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KATEDRA AWIONIKI I STEROWANIA

Tomasz Rogalski

In-Flight Tests in Students Projects

EWADE & READ 2018
EWADE 2018 - 14th European Workshop on Aircraft Design Education
Brno University of Technology, Czech Republic
7th to 9th November 2018

EWADE Session
08.11.2018, 14:10 to 15:50
http://Presentations2018.AircraftDesign.org

Origins of Flight Tests…

Aviation, science, education, flying laboratories for in-flight tests existed at Mythic Age already

aviation	• myth
science	• concept
flying laboratory	• wings
education	• lesson learned

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Flying Laboratories all over the World

There are lots of flying laboratories used in science and aducation activities in the World at present

- aircraft
- balloons
- rockets
- helicopters
- **and many others**

Flying Laboratories all over the World

There are lots of flying laboratories used in science and education activities in the World at present

- Cranfield University
- Delft University of Technology
- Technical University of Munich
- Technical University of Pensylvania
- **and many others**

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Why Do They Use Flying Laboratories?

What Fields Can We Use it On?

- Aircraft on-board Equipment
- Flight Aerospace Control Systems
- Flight Instrument
- Aircraft Installations
- Durability and Diagnostics of Aerospace Devices
- Aerospace Measure Systems
- Flight Testing
- other

Where in Education Can We Use it to Conduct In-Flight Tests?

- Regular student lessons
- Student projects
- Diploma projects
- Doctoral student research
- Other student activity

Scope of the Presentation

Not to

- present structure of flying laboratories
- present their development process
- answer the question: how, when, where, who developed them.

To

- give specific samples of usage flying laboratoriesi in flight tests in education
- present possibilities their applications
- familiarization with flying laboratories

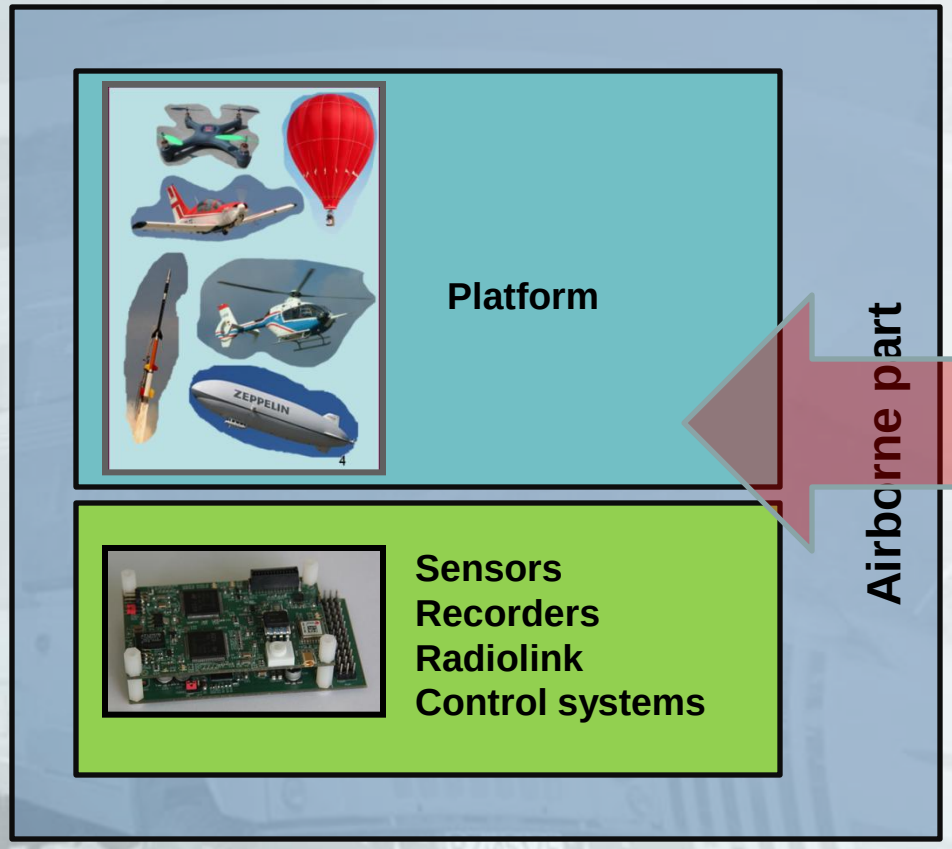
AND

- to down some myths

Some Myths Should be Downed

- In-flight tests are always very expensive
- Flying laboratory is always very sophisticated facility
- In-flight tests require staff having extraordinary skill
- There is no possibility to involve them into standard student courses

