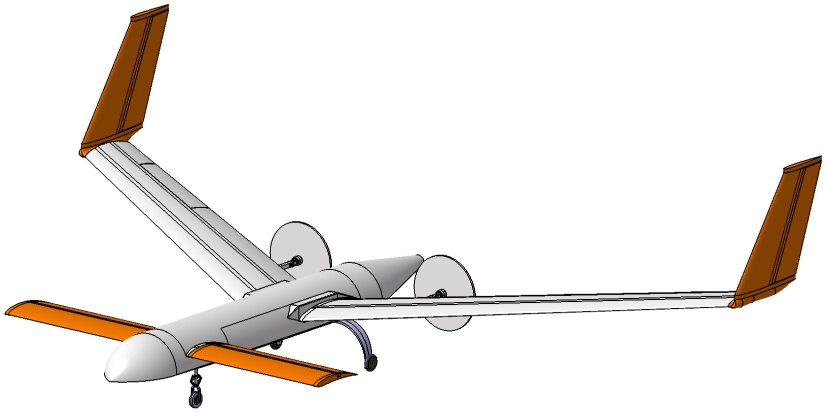
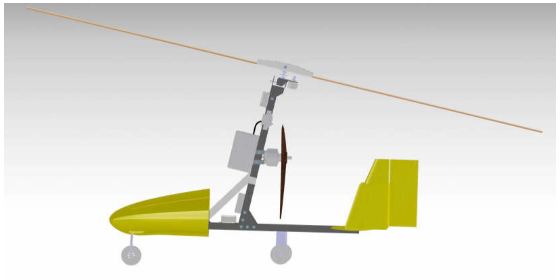
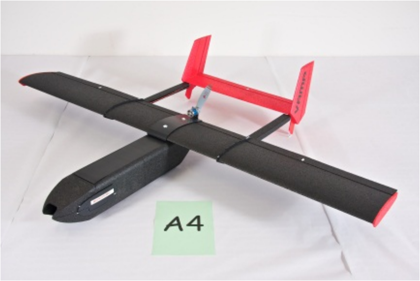
# Development of UAS for scientific monitoring

http://ewade2013.AircraftDesign.org
http://dx.doi.org/10.5281/zenodo.546608








11th European Workshop on Aircraft Design Education, Linköping, 17.-19.09.2013

17/9/2013 R. De Roo, J. Verbeke, I. Becuwe

# Aeronautical training

vives

ASSOCIATIE
K.U.LEUVEN

khbo
KATHOLIEKE HOGESCHOOL
BRUGGE - OOSTENDE

vives university college
KU Leuven association

KATHOLIEKE UNIVERSITEIT
LEUVEN

**Prof. Bachelor**
**-ATPL**
**-Technology**

**Academic Bachelor**
**Master**

# Aeronautical training

vives @ Flanders aerospace Competence center

**Faculty Engineering Sciences & Technology – Dept. Aeronautics:**

Located in Belgium at International airport of Ostend-Bruges (EBOS)

# UAS?

UAS (Unmanned Aerial System)

UAV
(Unmanned Aerial vehicle)

Groundstation
(Telemetry, communications, command)

# UAS developments

<u>Creating a UAS competence centre:</u>

- ➢2004~2010: uncoupled projects/theses
  - Conceptual design of a mini-UAV with methanol fuel cell
  - UAV data monitoring
  - Telemetry and data acquisition for VUT 700 Specto UAV
  - …

- ➢2010: Focus on scientific research with UAS

➔ Litus project

# Litus

## Project description:

- 3-year project (summer 2010 – summer 2013)
- Aim: Development of a UAS platform for scientific monitoring of the Flemish coast and North Sea
- Collaboration Vives/ KULeuven / foreign universities / industrial partners
- Extended to summer 2014

# Litus

<u>Application:</u>

- ➢To improve coastal weather forecasts models through daily measurements along the coast

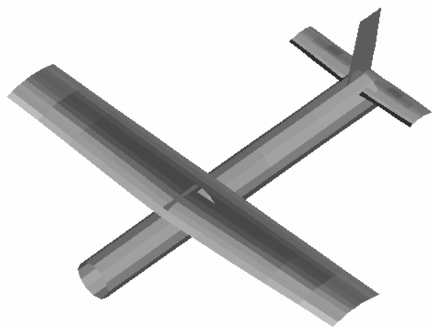
- ➢Flexible payload implementation
  - – Payload test platform
  - – Pollution detection
  - – Coast police assistance
  - – SAR
  - – …

# Litus

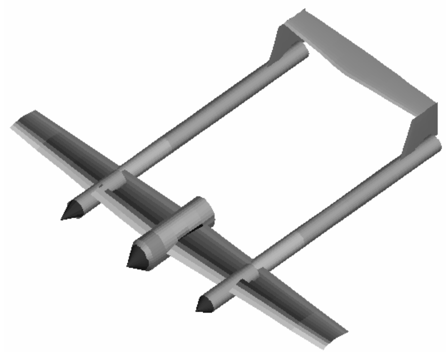
Conceptual design phase

- Exploration of legislation (or lack thereof)

- Aerodynamics and performance of three configurations investigated by Master students Vives



