins
- **Costs** and Cost model
- ...
- **Design objectives!!**
 - MTOW? Cost? (What cost and what cost model?) Fuel consumption? Other(s)??

What reference aircraft?

An aircraft...

- Whose complete data set is available (in any form)
- For which designers and discipline specialists are still available (chief designers, aerodynamics, weight specialists,...)
- For which there are disclosure possibilities (e.g., aircraft no more operational, out of production, ...)

• **FOKKER 100???**



The Fokker 100

**FLY
FOKKER**



FOKKER 50

FOKKER 70

FOKKER 100

[BASICS](#) [INTERIOR](#) [PERFORMANCE](#) [ENVIRONMENT](#) [AVIONICS](#) [OPERATION](#) [AIRWORTHINESS](#)

FOKKER 100 REGIONAL JET

The Fokker 100 is a regional jet in service with over 40 [operators](#) worldwide. The Fokker 100 was manufactured during 1988 through to 1996 and a total of 278 were built.

Prevailing market conditions have made a number of Fokker 100 aircraft available at affordable prices or monthly lease rentals. Favorable operating expenses and substantial revenue potential combine to make the economics of the Fokker 100 very compelling. The Fokker 100 is the natural successor of the *F-28 Fellowship* and is formally certified as the F-28 Mk0100.

Go directly to the Fokker 100 specifications:

- [Basics](#)
- [Interior](#)
- [Performance](#)
- [Environment](#)
- [Avionics](#)
- [Operation](#)
- [Continued airworthiness](#)
- [Availability](#)

Range Capability

- [View Range Capability](#)

