DESIGN PHILOSOPHY AND REALIZATION OF AN EXPERIMENTAL AIRCRAFT SUPPOTRTING UAV APLICATIONS IN CIVIL SECTOR (VUT 001 MARABU)

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Designer of the VUT 001 Marabu and first author…

Introduction

Major issues connected with development of UAVs (Unmanned Aerial Vehicles) for civil sector :

- ***Non-existence of regulation requirements for development and operation of civil UAVs***
- ***Simultaneous development of 2 critical elements:* Aerial Vehicle *and* Ground Control Station**

Simultaneous development of both major elements (an aerial vehicle and the ground control station) makes first flight tests risky with high probability of aerial vehicle destruction.

Such development approach is possible only for very small UAVs or for military aircraft (where producers have special ranges available for tests).

Opportunities for such tests are very limited in European airspace and is very expensive.

Adaptation of existing designs into OPV (Optionally Piloted Vehicles) cannot utilize full potential of the airframe for UAV missions.

Institute of Aerospace Engineering (IAE) / Brno University of Technology

History of IAE's involvement in UAV projects:

UAVNET project (5.FP EU)

EU project joining 15 European research and academic institutions from whole Europe. The project was coordinated by Israel Aircraft Industries and participants were (among others) DLR, NLR and Warsaw University of Technology. UAV concepts discussed within the project were usually aircraft within the size typical for Czech aviation industry.

UAVNET Alliance

Continuation of UAVNET project (not funded by EU). Regular meetings of partners are still organized.

EU project proposals in 6.FP and 7.FP

Numerous proposals for EU projects were introduced by UAVNET partners in last 5 years, covering issues related to UAVs or advanced automation for conventional aircraft. Proposed projects included MARISPA, HAPATS, THATNET, PPLANE. Most of them were not funded.

Institute of Aerospace Engineering (IAE) / Brno University of Technology

INSTITUTE OF AEROSPACE ENGINEERING (IAE)

Pedagogical activities

Aircraft Design (MSc.)
Air Transport (MSc.)
Proffessional Pilot (Bc.)
Ph.D. study programmes

Cooperation with Industry

Aerodynamics
Stress analyses
Reliability analyses
Static and dynamic structural Testing
(CAA Czech Republic approval)

Scientific and research activities

Flow analyses
Stress analyses
Design and computer modeling
Static and dynamic testing of structures

Project VUT 001 MARABU

Development of civil UAV supported by Ministry of Industry and Trade (Czech Republic), held together with industrial partners (2006-2009)

Solution proposed

- **Development of a „Flying Test bed“** *(at the first stage proposed as piloted aircraft with 600kg MTOW – to overcome legal issues)*
- **Preparation of the experimental aircraft for integration of equipment and systems developed for UAVs** *(based partially on COTS components) ..* ***and step-by-step integration of suitable UAV systems***
- **Development of new propulsion units**

Project Partners

Coordinator:

Letecký ústav (IAE)

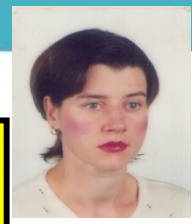
Partners:

První Brněnská strojírna Velká Bíteš, a.s.,

JIHLAVAN airplanes, s.r.o.,

PLASTSERVIS-L, s.r.o.,

CHIEF DESIGNER



TECHNICAL SECRETARIAT

VICE CHIEF DESIGNER
STRUCTURE AND CERTIFICATION

DESIGN

AERODYNAMICS

TECHNOLOGIES

SYSTEMS & RELIABILITY

TECHNICAL DOCUMENTATIO N

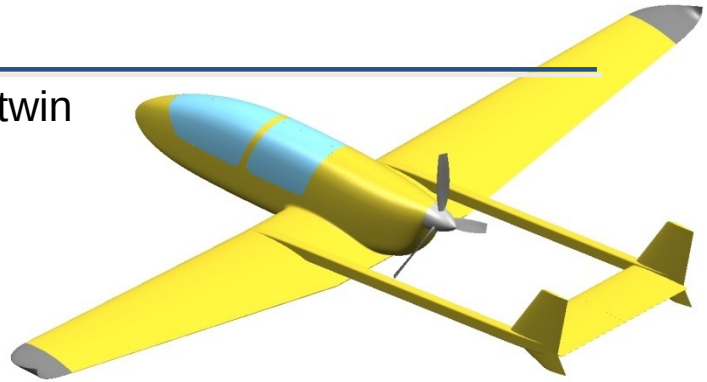
GROUND AND FLIGHT TESTS

ORGANIZATION STRUCTURE OF DEVELOPING TEAM OF VUT 001 - MARABU

Early Development

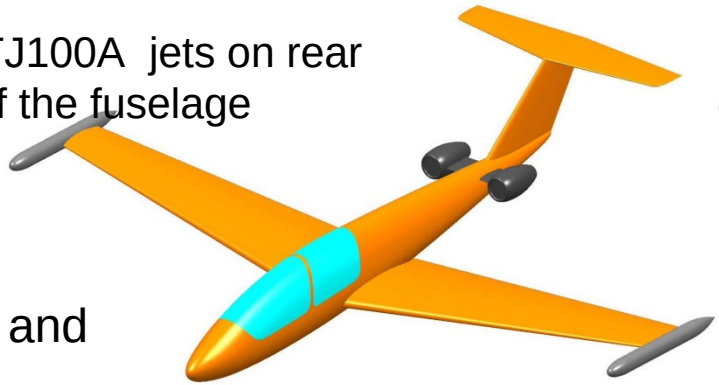
Variant A

Czech piston engine M 132 and twin boom fuselage concept



Variant B

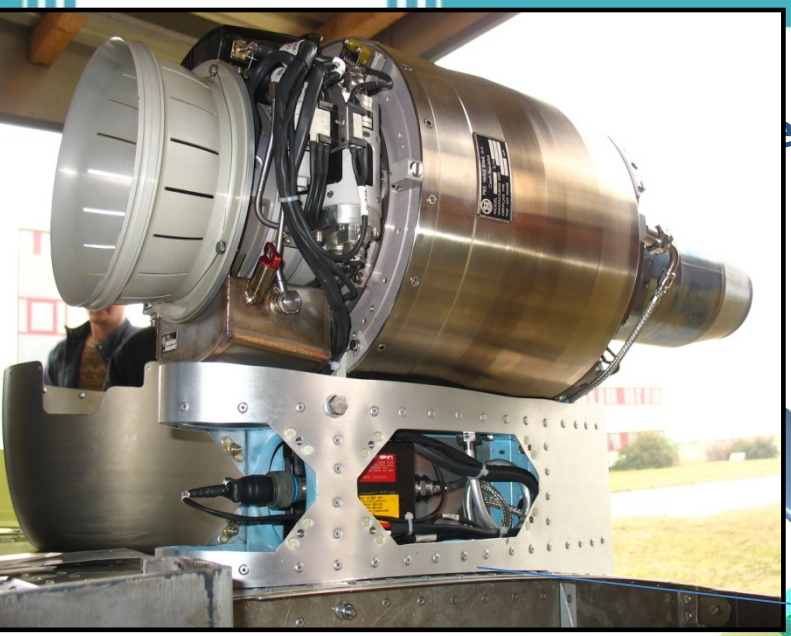
Two TJ100A jets on rear part of the fuselage



