

# Survey on aircraft design education in European academia curricula

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**Disclaimer:**

**This is not a lecture!**

It is a survey on the way “we” give lectures (in aircraft design)

# Why this surveys? The TUD situation

We used to have the following situation (2005):

1. One “**classic**” **Aircraft Design course** in the 3<sup>rd</sup> year (7 Credits) of the BSc
2. The Design Synthesis Exercise (sometime on aircraft)
3. Two aircraft design courses in the MSc
  - On **aerodynamic design** of passenger aircraft (transonic design)
  - On aerodynamic and performance of **combat aircraft**

# Old Aircraft Design course at TUD

## Old Aircraft Design course topics:

1. Design process
2. Analysis of requirements (intro into market analysis and certifications aspects)
3. On matching aircraft configurations and mission and objectives
4. Fuselage design
5. Preliminary weight estimation and sizing (matching plot)
6. Wing and HLDs design
7. Propulsion (basic thermodyn., engine selection and sizing)
8. Refined weight estimation, Stability& control (tail design)
9. Refined drag estimation and sustainability aspects

## Assessment

Each student gets assigned one set of TLAR and, by means of 6 reviewed assignments, performs **the whole conceptual design** (including iterations and reworks) of the aircraft (any type)

# Current Aircraft Design education in the BSc

## **Courses addressing Conceptual Airplane Design:**

- AE1201 Aerospace Design & Systems Engineering elements I 4EC
- AE2101 Aerospace Design & Systems Engineering elements II 3EC
- AE3201 Systems Engineering and Aerospace Design 3EC

## **Projects addressing Conceptual Airplane Design:**

- AE2100 Thematic project: “wing design” 5EC
- AE3200 DSE (quite some every year) 15EC

## **MSc Courses addressing Airplane Design:**

- New course on MDO for aerospace applications (a multidisciplinary wing design optimization) 4EC

# Better or worse?

Old Aircraft Design course has **merged** with

- Aircraft Systems course,
- Space design courses
- Systems Engineering course.

Then has been **split into three courses** taught at the first, second and third Bachelor year

...for a total of about 4.5-5 credits (vs. 7 in the old course)

# What's the deal?

## **Conceptual Airplane Design content**

- AE1201 Aerospace Design & Systems Engineering elements I
  - Design process, analysis of requirements and certification aspects
  - Aircraft configurations
  - Preliminary weight estimation and sizing (matching plot)
- AE2101 Aerospace Design & Systems Engineering elements II
  - Wing and some systems (HLDs, fuel system, de-icing, etc..)
- AE3201 Systems Engineering and Aerospace Design
  - Refined weight estimation
  - Stability and control (Tail design)

# Current problems

- By splitting the course over three years, **the design cycle is broken** and the student focus discontinued. **The appreciation & execution of important design iterations are largely lost.**
- Students **lacks some of the knowledge** required to follow the module on Wing and HLD analysis (aerodynamic course starts later).
- Lowered quality in DSE projects on aircraft design
- Students in the MSc lack the necessary vision of the aircraft as a whole (while we are trying to educate them on more specialist disciplines as required by the T-shape educational model)
- Students learning MDO for aerospace application lack the “design sense”



# Thereby the survey

1. To understand how others are doing
2. To get feedback and suggestions
3. To start a discussion on Aircraft Design education (possibly including not only academia)
4. To find the set of solutions that better fit the specific situation (e.g. amount of students)

# The questionnaire on Aircraft Design (AD) Education

1. Do you teach AD at BSc or MSc?
2. How large is the course in terms of length/credits
3. How many students are taking the course?
4. What are the topics covered?
5. Teaching methods
6. Assessing methods
7. Study material (notes, textbooks)
8. Use of support software (in house/commercial)
9. Availability of course material for externals?
10. Level of (teacher's) satisfaction
11. Proposed improvements/current limitations

# Results

- 14 filled questionnaires
  - 4 Italy (Pisa, Napoli, PoliMI, PoliTO)
  - 2 Russia (MAI)
  - 2 France (Sup)
  - 4 Germany (TU Hamburg, Berlin, Aachen)
  - 2 Sweden (LIU, KTH)

By the way, THANKS!!!