Let's Start from the General Structure …



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… and Proceed to Details









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Optionally Piloted Vehicle

- MTOW 495kg
- Max. Airspeed (Vne) 270 km/h
- Min. Speed 65 km/h
- 2 seats

Optionally Piloted Vehicle

Research and education

- flight tests of control laws for ultralight aircraft
- tests of heavier onboard equipment
- activities for 4 students at the same time – two person on board the aircraft and two persons in the car (ground station)
- relatively low operating costs

Limits

- only two students on board

Optionally Piloted Vehicle – Diploma Project

Title	• Aircraft handling qualities assesment in selected flight phases
Author	• student of Aviation Faculty
Objectives	• in-flight test maneuvers preparation • In-flight experiments and data analyzes
Content	• Handling characteristic during typical flight phases (horizontal flight, coordinated turn). • Static and dynamic stability tests. • Aircraft characteristics during landing at different configurations.

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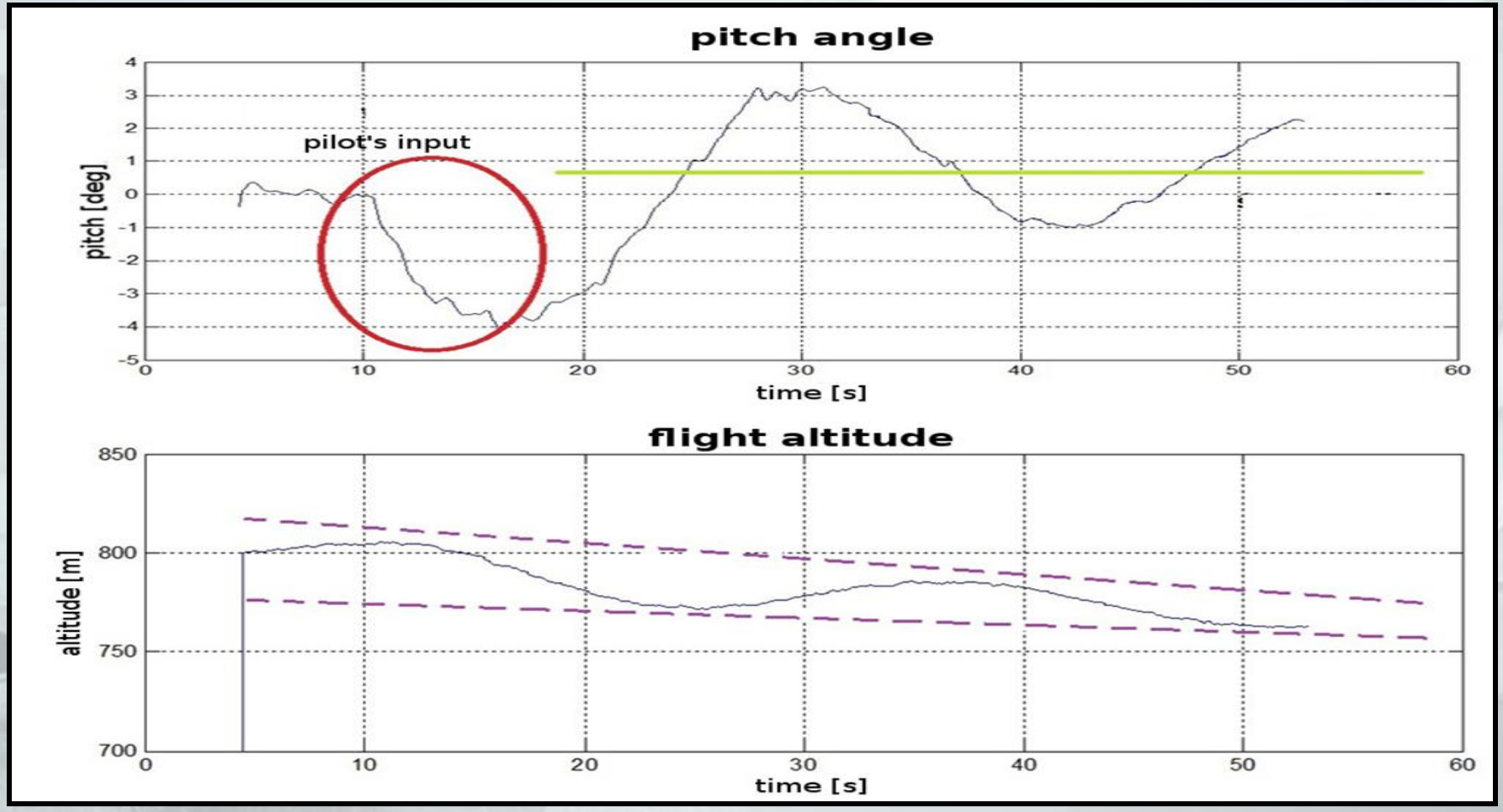
Optionally Piloted Vehicle – Diploma Project