Variant C

Rotax piston engine and butterfly tail unit

History of
VUT 001
Marabu *concepts*



Final VUT 001 MARABU variant

elopment

Metal horizontal tail unit

All-metal outer wing and wing centre section

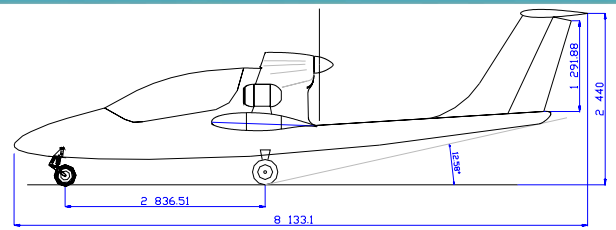
Fuselage from composite materials

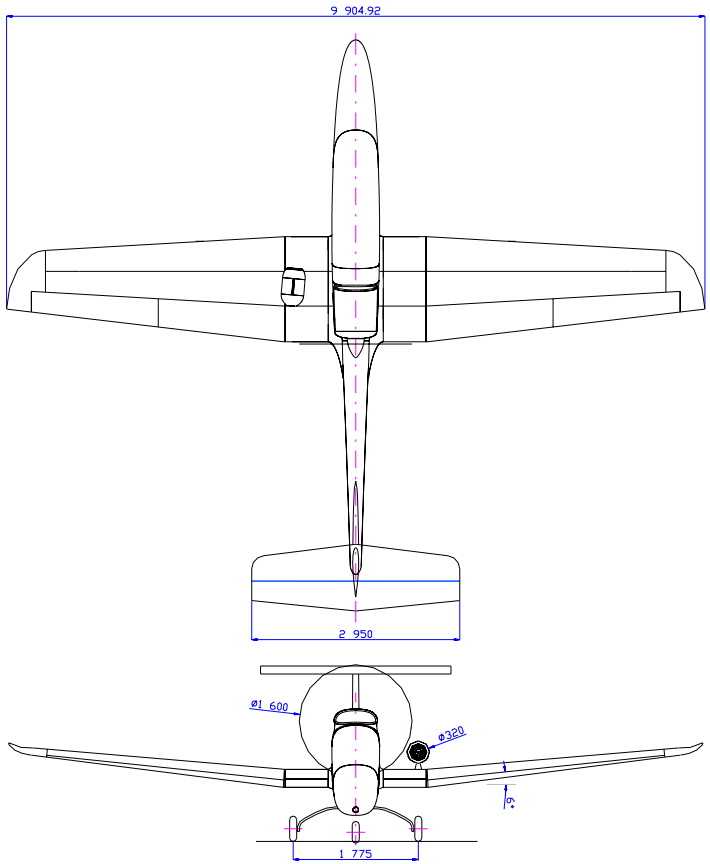
Removable nose from composite materials

Final version of VUT 001 MARABU with combination of ROTAX 912 and jet TJ100A engines

VUT 001 MARABU

Geometric and performance characteristics





Wing span	**9,9** m
Length	**8,1** m
Height	**2,4** m
Max. take-off weight	**600** kg
Payload weight	**280** kg
Max. fuel weight	**89,28** kg (124 l)
Max. speed	**260** km/h
Flight endurance	upto **7** hours