**Conventional**



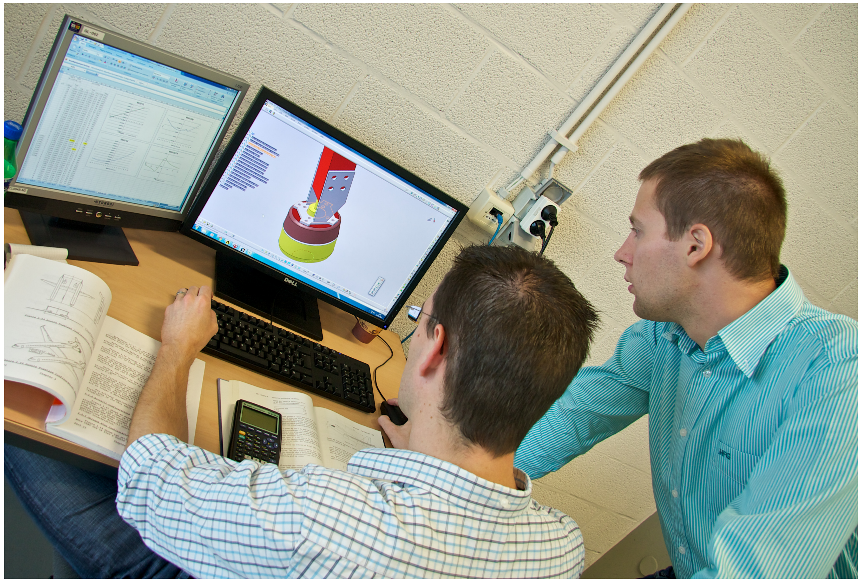
**Twin boom**

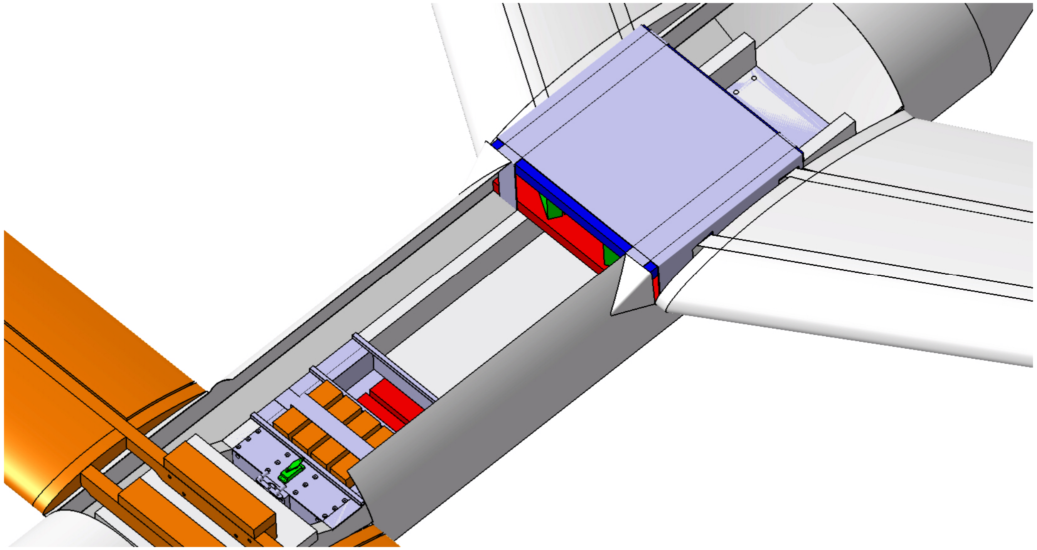
**Canard**

# Litus

## Detailed design phase – 3D design

- Mainly by design team

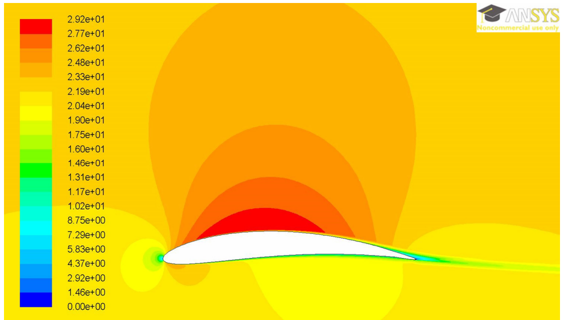




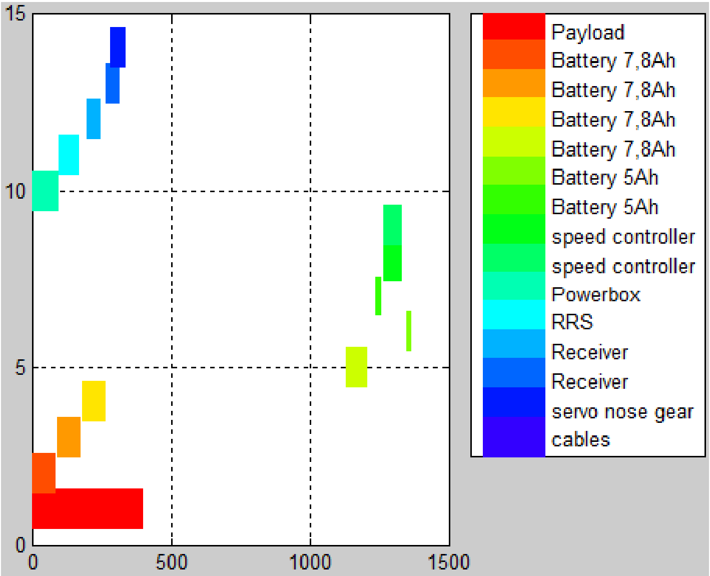
**Useable volume = 0,7 x 0,5 x 0,3m**

# Litus

## Detailed design phase – stability




- ➢Basic CFD analysis: Master thesis Vives
- ➢Weight & Balance for stability: Master students KULeuven