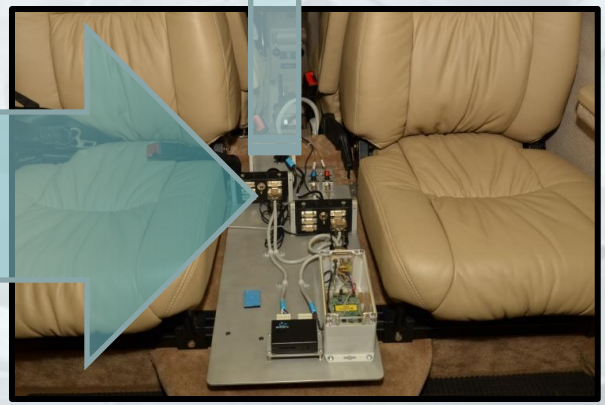
Longituidal Stability Tests

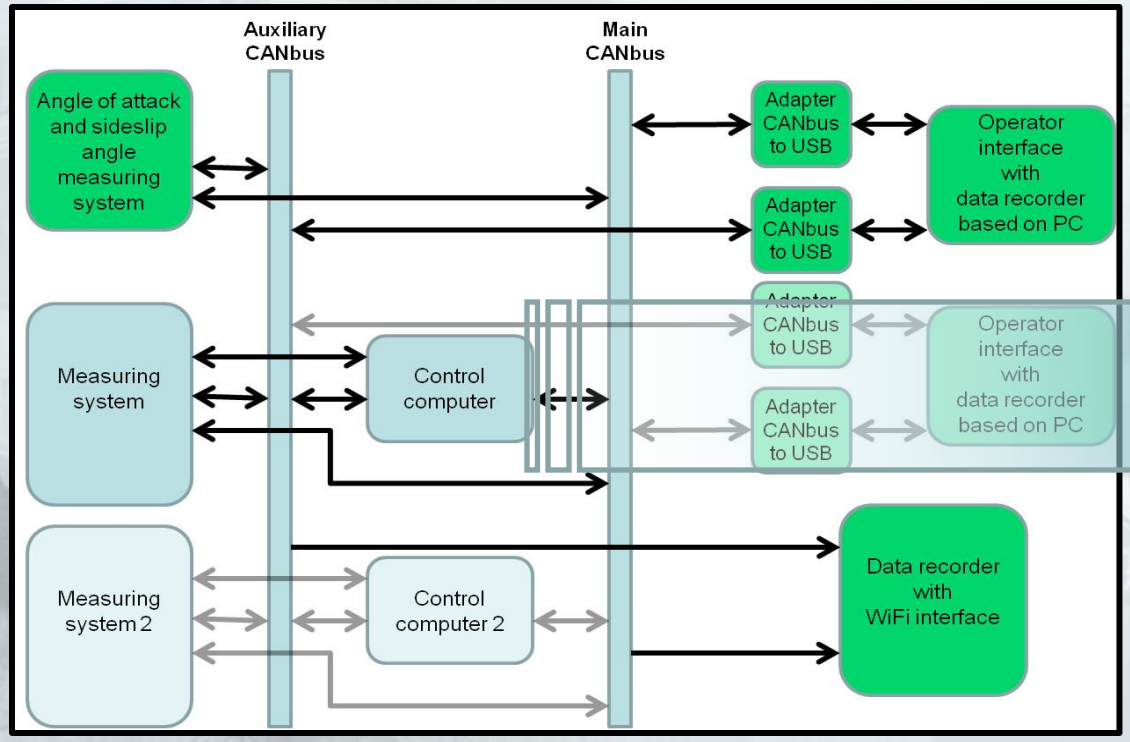


General Aviation Plane

Piper Seneca V

- MTOW: 2155 kg
- Never exceed speed: 378 km/h
- 6 seats





General Aviation Plane

Research and education

- flight tests of control laws for general aviation planes
- tests of heavier onboard equipment
- activities for small group of students – six persons on board the aircraft

Limits

