

Workshop no 2
BRUSSELS, Polish Science Contact Agency
Nov 23, 2009



Smart AEROVAN Concept

topic AAT.2010.6.2.1

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General Aviation and European Air Transport System - Third Call FP7

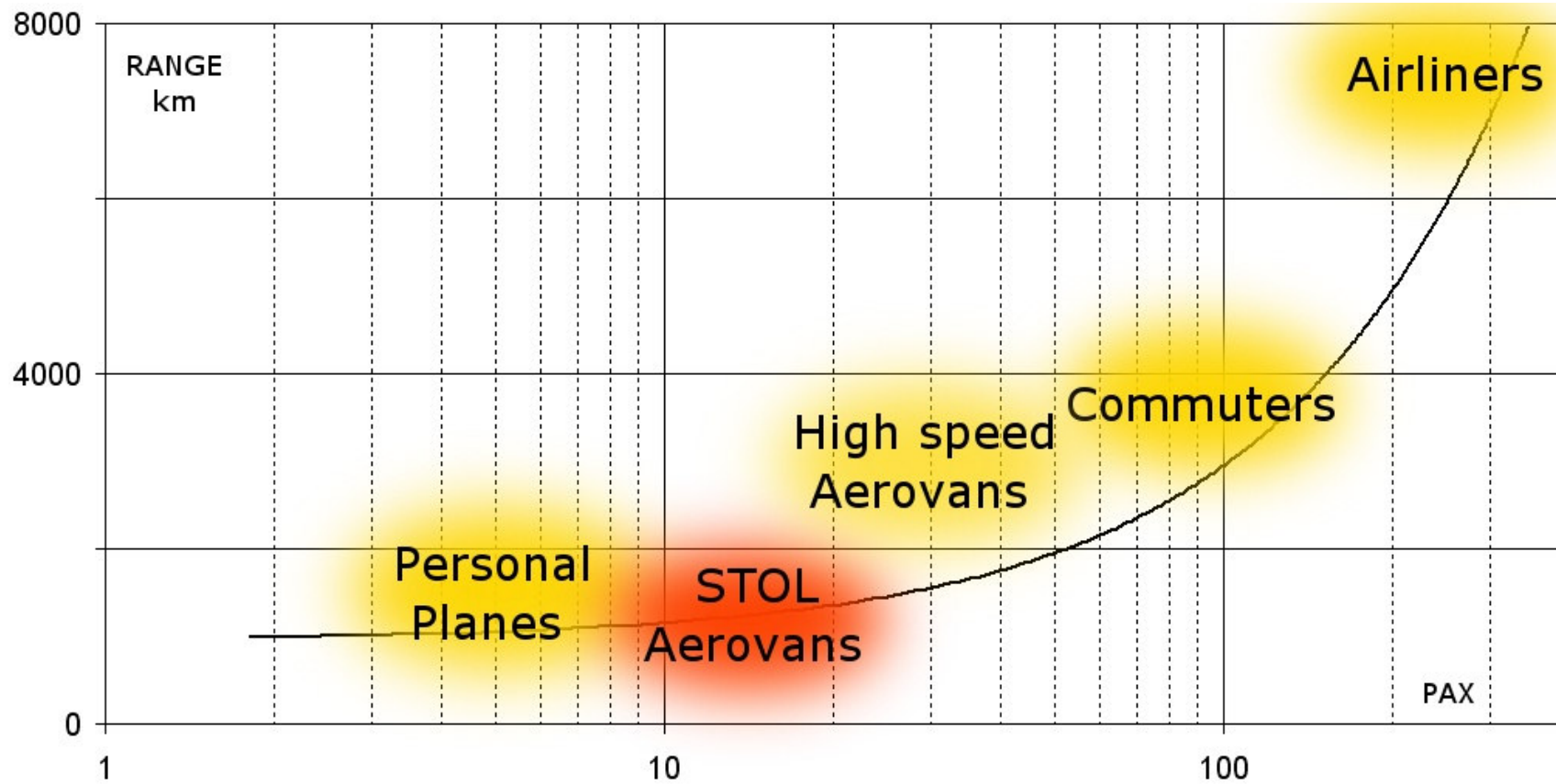
Outline of presentation



1. **Role of AEROVAN** in passenger transport system
2. Motivation for up-stream research
3. **Tandem wings configuration** as a potential candidate
4. Review of tandems
5. Remarks about possible configuration details and performances
6. Does it fit to the workprogramme? - **overcoming the weaknesses of current configurations**
7. Consortium
8. **Structure of the project**