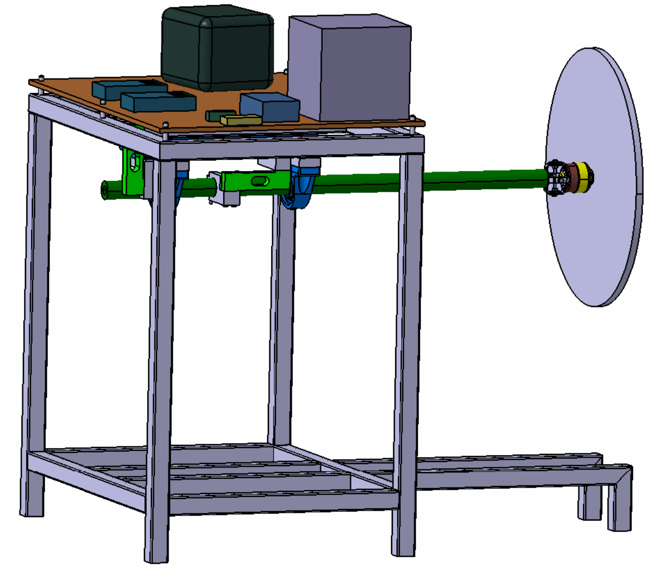


# Litus

## Detailed design phase – motor

- Unknown performance COTS motor/propeller

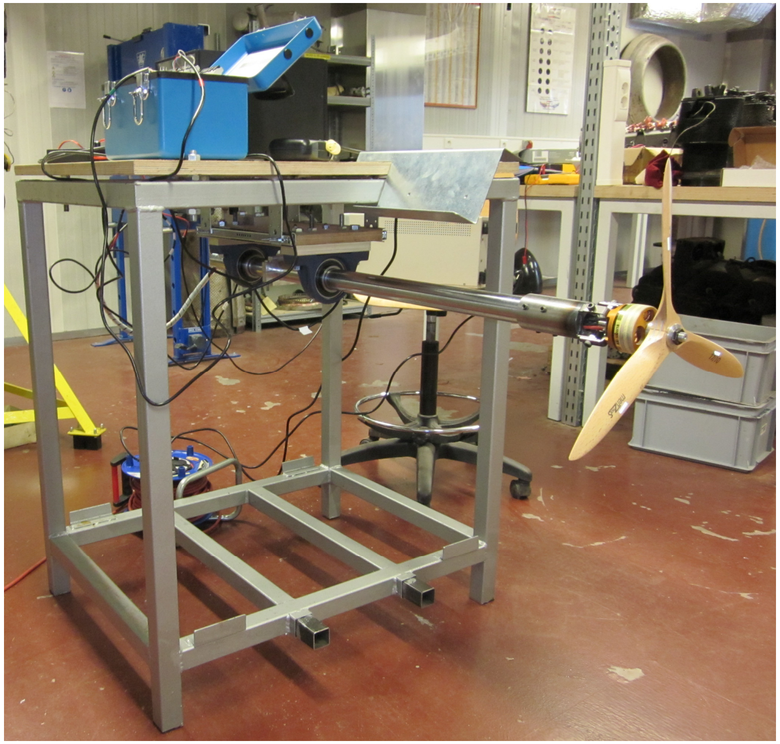
- Design and construction of test bench by a Vives and Erasmus (Brno) student



# Litus

## Detailed design phase – motor

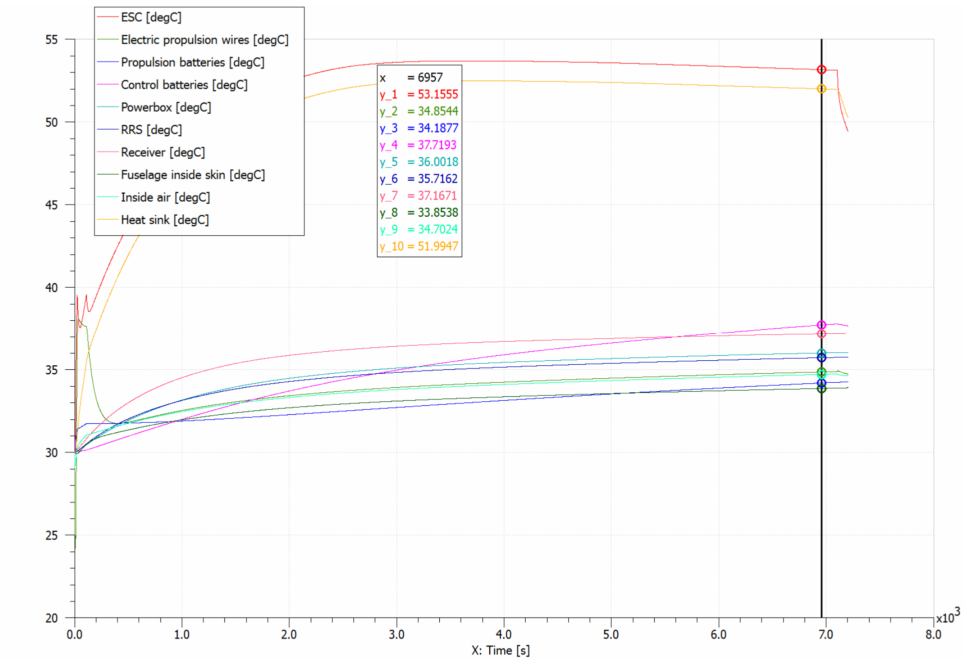
- Testing: Erasmus student (Madrid)