- the higher operating cost
- MEP(L) pilots rate required

General Aviation Plane – Diploma Project

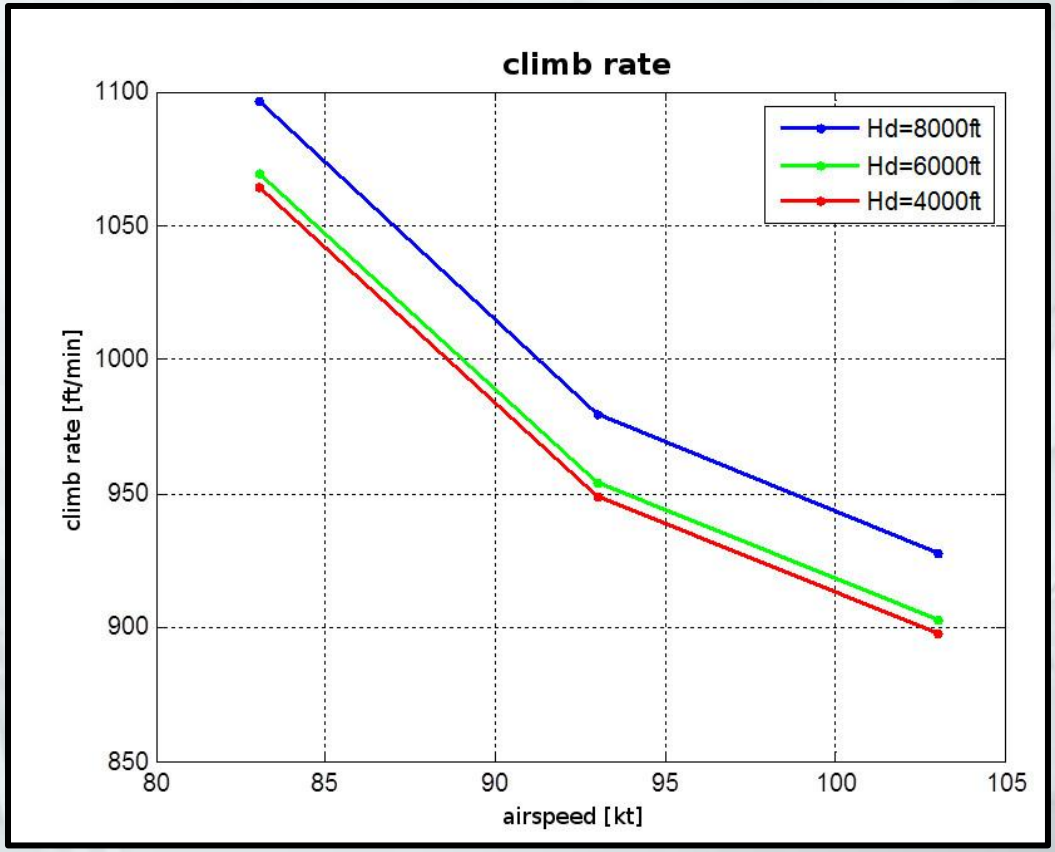
Title	• Investigation of general aviation aircraft performances
Author	• student of Aviation Faculty
Objectives	• in-flight test maneuvers preparation • In-flight experiments and data analyzes
Content	• Max speed at horizontal flight investigation • Climb rate investigation • Stall speed investigation.