Components of the passenger air transport system



Aircraft of this category on the market



DHC-6 Twin Otter

2*700 KM; 265 km/h; 150 m



GAF NOMAD

2*450 KM; 311 km/h; 200 m



Cessna 208 Caravan

675 KM; 320 km/h; 400 m



Antonov An-28 SkyTruck

2*960 KM; 250 km/h; 500 m



PC-6 TURBO PORTER

550 KM; 232 km/h; 197 m

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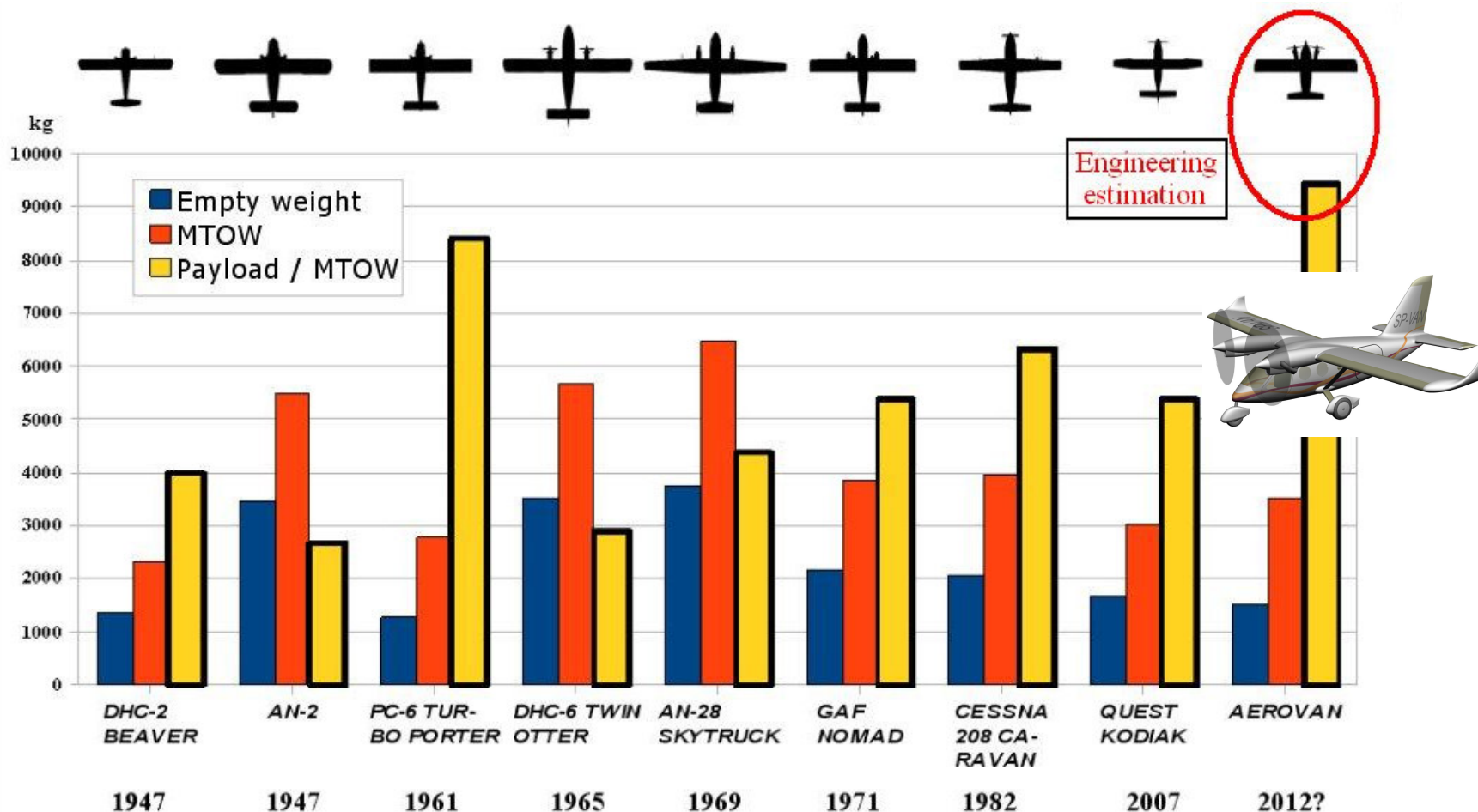