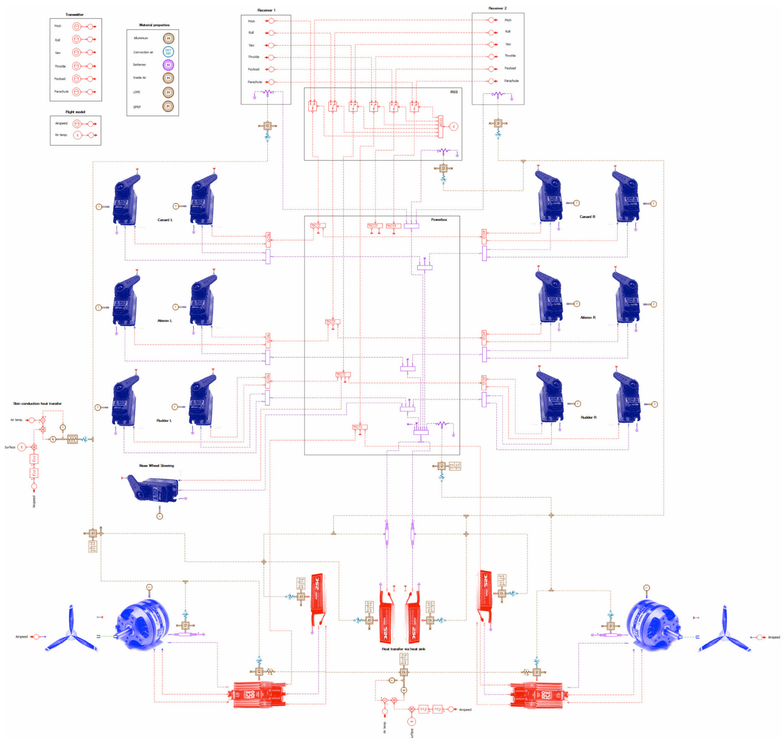


# Litus

## Detailed design phase – performance

➢Energy management and thermal simulations: Master thesis Vives & LMS

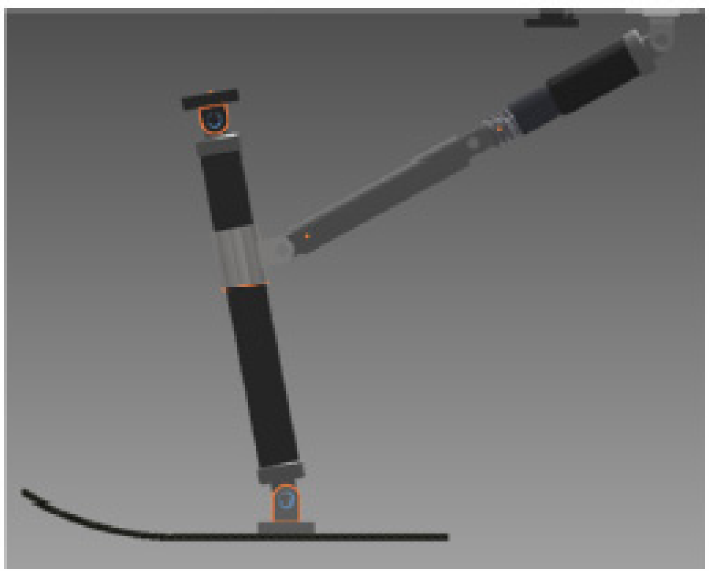


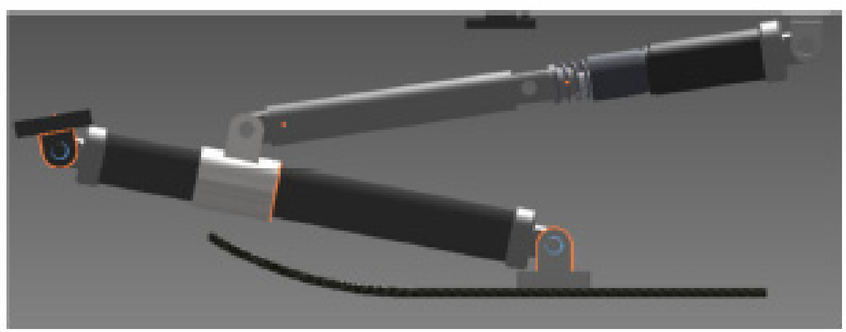



# Litus

## Detailed design phase – landing gear

- Development: Integrated practicum Master KULeuven
  - Too expensive and complex
  - New simple design by design team

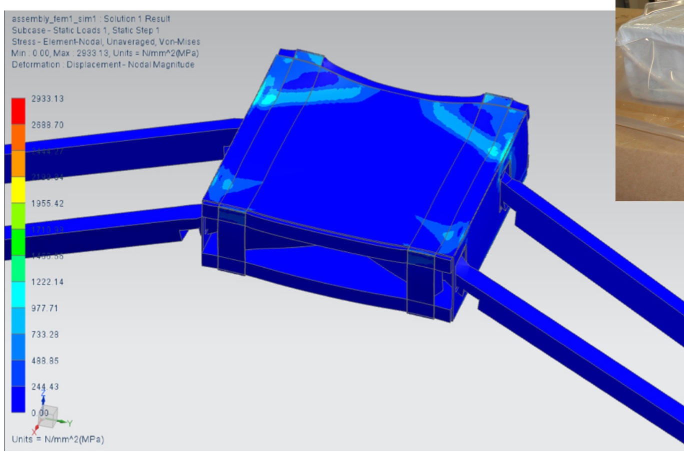




# Litus

## Detailed design phase – wing box

- Finite element modelling, prototyping and testing: Master Vives




# Litus

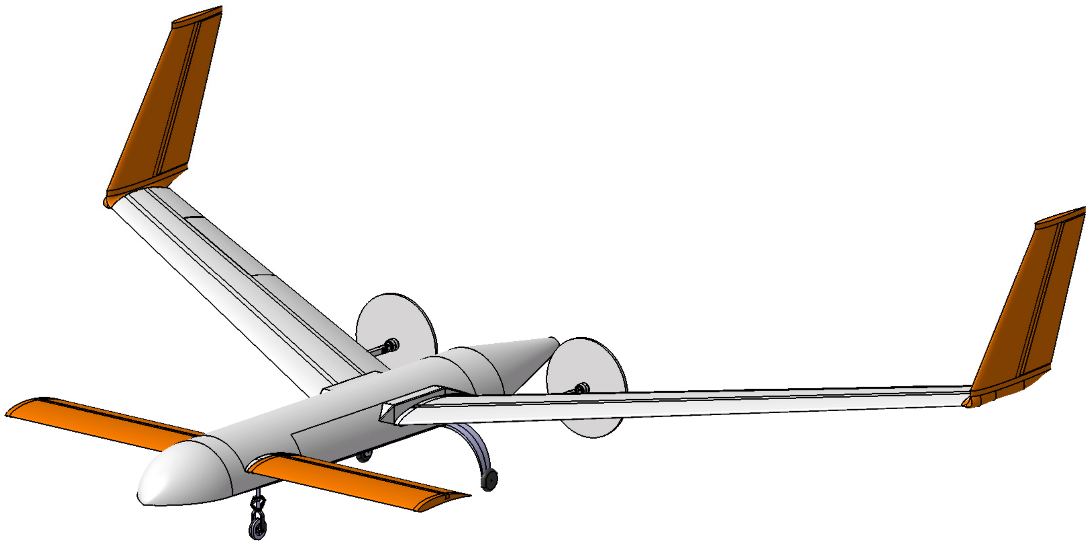
## Detailed design phase – safety

- Separated electrical systems propulsion, flight control and payload
- Redundant control system (receivers, flight controls, …)
- Onboard aircraft monitoring sent through telemetry to ground station
- Autopilot (assisted) flight
- …