General Aviation Plane – Diploma Project

Climb Rate Tests

	Pomiar co 30 sek.	Pomiar w odstępach 1-minutowych, lewy i prawy silnik			
Czas	**Wysokość**	**Obroty silnika**	**Ciśnienie ładowania**	**Temperatura na wlocie silnika**	**Temperatura otoczenia**
min.	ft.	RPM	in. Hg	°F	°F
0	3000	2500	32	1311	32
		2500	32	1283	
½	3540				
1	4060	2495	32	1301	26.6
		2500	31.5	1280	
1 ½	4620				
2	5080	2500	31.5	1278	24.8
		2500	31.5	1264	
2 ½	5520				
3	6000	2495	31.5	1271	24.8
		2505	32	1261	
3 ½	6520				
4	6980	2500	315	1266	24.8
		2510	32	1258	
4 ½	7440				
5	7900	2505	31.5	1264	21.2
		2510	32	1254	
5 ½	8360				
6	8860	2505	31.5	1263	19.4
		2510	32	1251	
6 ½	9040				

Original recorded data



Gliders

Gliders

- MTOW: about 500 kg
- Never exceed speed above 200 km/h
- 1 or 2 seats

Gliders

Research and education

- flight characteristics investigation
- portable devices tests
- low operational costs - cheap in use

Limits

- only one student on board
- non complex devices applied

Portable flight data recorder (Puchacz)

. Symbols pointing airbrakes positions (PW-6)

Gliders – Diploma Project

Title
- Investigation of airbrakes efficiency

Author
- student of Aviation Faculty

Objectives
- Investigation of airbrakes eficiency
- In-flight experiments and data analyzes

Content
- Investigation of airbrakes efficiency during flight at different airspeeds
- Tests done for different types of gliders
- Reports about test flights

Gliders – Diploma Project

Title

- Investigation of G-force during glider aerobatic flight.

Author

- student of Aviation Faculty

Objectives

- Investigation of G-force magnitude
- In-flight experiments and data analyzes

Content

- Problem statement
- Equipment development
- In-flight tests done
- Reports about test flights preparation