Quest Kodiak (2007 r)

750 KM; 320 km/h; 250 m

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Comparison between payload/MTOW of existing Aerovans and the future, optimised configurations performance



Aerovans used for the scheduled flights by professional airlines



Examples:

1. Maldivian Air Taxi, offering scheduled regional passenger services and operating 16 DHC-6 TWIN OTTERs;
2. Martinaire, USA, offering scheduled passenger services and operating 31 CESSNA 208 CARAVAN;
3. North Wright Airways, Canada, offering scheduled passenger services and operating 2 HC-6 TWIN OTTERs and 2 CESSNA 208 CARAVANs;
4. Wiggins Airways, USA, offering scheduled passenger services and operating 16 DHC-6 TWIN OTTERs and 32 Cessna Caravans;
5. and many other airlines at different continents.

Smart aerovan - motivation



1. Essential decreasing the stall speed (lower landing speed, shorter take-off run);
2. Increasing the cruise speed;
3. Decreasing of sensitivity with respect to CG travel (lower trim drag, passengers can use any seats independently on their weights);
4. Higher aerodynamic efficiency (lower fuel consumption) due to optimal aerodynamic configuration (slats, flaps, elevons, spoilers) controlled by computer;
5. Higher comfort of travel due to gust alleviation (flaps, elevons, spoilers deflections controlled by computer);
6. Aerodynamic optimisation of power unit (redundancy increasing safety level, pushing propeller decreasing flow velocity around the fuselage and decreasing the noise level, lower fuel consumption with one engine operated in cruise)



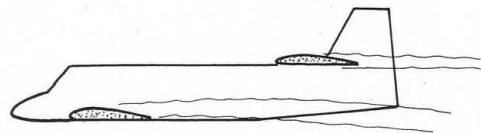
Tandem wings – a promising configuration

In the past a lot of tandem configurations have been designed and manufactured, but only a few of them were successful, because there were not chance for smart, intelligent enough configuration supplemented by Automatic Flight Control System. **In the past the technology was not mature enough to control successfully application of tandem wing configuration!**

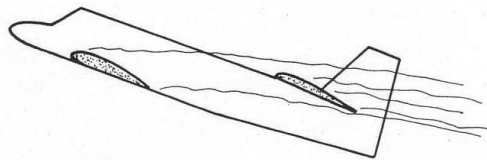
A good analogy comes from super-manoeuverable combat aircraft – high agility and super-manoeuverability became possible when fly-by-wire system was applied to control naturally unstable aircraft.



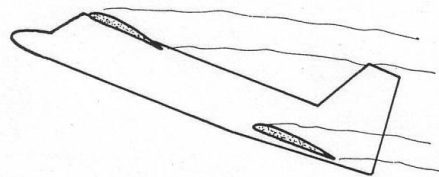
Tandem wings – advantages and drawbacks



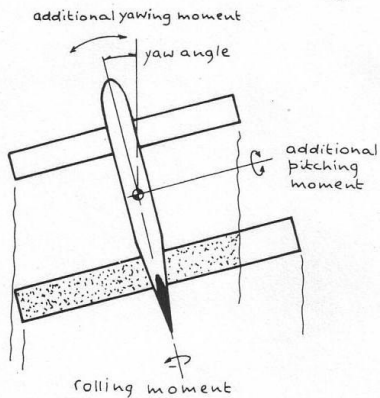
a. Low interference when cruising.



b. Most interference at low speed.