Contact Fokker

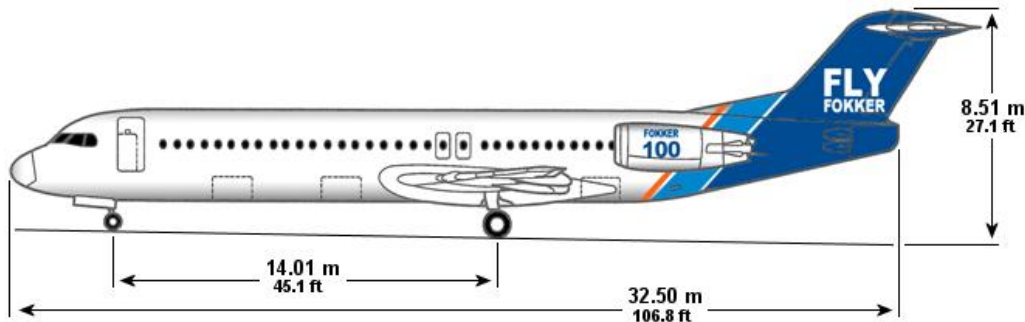
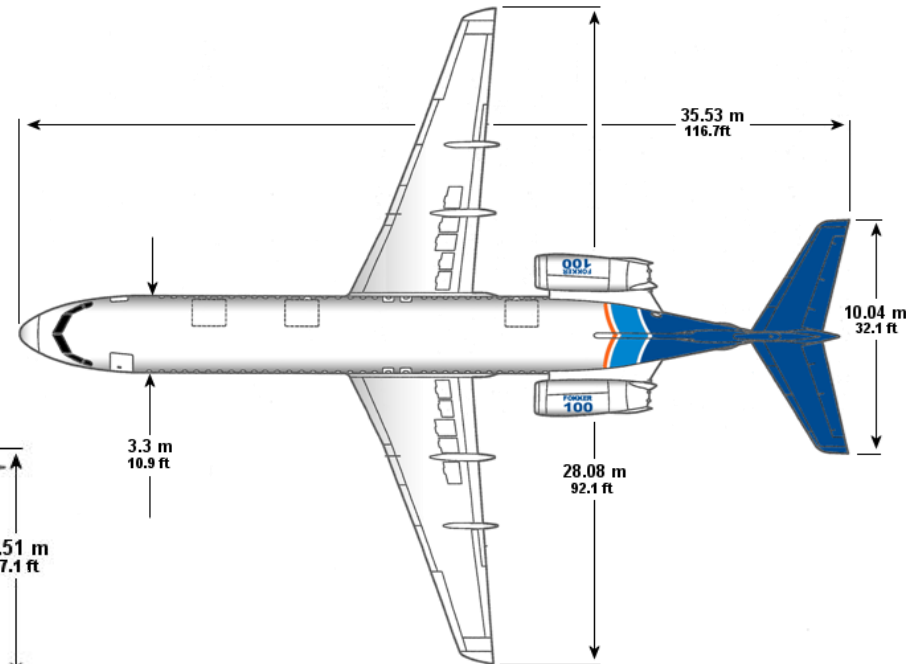
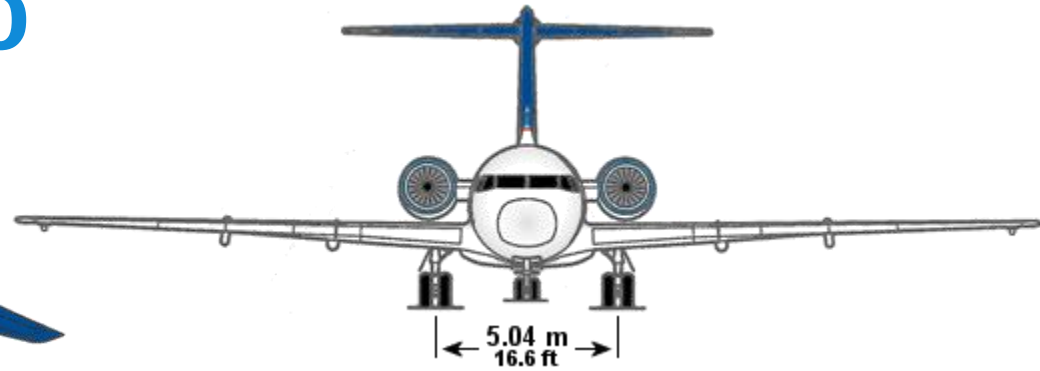
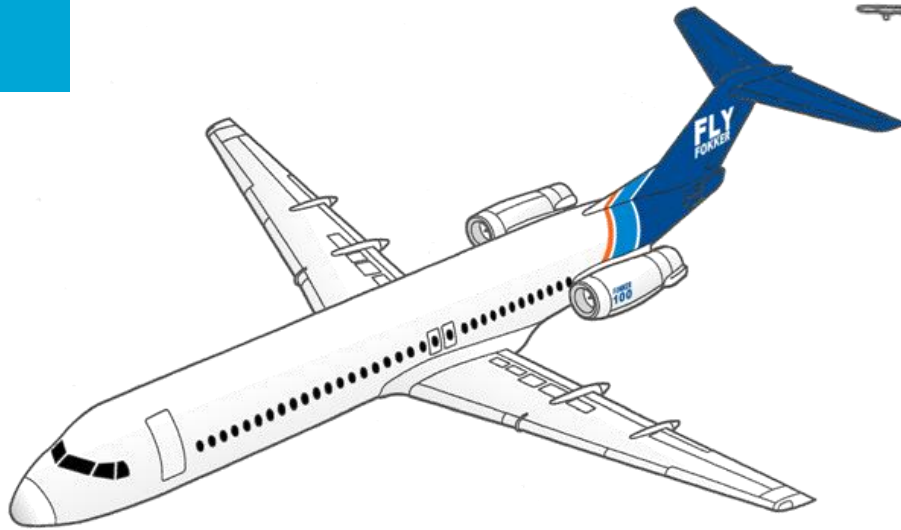
- [Your Direct Contacts](#)