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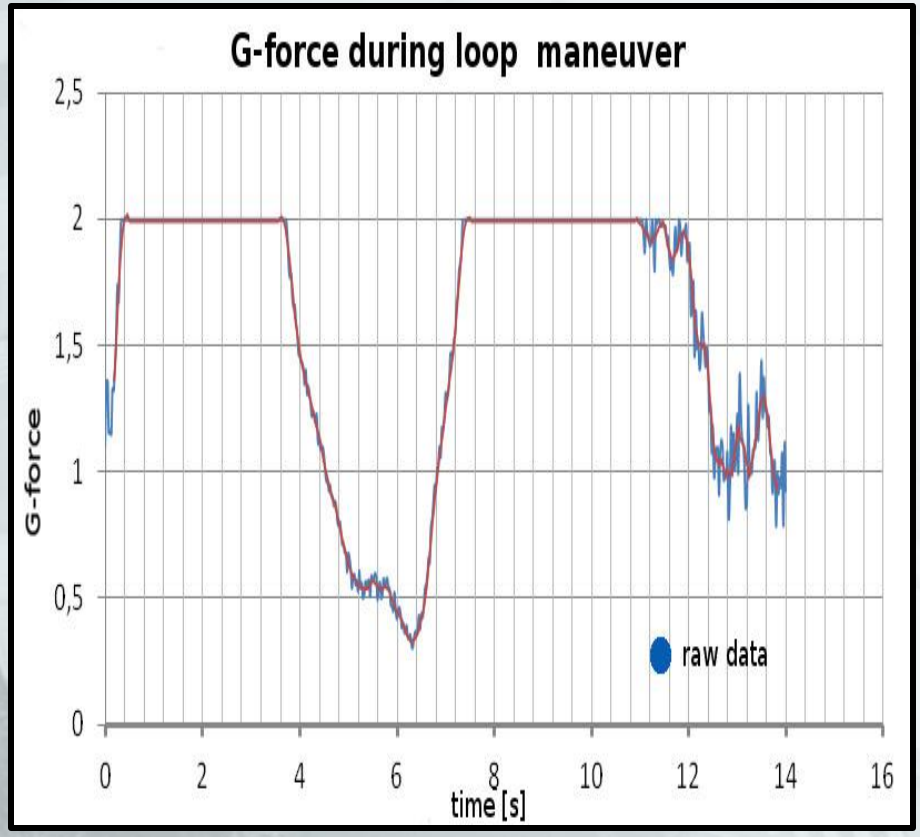
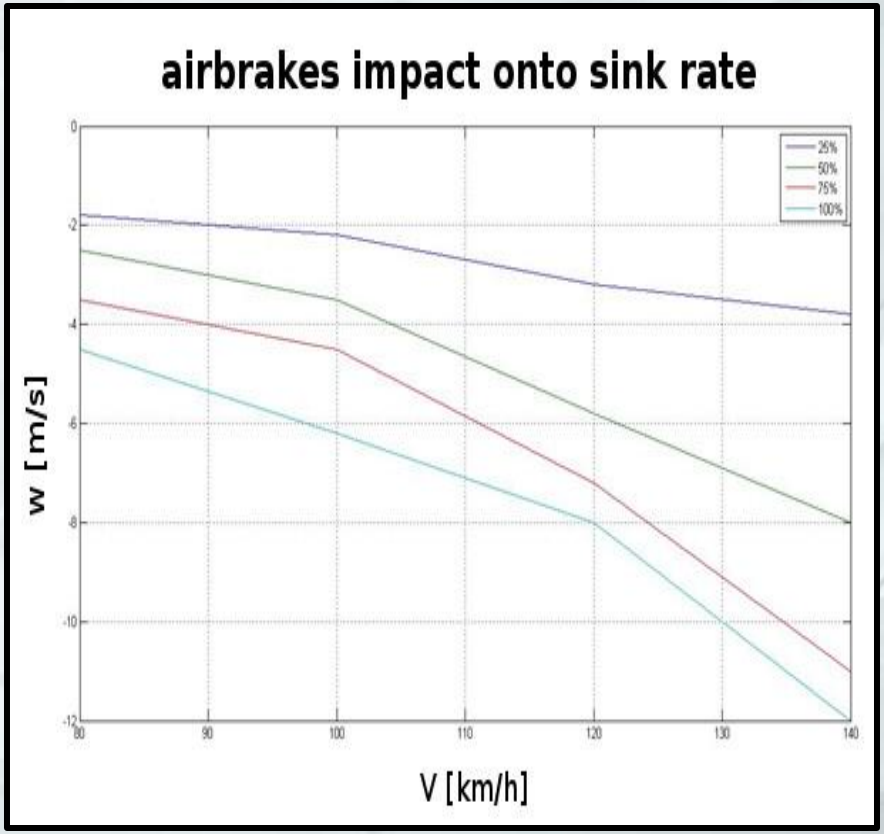
Gliders – Diploma Project