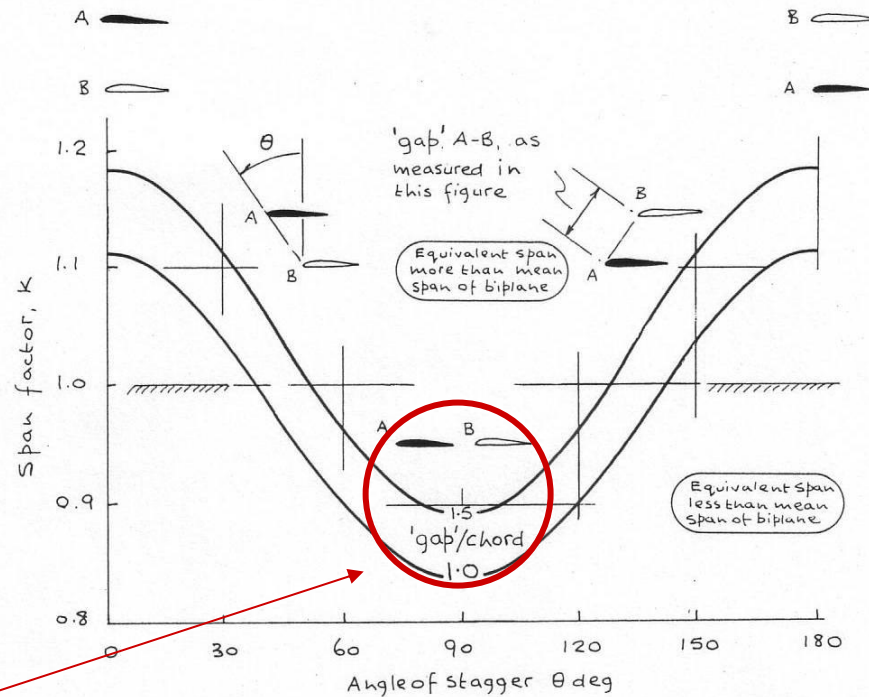


c. Least interference at low speed.



d. Some possible interactions between a foreplane and a mainplane working in its wake.

$$DRAG = \frac{1}{2} C_{D0} \rho V^2 S + \frac{2}{\rho V^2 \pi e} \left(\frac{W}{b} \right)^2$$



a. Estimated variation in Munk's span factor, K, with angle of stagger for a pair of biplane wings with 'gap'/chord 1.0 to 1.5 and a aspect ratio 6.

Lower span factor & lower equivalent span



Tandem wings – advantages and drawbacks

Advantages:

- very low take-off and landing speed due to high lift devices on both planes;
- very mild stall characteristics;
- stiffer structure if lateral beams used as fuel tanks;
- beam fuel tanks easier to be sealed than wing fuel tanks;
- easier trimming due to CG travel;
- during cruise, when the rear pushing propeller is working the flow around passenger cabin is slower, and in the result the cabin noise level could be lower;
- higher safety level during take-off and landing when 2 engines are in operations;
- lower landing speed, lower community noise;

Drawbacks:

- higher risk for potential producer, no too much experience;
- higher induced drag;
- sophisticated AFCS is needed;
- a small weight increase is expected;





Review of tandems built & flown over the years



Langley Aerodrome



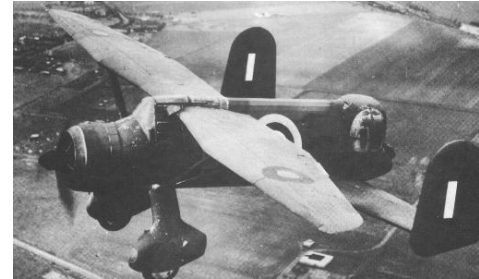
Blériot VI *Libellule* ("Dragonfly")



Flying Flea (*Pou du ciel* literally)