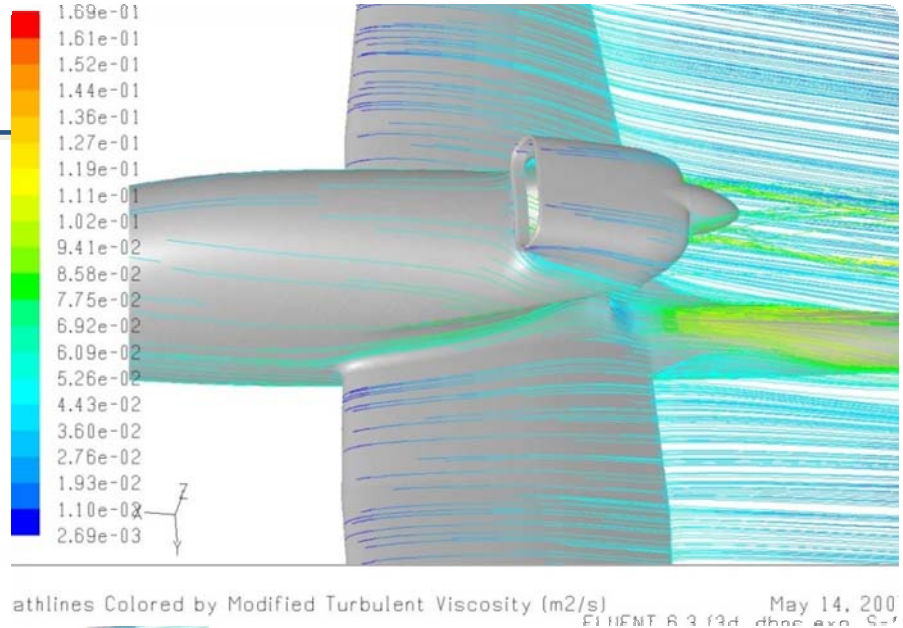
BAE HERTI – *DP019933*

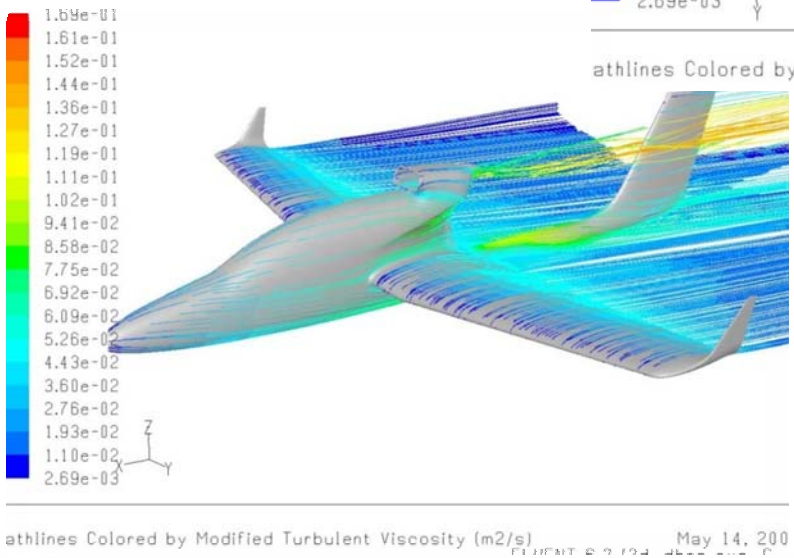
HERTI stands for "High Endurance Rapid Technology Insertion“ (developed in Warton, UK).

Airframe based on motor glider from J&AS Aero Design, Poland. HERTI was also the only UAV to have flown in the UK with the flight being certified by the UK Civil Aviation Authority.