# Litus

## Detailed design phase

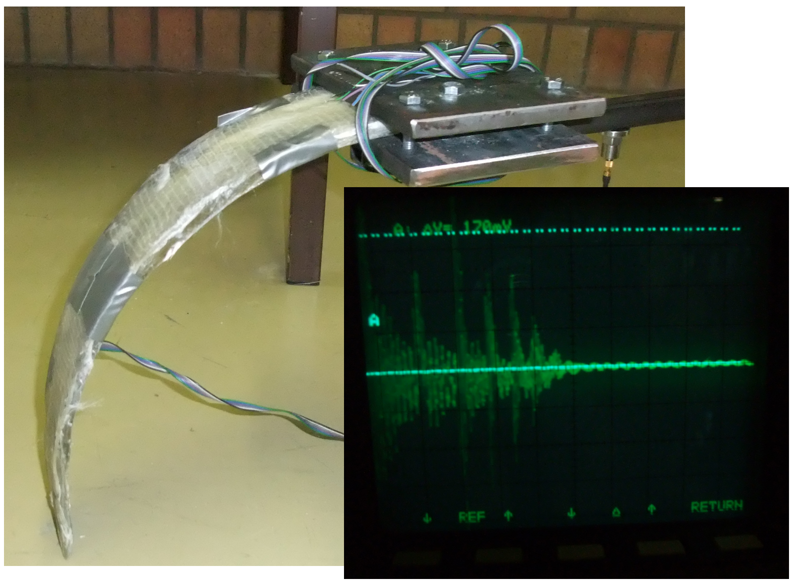
- ➢Lifting canard configuration with two push propellers
- ➢Lightweight glass fibre structure
- ➢Brushless DC motors
- ➢LiPo batteries
- ➢Cruise speed: 80km/h
- ➢Stall speed: 50km/h
- ➢Max endurance: 2h
- ➢Max range: 160km
- ➢Total mass: 65kg
- ➢Max payload: 15kg
- ➢Wing span: 6m