Miles Libellula M 35, M 39 & M 39B



Westland P.12 *Lysander* - Delanne Tail



Lockspeiser LDA-1



Rutan's Quickie



Rutan's Proteus



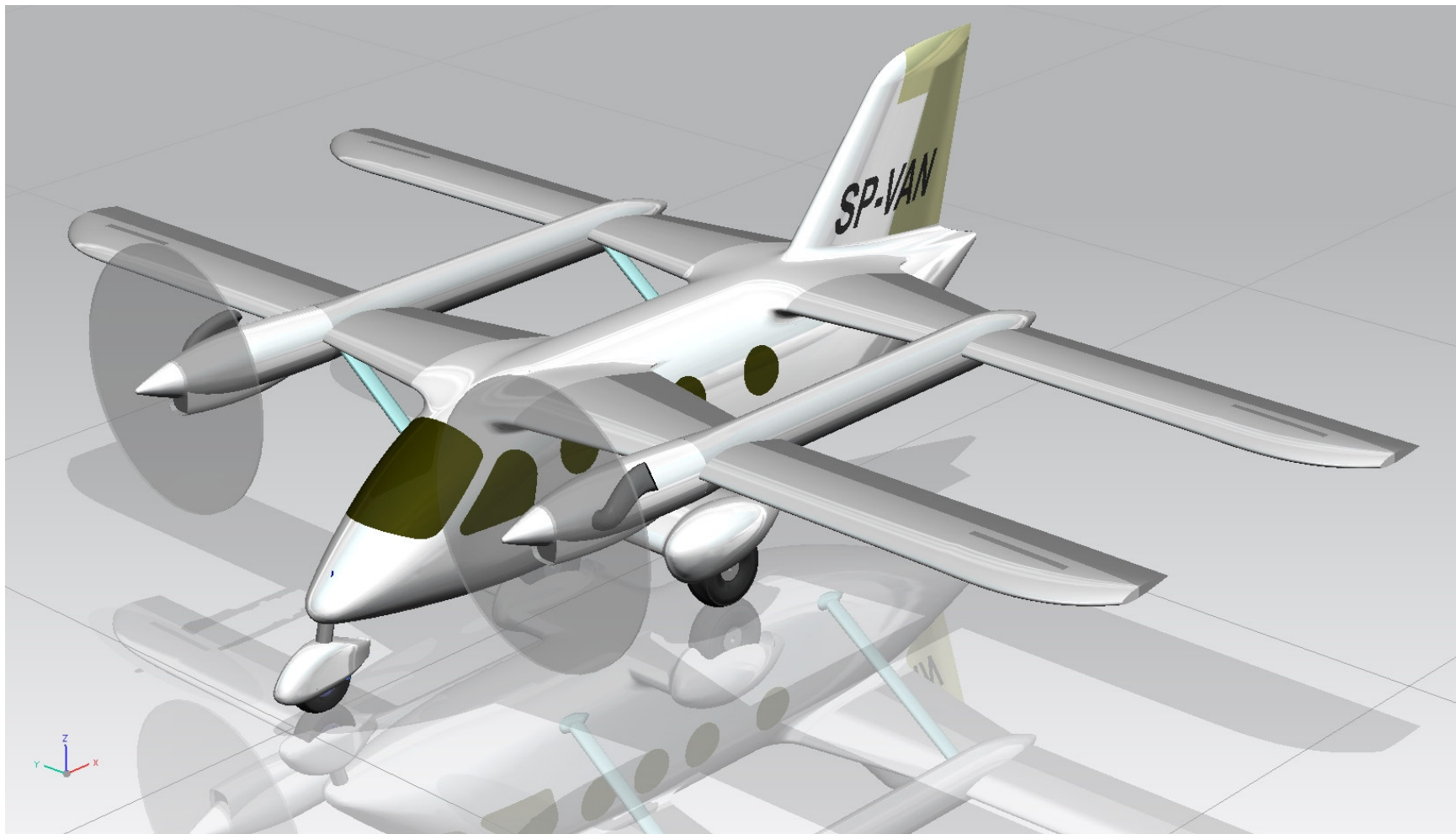
DraganFly TANGO 11/24

Rutan's **ATTT** – most successful tandem ever built



- Initiated and supported by DARPA in 1987;
- MTOW=25 tons, payload=5 tons, $C_L/C_D=20$, scaled model build (0.62)
- **$C_{Lmax}=3.55$**
- Competitor of Lockheed's Hercules, a reason for the failure of the project?