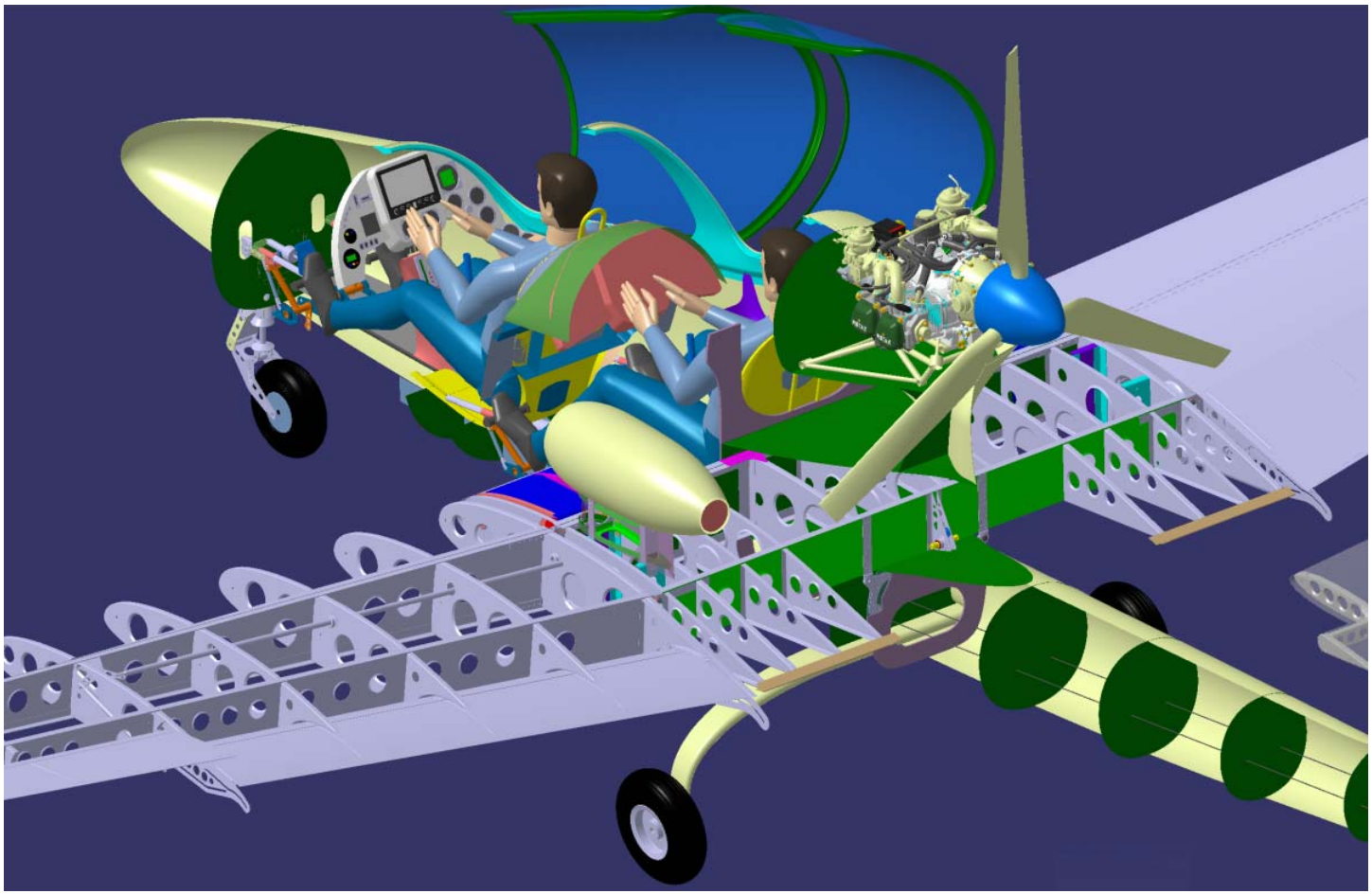
Development of the Aircraft

Shape optimization of engine nacelle.





Development of the Aircraft



Development of the Aircraft

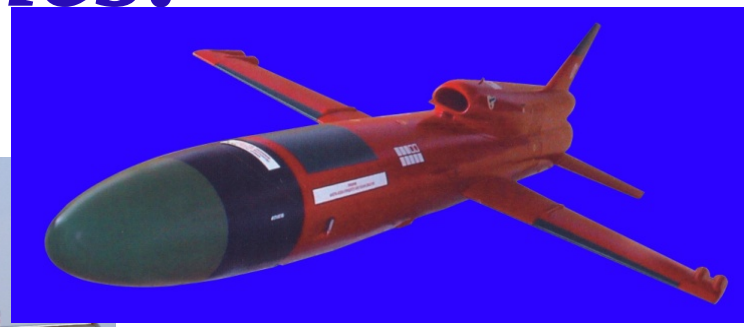
Small jet engine developed in **PBS**, Velká Bíteš.

TJ 100M

TJ100M jet engine with thrust up to 1100N designed for UAV applications

Development of the fuselage.