Downloads

- [Support Solutions \(PDF, 1 MB\)](#)
- [Fokker 50 \(PDF, 0.6 MB\)](#)
- [Fokker 70 \(PDF, 0.6 MB\)](#)
- [Fokker 100 \(PDF, 0.7 MB\)](#)
- [More Downloads](#)

<http://www.flyfokker.com/Fokker-100>

The Fokker 100

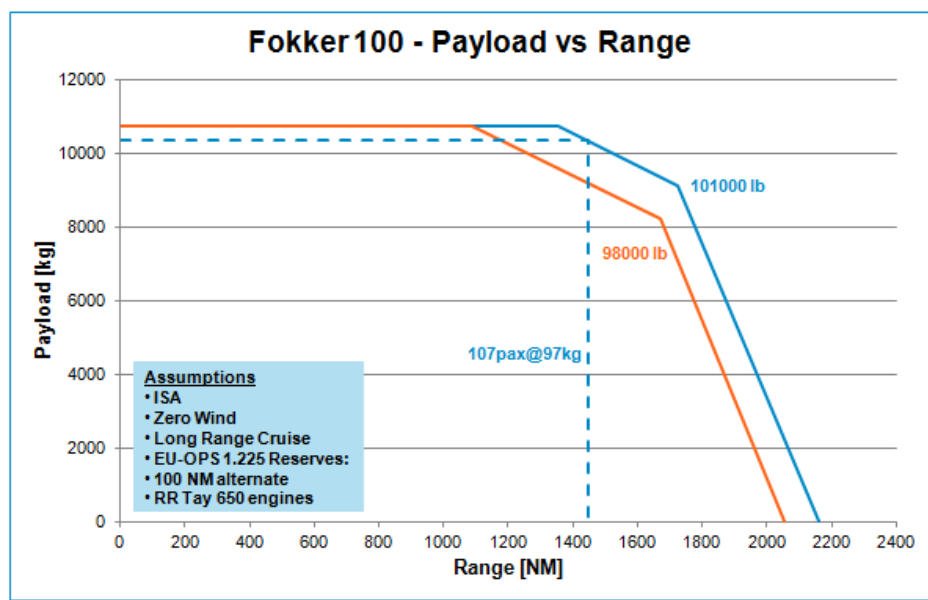


<http://www.flyfokker.com/Fokker-100>

The Fokker 100

Dimensions and areas

Overall length	35.53 m	116.7 ft
		27.1 ft
		106.8 ft
		10.10 ft
		1006.46 ft ²
		92.1 ft
		16.6 ft



Weights

MTOW	45,810 kg*	101,000 lb
	44,450 kg	98,000 lb
MLW	39,915 kg	88,000 lb
MZFW	36,740 kg	81,000 lb
Fuel capacity	10,731 kg**	23,660 lb*
	10,293 kg	22,690 lb

<http://www.flyfokker.com/Fokker-100>

What's in for the CEAS/TCAD community?

- A reference aircraft to validate our aircraft design tools
- A baseline to evaluate the impact of MDO studies
- A baseline to evaluate the impact of new technologies (e.g., relaxed stability, new materials, new structure design & manufacturing approaches, flow control devices...)
- ...

What's in for FOKKER?

- Opportunity to evaluate the impact of MDO studies
- Opportunity to evaluate the impact of new technologies (relaxed stability, new materials, new structure design & manufacturing approaches, flow control devices...)
- Opportunity to benchmark design tools
- Opportunity to benchmark design teams
- Eased accessibility to design and optimization tools?
- A community to submit "request for proposals", design cases and contests...

How to proceed?

- A preliminary request has been sent to Fokker by TUD
- Should we let TUD and NLR proceed with the first phases of the request?
- Should we approach Fokker as CEAS/TCAD?
- ...

What else is out there?

- Any Airbus-like design?
- Any ATR-like design?

...and what about these?



Let's think this together!

CEAS SCAD

25•27 November 2014
ONERA TOULOUSE • France