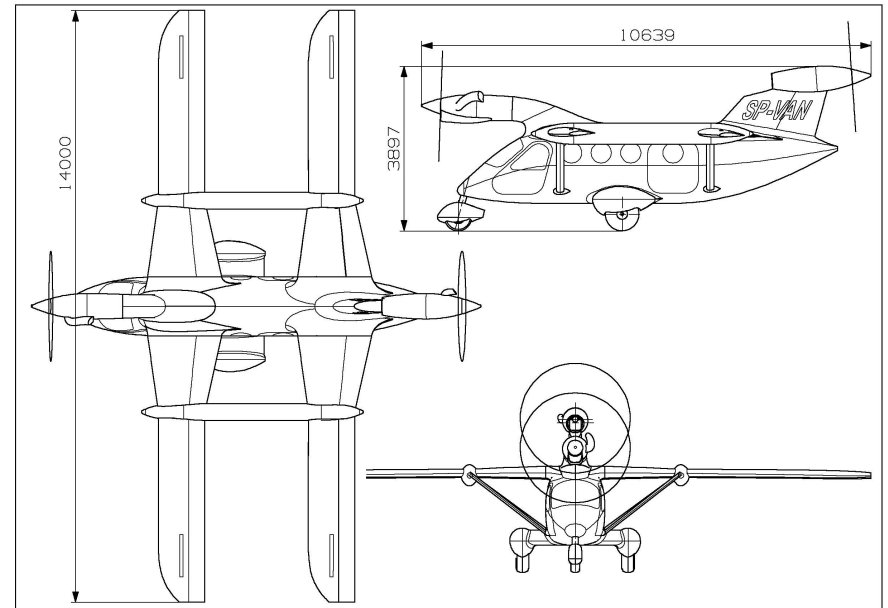
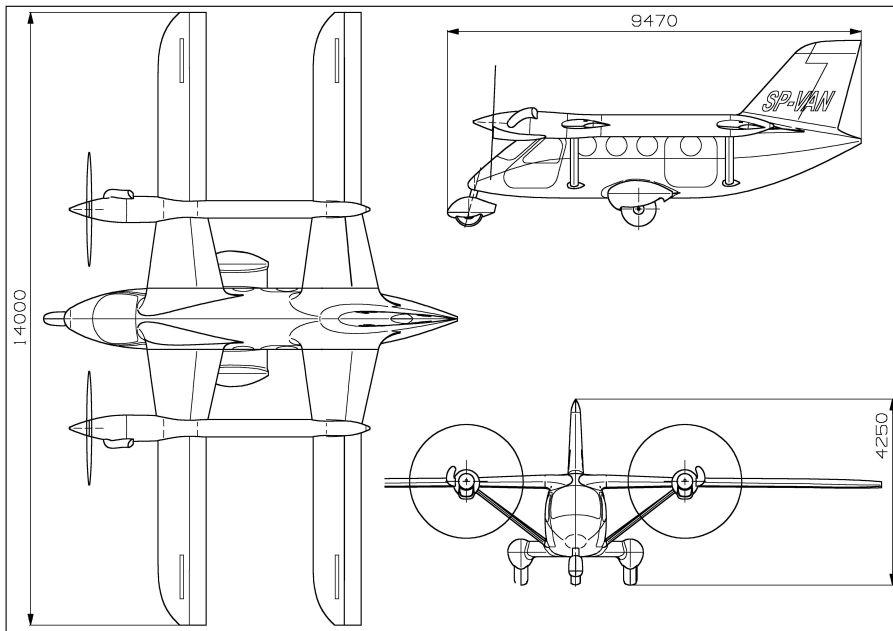
Pulling propellers configuration



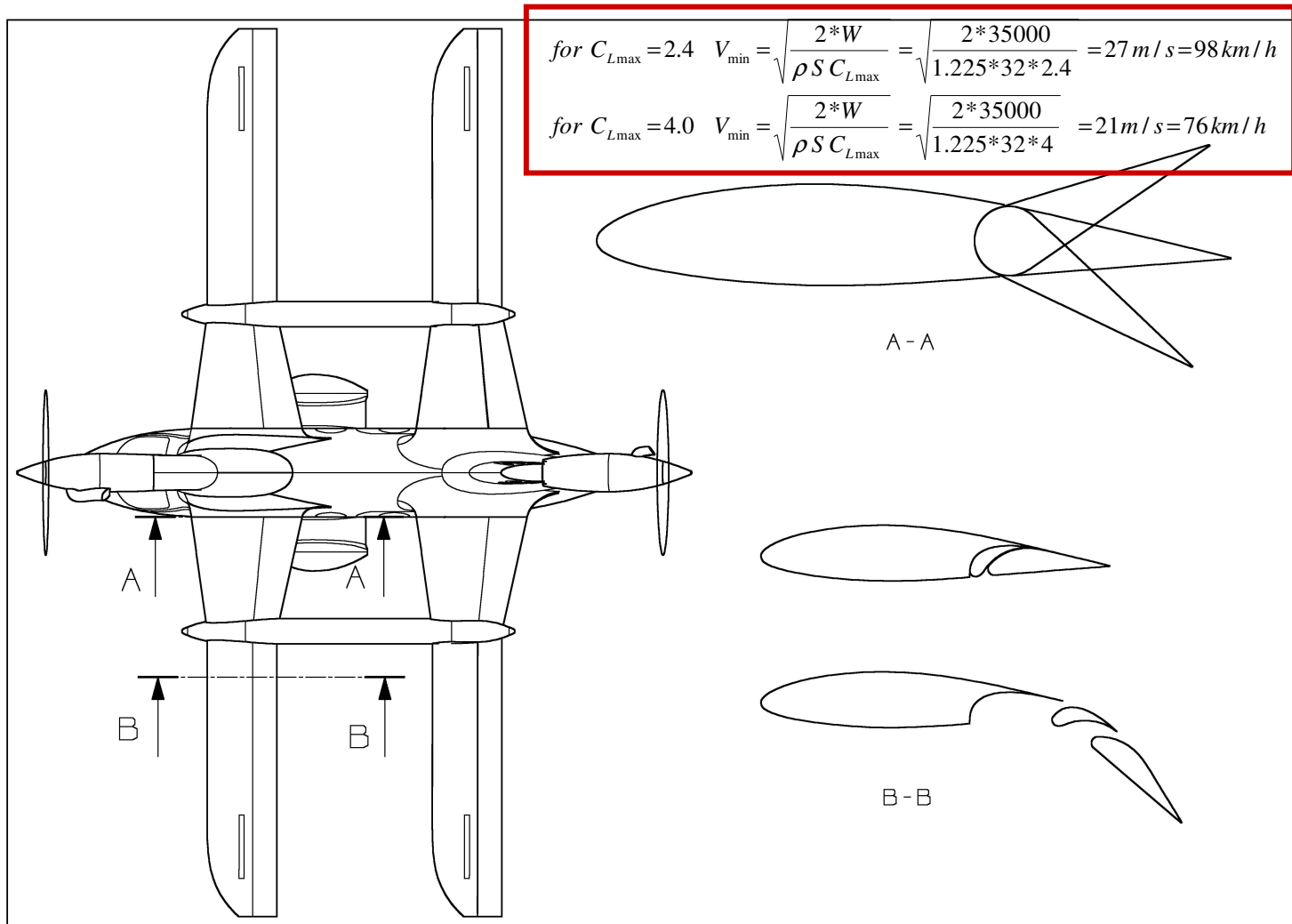
Pulling & pushing propellers configuration