Results of Flight Tests

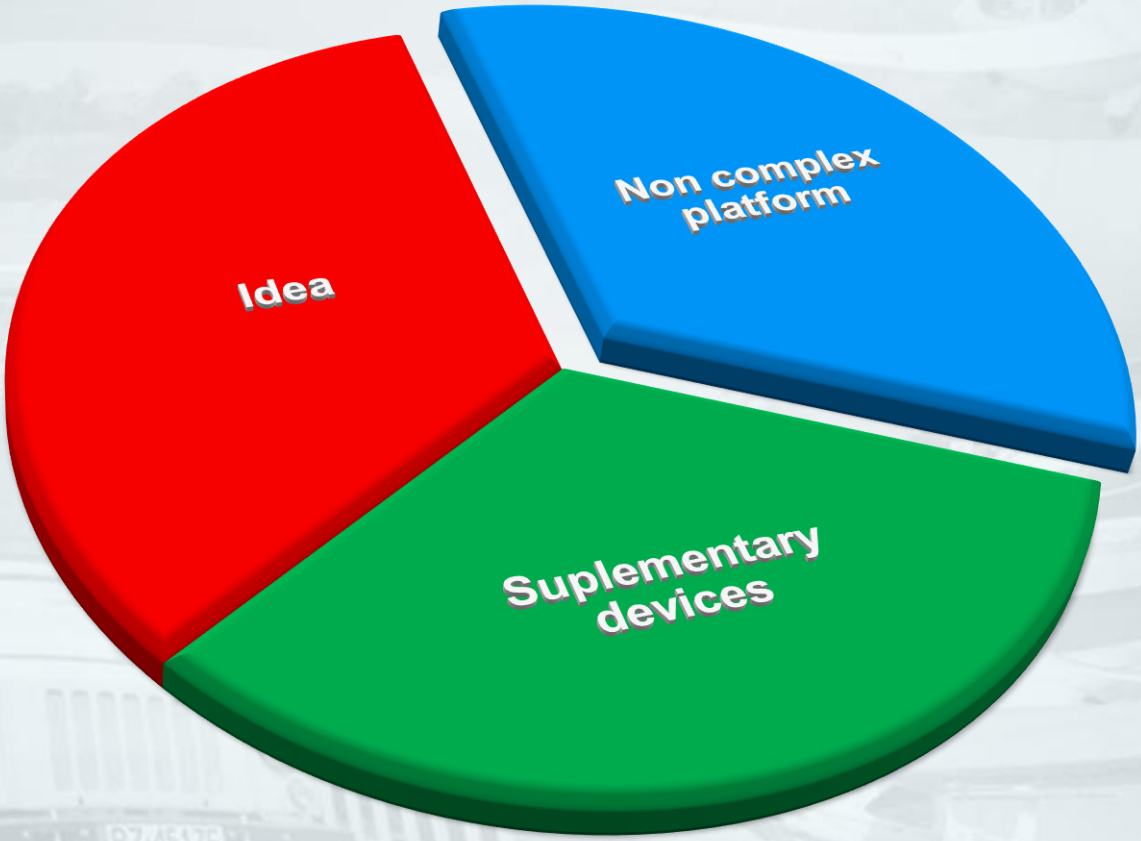


„Investigation of G-force during glider aerobatic flight”

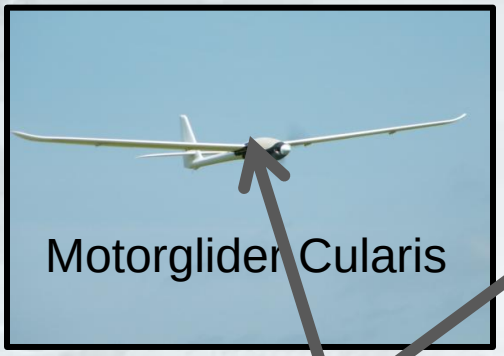


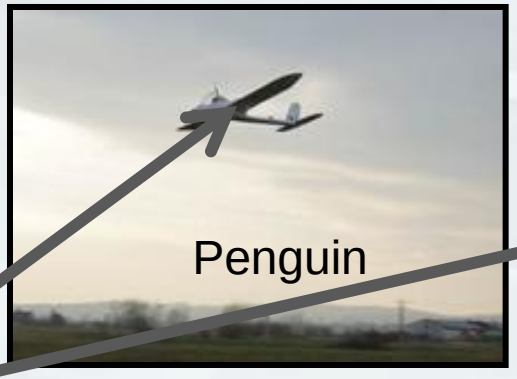
„Investigation of airbrakes efficiency”