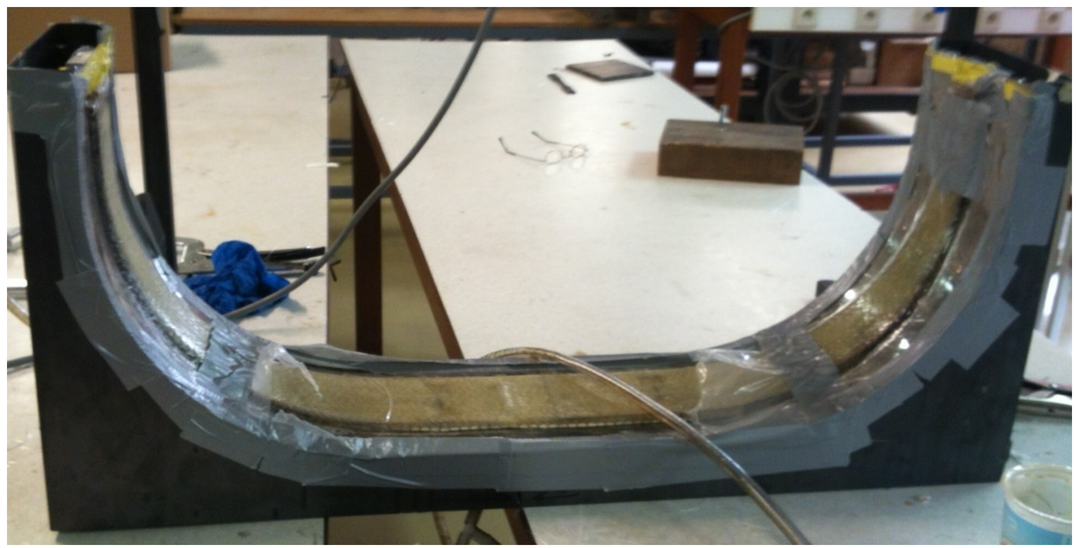


# Litus

## Production and testing– landing gear

➢Development, production and testing: Vives Polymer Engineering Master students

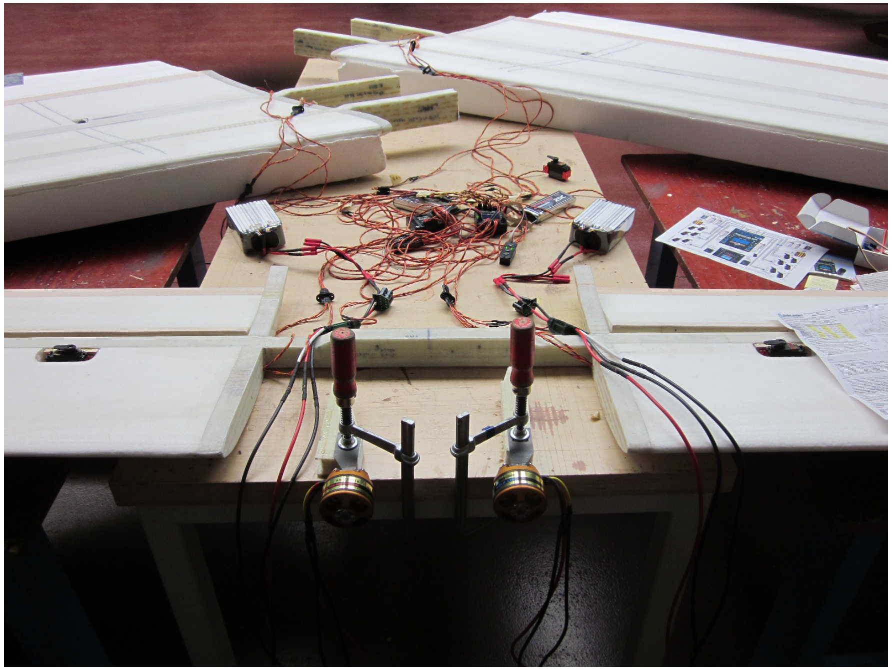


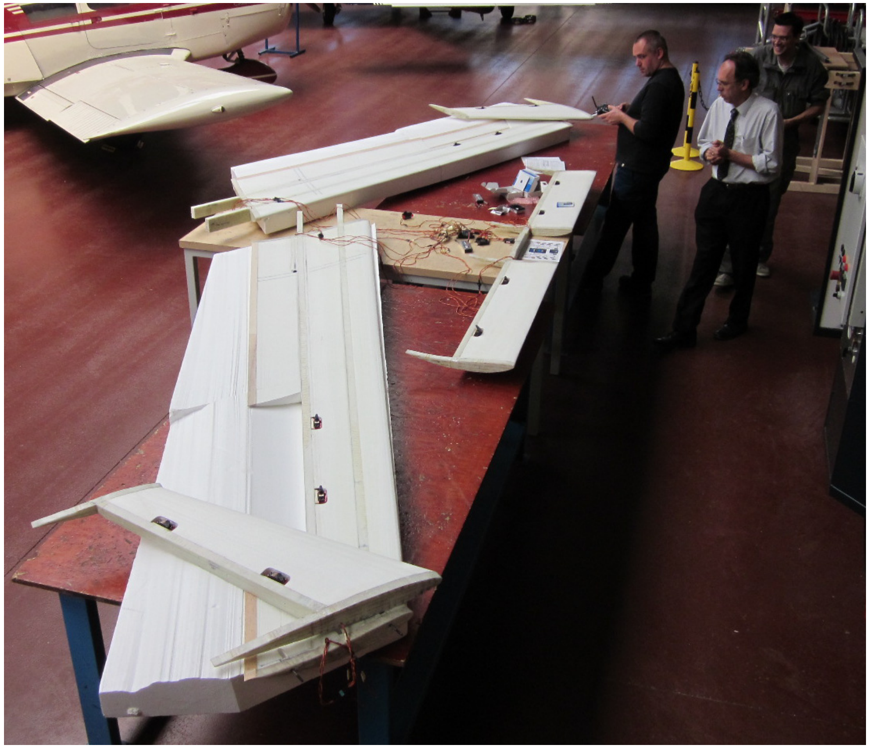



# Litus

## Production and testing – electrical system

➢Design team and Erasmus student (Brno)





# Litus

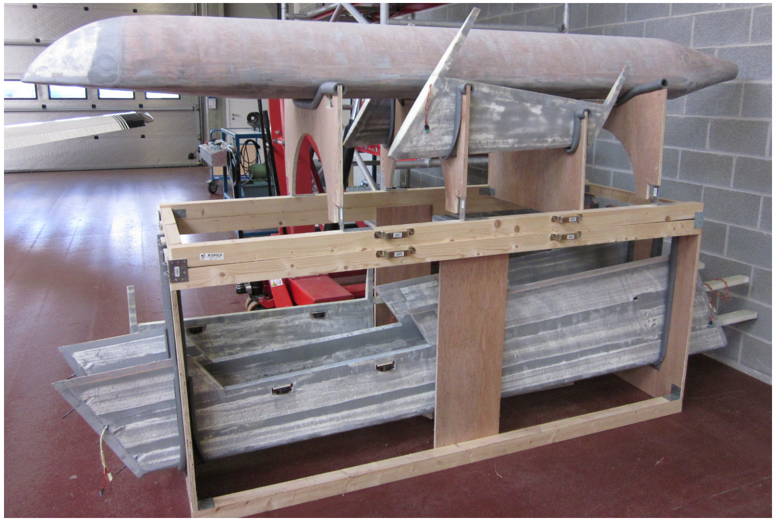
## Production and testing – glass fibre structure

- Design team, Erasmus student (Brno) and volunteers

# Litus

## Status

- ➢Finished:
  - Production of most parts
  - Electrical system
  - Safety documents for BCAA
- ➢In progress: Wing box
- ➢To do 2013-2014:
  - Final assembly and painting of parts
  - Autonomous control capabilities



- ➢First flight: summer 2014!!

# Parallel research

Development of the G55 UAV for Federal Police

➢Police helicopters are equipped with cameras (visual, thermal, ...) for observation

- No permit to fly in danger zones (nuclear power plant, fires, ...)
- Very expensive
- Limited flight time


➢Request to Vives:

**Develop a small UAV with 2kg payload**

# Parallel research

Development of the G55 UAV for Federal Police

- Two Vives Bachelor students calculated, designed and manufactured a 20kg UAV with 2m wingspan)

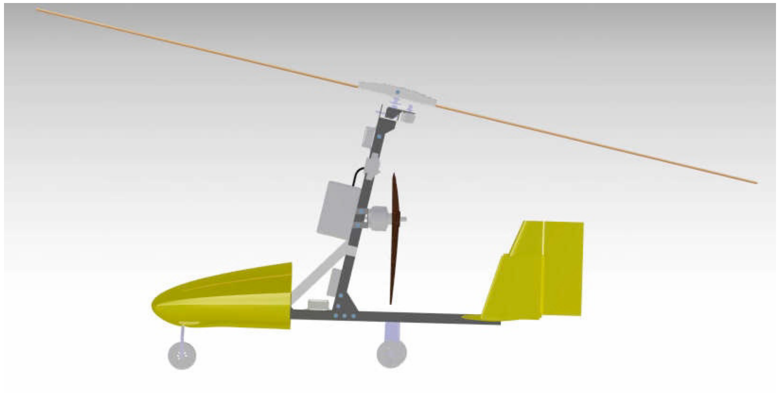
Successful test flight!