Power units arrangement – a comparison



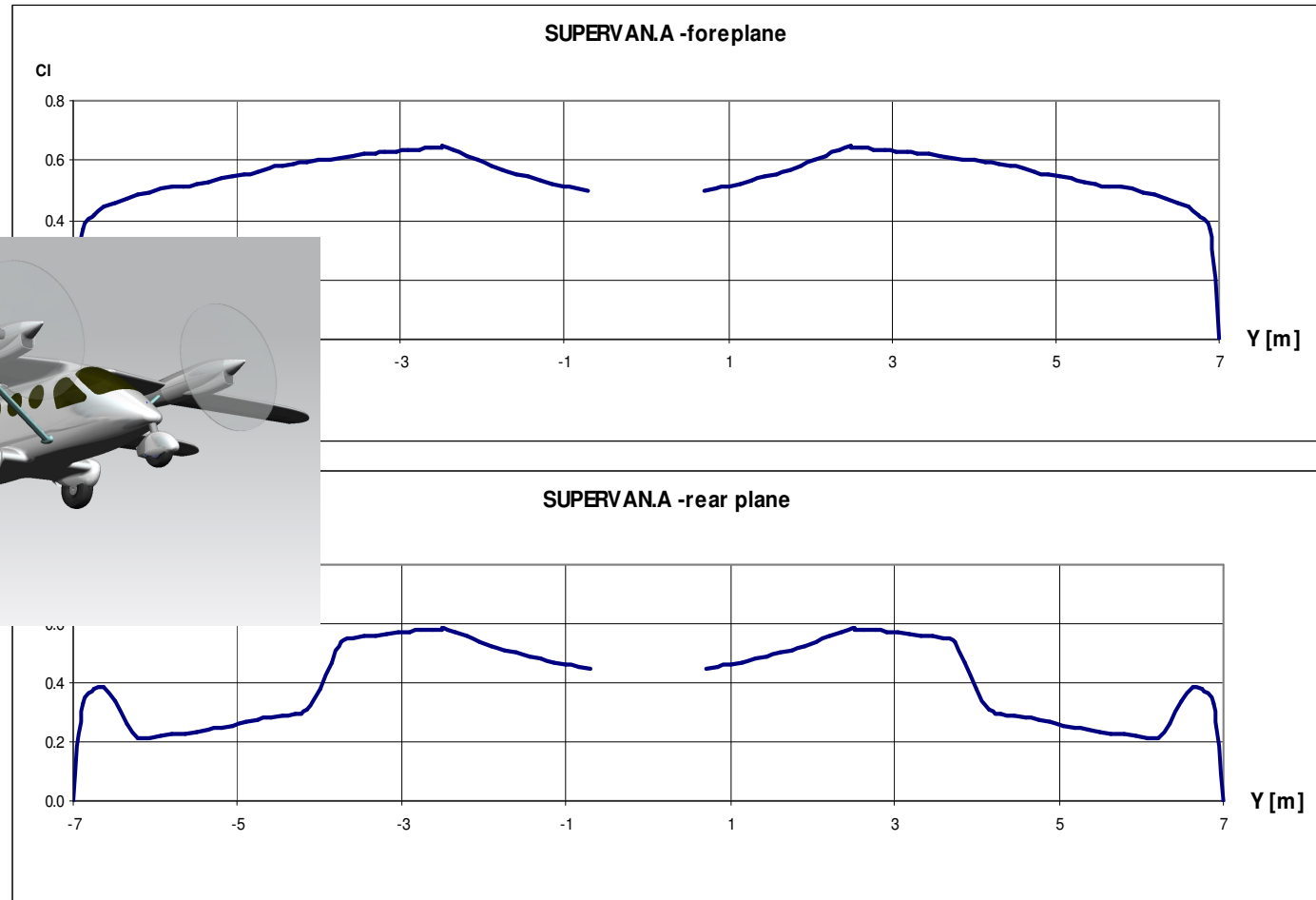
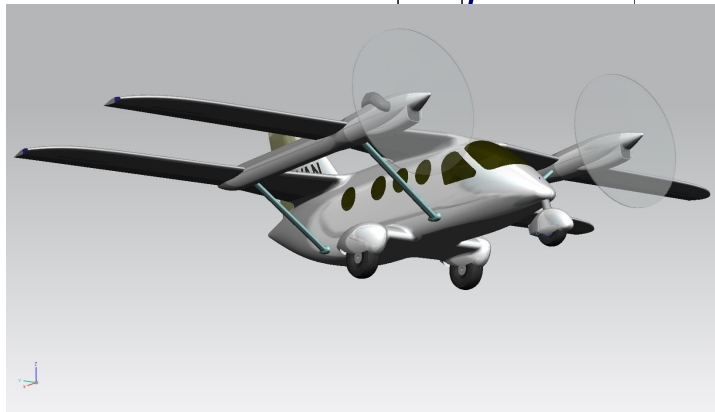
Super High Lift System ($C_{Lmax} \sim 4$)