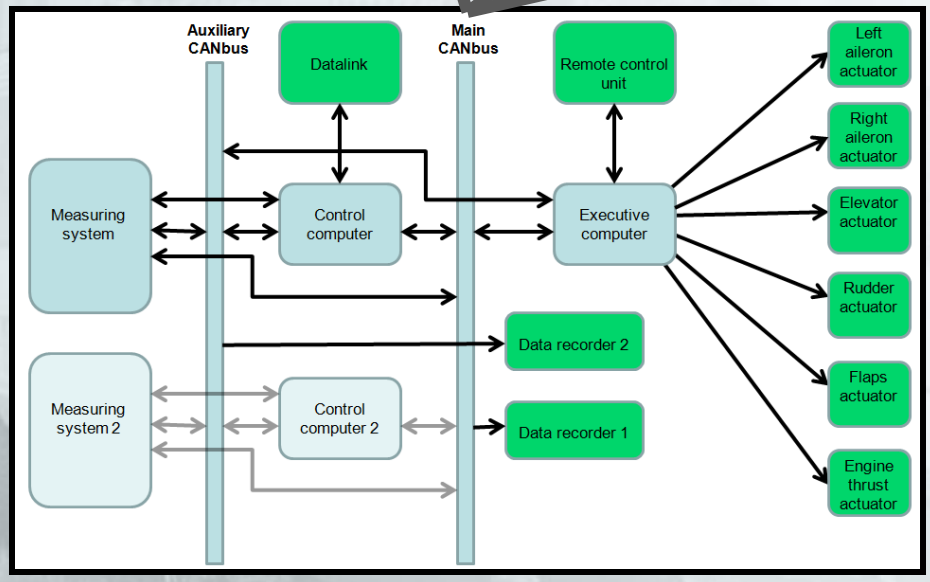
Non Complex RPAS Sets

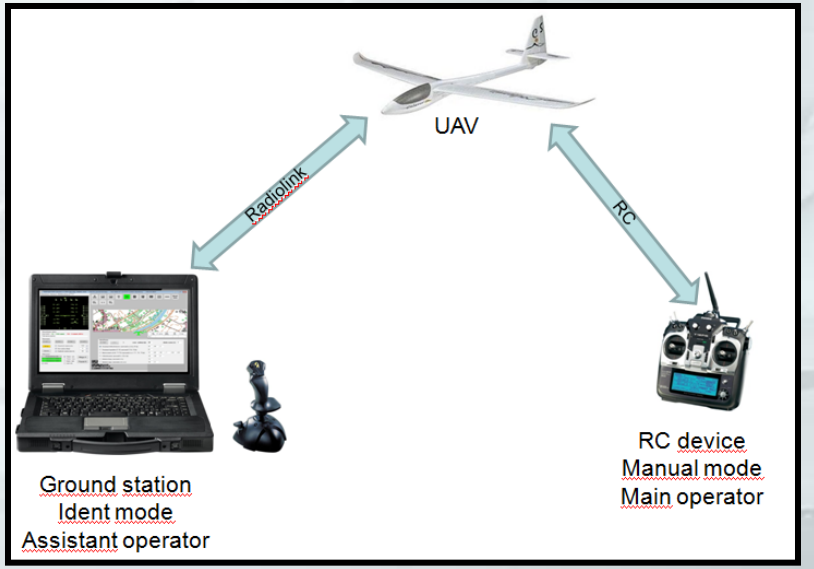


Non Complex RPAS Sets









Non Complex RPAS Sets

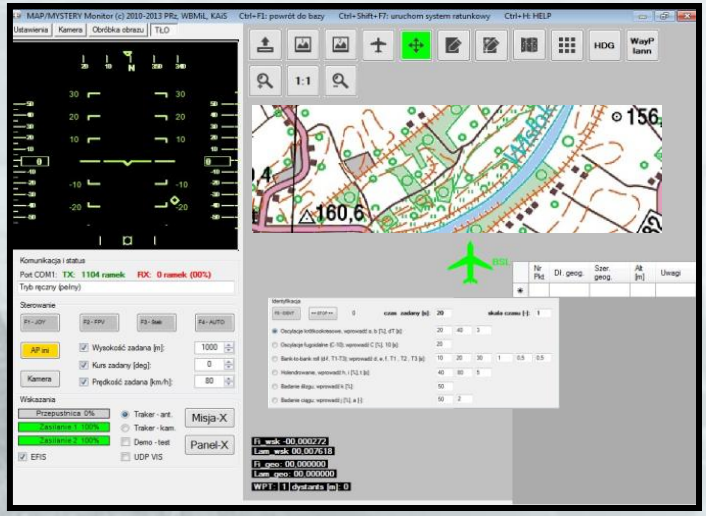
Research and education

- flight tests of control laws for small unmanned aerial vehicles
- identification and verification of a mathematical model of small flying constructions
- tests of small onboard equipment
- flight tests of remotely piloted systems in high-risk situations
- activities for big group of students
- training operators of unmanned aerial vehicles
- very low operating costs

Limits

- strong dependency on weather conditions
- too little space for additional equipment

Non Complex RPAS Sets - Regular Lessons



Courses:

- aircraft control systems
- flight recorders and data analyses
- aviation radio systems
- In-flight tests
- aerodynamics
- …

Conclusion

For these reasons flying labs are welcome solutions