# Parallel research

## Development of a UAV autogyro

- Two Vives Bachelor students designed and manufactured a UAV autogyro

- Result:
  - Weight: 5kg (Payload: 0,5kg)
  - Rotor diameter: 2m



# Parallel research

## Development of a UAV airship

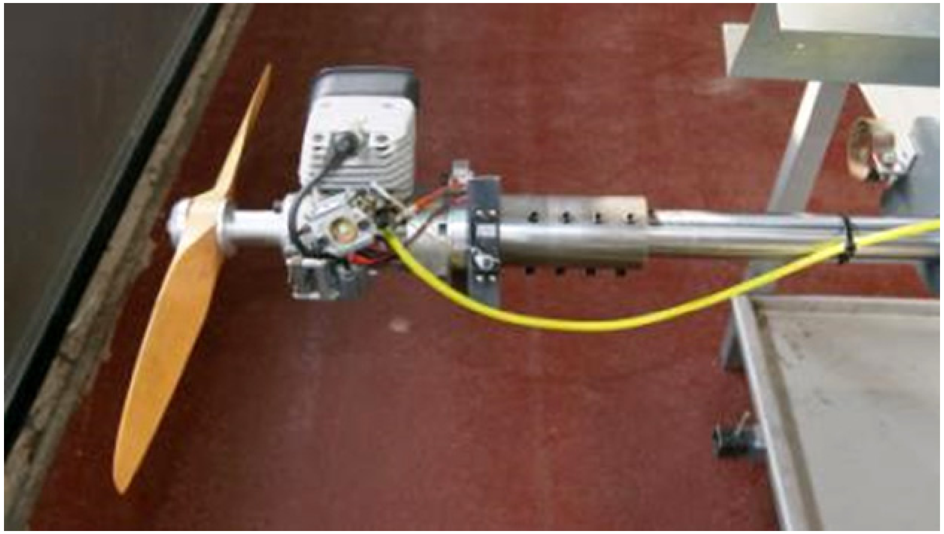
➢A Vives Bachelor student manufactured and automated a UAV airship based on existing plans

➢Result
- 1,7m Mylar bag
- Triple engine control
- Glass fibre gondola
- Helium filled
- Ultrasonic sensors for altitude control and obstacle avoidance

# Parallel research

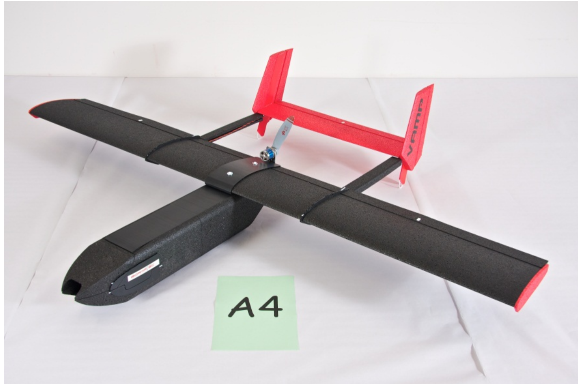
Modification of test bench for testing of small combustion engines

➢Request to Vives: UAV performance improvement by changing motor (Vives Bachelor student)



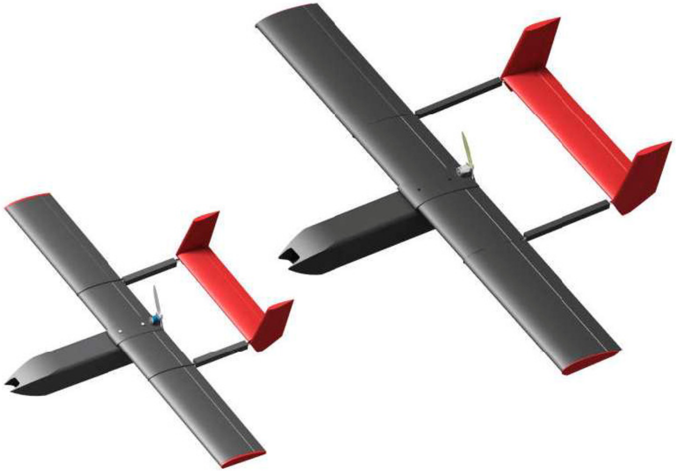
# Parallel research

## Reverse engineering of an existing UAV




- Reverse engineering
  - Aerodynamics
  - Performance
  - Stability and control

- Re-design with twice the payload

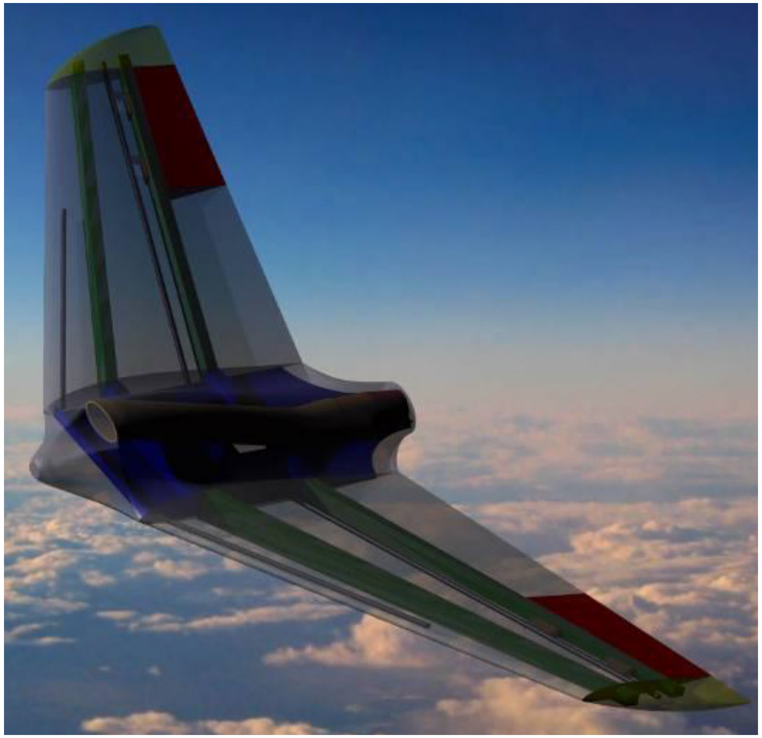


- Two Vives master students

# Parallel research

## Development of a UAV flying wing

- Two Vives Bachelor students designed a flying wing UAV
- Result
  - EDF tested
  - Production ready design