Small Turbojet Engines:



YA HOON ALPHA

TJ-100M

Outside diameter 272 mm
Length 485 mm
Total Weight 19 kg

Max. thrust >1 kN
Nominal thrust >0,89 kN
Idle thrust <0,16 kN

SFC* <0,12 $kg \cdot N^{-1} \cdot h^{-1}$
Fuel JET A-1

Engine RPMs: - idle 30 000 min^{-1}
- max. 58 000 ÷ 60 000 min^{-1}

Visualization of final painting scheme

First flight is scheduled on the second half of 2009

Design Features for Integration of UAV Systems

During design attention was paid to include design features enabling later integration of UAV systems. These include:

1. **Careful basic concept definition**
   - Un-obscured forward view
   - Optimized performance (including great duration)
2. **Move towards the concept of more-electric-aircraft** (as far as possible for given aircraft class)
3. **Space left for future integration of back-up electrical system**
   (to ensure safety reliability and to increase total amount of power available)
4. **Integration of selected UAV equipment from the beginning**
   (integration of TJ 100M engine)

Possible Future Development of VUT 001 MARABU

I. Continued step-by-step integration of UAV systems

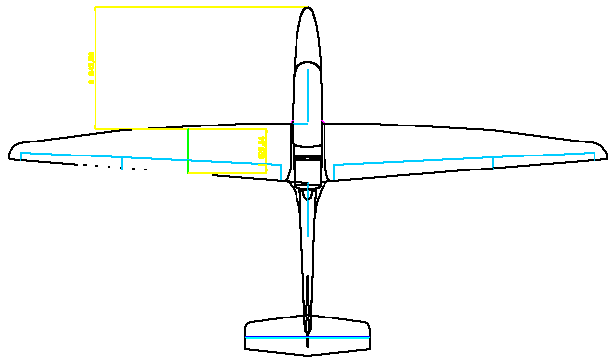
Absolute priority for continued development of UAV systems and autonomous aerial vehicle. (Together with partners developing advanced UAV systems.)

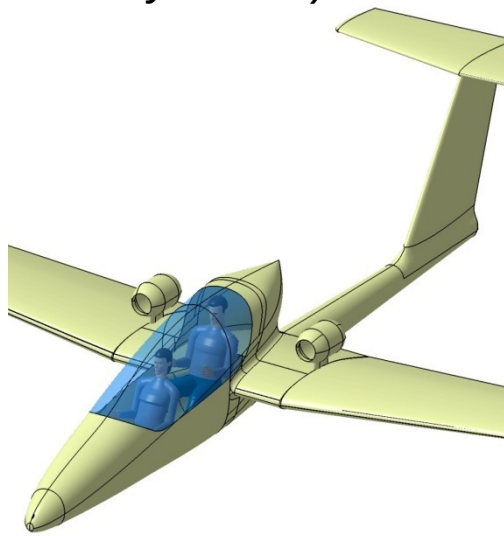
II. Test bed for continued development of UAV jet engines

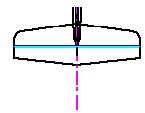
(Continued development and testing of TJ 100M)

III. Use of the airframe out of UAV applications

Adaptation to different aircraft classes increases effectiveness of the project outputs. For example, redesign of the wing can lead to design of motor glider (in CS-22 category).







Other UAV activities on BUT

VUT 700 SPECTO

VUT 700 SPECTO is a flying testbed developed at Institute of Aerospace Engineering at Brno University of Technology. The airplane span is 4.2 m and maximum take-off weight is

Wing span *4,2 m*
Max. take-off weight *20kg*

The airplane has all-composite structure and pusher propeller. This concept is typical for unmanned aerial vehicles.

Recently, the maiden flight was successfully carried out. The airplane is currently controlled by remote control, but the objective is to install an autopilot to upgrade VUT 700 SPECTO to full UAV.




Thank you for your attention …

Acknowledgment

Some of the presented activities were supported by Ministry of Industry and Trade (in the frame of grant project **FI-IM3/041**).