# Do you teach AD at BSc or MSc?

	MAI	RTWH	Pisa	Naples	Milano	Hamburg	LIU	SupAero	Polito	TU Berlin	KTH	TUD	(%)
BSc 1												x(50%)	3
BSc 2										x		x(50%)	11
BSc 3		x						x				x(40%)	18
MSc 4	x	x				x, (x)	x	x			x	(x,x)	46
MSc 5	x		x(40%)	x	x				x(50%)				30

(x): Beyond classic AD (e.g., MDO, advanced aerodynamics,...)

(%): AD subject as percentage of the course size

# Size of the course

	MAI	RTWH	Pisa	Naples	Milano	Hamburg	LIU	SupAero	PoliTo	TU Berlin	KTH	TUD
BSc 1												4(50%)
BSc 2										6		3(50%)
BSc 3		5						40h				3(40%)
MSc 4	8	5				?, (?)	6m nts	30h			9	(4,4)
MSc 5	12		12(40%)	9	8				8(50%)			
total	20	10	3	9	8	?	?	?	4	6	9	5(13)

(x): Beyond classic AD (e.g., MDO, advanced aerodynamics,...)

(%): AD subject as percentage of the course size

# How many students taking the course?

	MAI	RTWH	Pisa	Naples	Milano	Hamburg	LIU	SupAero	PoliTo	TU Berlin	KTH	TUD	TOTAL
BSc 1												400+	
BSc 2										90		350	
BSc 3		100						180				300	
MSc 4	15	100				25,25	25	60			30	(100,100)	
MSc 5	15		60	55	25				25				

# Teaching method

	MAI	RTWH	Pisa	Naples	Milano	Hamburg	LIU	SupAero	Polito	TU Berlin	KTH	TUD
BSc 1												L,DL
BSc 2										L, S, GP		L,IP
BSc 3		L,GP,I P						DL?				L,IP,GP
MSc 4	L,IP	L, IP				L,?P/L,DS ,IP	L, DL	L, GP			O	(L,S),(L,S,O)
MSc 5	L,?P		L,IP	L, ?P	L, DL, S, GP				L, GP			

L: lecture

GP: group project/assignment

IP: individual project/ assignment

DL: design/computer lab

S: seminar

O: others

# Assessing method

	MAI	RTWH	Pisa	Naples	Milano	Hamburg	LIU	SupAero	PoliTo	TU Berlin	KTH	TUD
BSc 1												W,CT
BSc 2										?R, W,O		W,IR
BSc 3		W						?R				E, GR, IR
MSc 4	W,IR	W				W/O	GR	?R			W,O , IR,g R,C T,	(W),(W)
MSc 5	L,IR		O, ?R	W,O, GR	W,O				O, GR			

W: written exam

IR: individual (project) report

GR: group (project) report

O: oral exam

P: presentation

CT: computer test



# Study material

Almost all use combination of :

- lecture notes
- (part of) textbooks
  - Torenbeek
  - Raymer
  - (Roskam and Howe)
  - Not specified textbook



# Course description and study material accessible on the web to others?

	MAI	RTWH	Pisa	Naples	Milano	Hamburg	LIU	SupAero	PoliTo	TU Berlin	KTH	TUD
	n	n	y	?	y	?	n	y	y	n	y	n

In case of positive answer, not clear what is available.

# Enough aircraft design education?

suff	MAI
A lot	RTWH
suff	Pisa
Almost suff	Naples
?	Milano
Suff/a lot	Hamburg
Suff, but never enough	LIU
suff	SupAero
?	Polito
suff	TU Berlin
Too little	KTH
Too little	TUD

# What several teachers miss

- Possibility to build&fly
- More possibilities for the student to practice and develop “the design feeling”
- More contact/interaction teacher student
- MDO
- ...

**Can we draw any conclusion?**