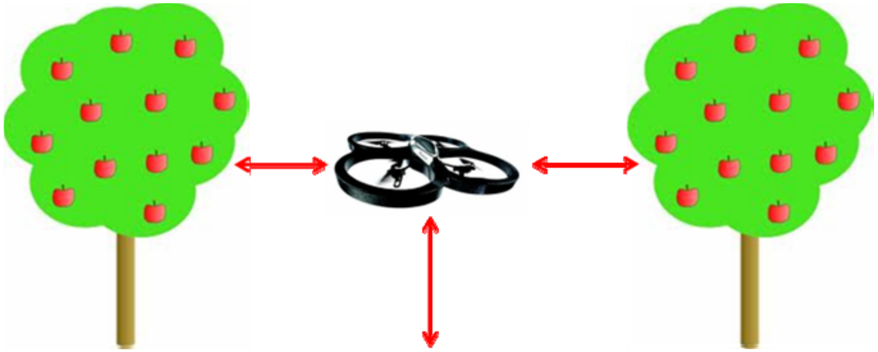


# Parallel research

## Doctoral research by Jon Verbeke

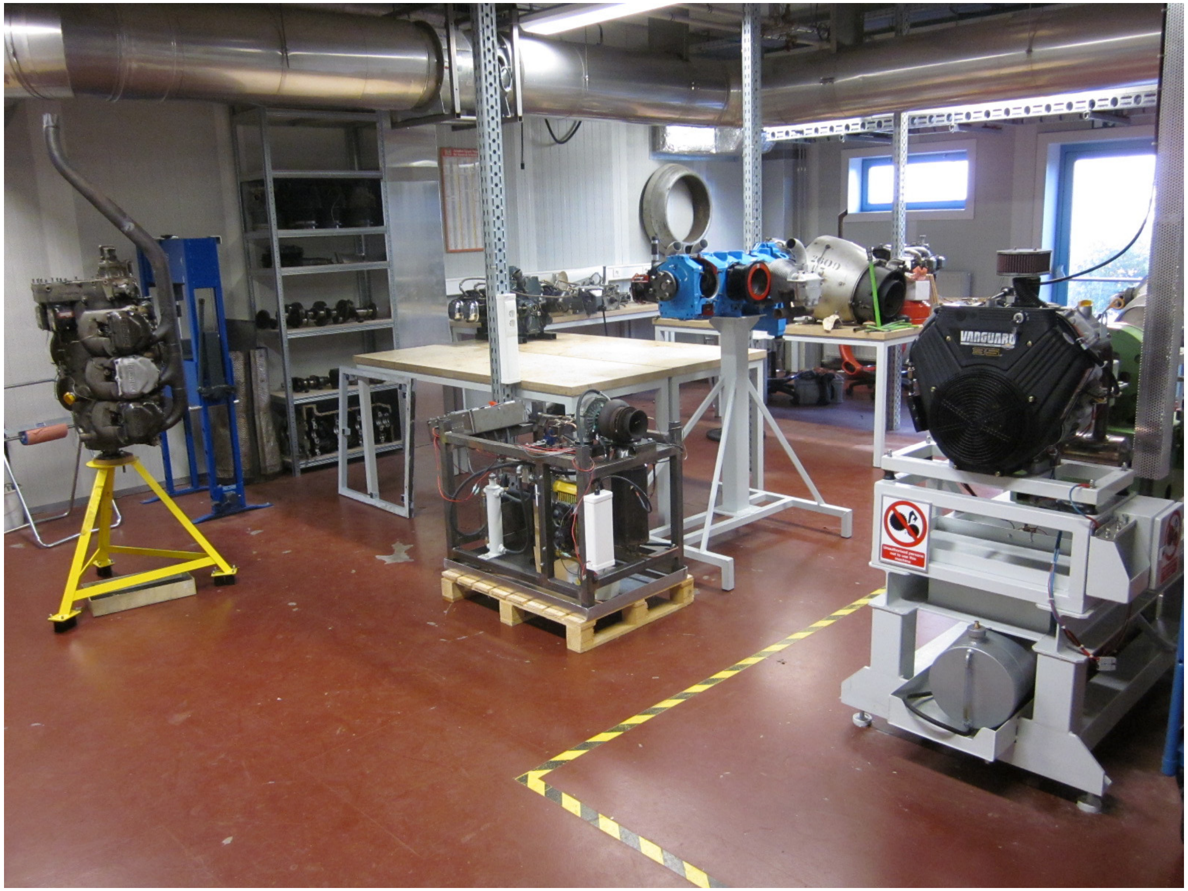
➢Autonomous rotary UAS for inspection of orchards and vineyards

- Autonomous navigation through orchards in between tree rows
- Cameras and image processing techniques perform fruit yield estimation
- Long endurance and innovative design for narrow passages



# Testing @ VLOC

Acoustic isolated engine test lab



# Testing @ VLOC

## Indoor flight lab for rotary UAS

- 7 x 7 x 4m volume
- Safety:
  - Net
  - Soft floor
- Near future: external camera positioning system

# Governmental work

➢2012: Vives participates in BeUAS

➢Is a member of the legislation workgroup which writes the new upcoming legislation together with BCAA

➢Is working together with the Federal government in selecting a suitable commercial rotary UAS for the Civil Defence agency with the purpose of disaster monitoring

# Conclusion

The Vives UAS competence centre

- Successful start
- More than 30 students, both national and international have been involved in UAS research and development
- UAS course from Sept. 2013
- In the future, the focus will lie on further expansion towards the industry and starting new projects together with other academia and companies.

# Questions?

vives

ASSOCIATIE KU LEUVEN

KU LEUVEN

LMS® A Siemens Business

ACROSOMA STRUCTURAL COMPOSITE TECHNOLOGY

Septentrio satellite navigation

UNIVERSIDAD POLITECNICA MADRID

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