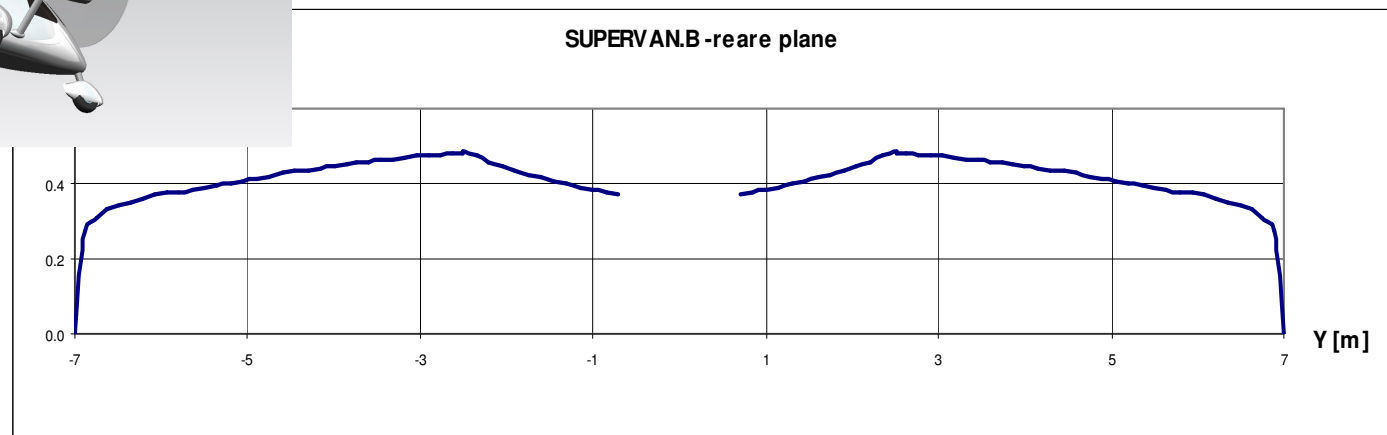
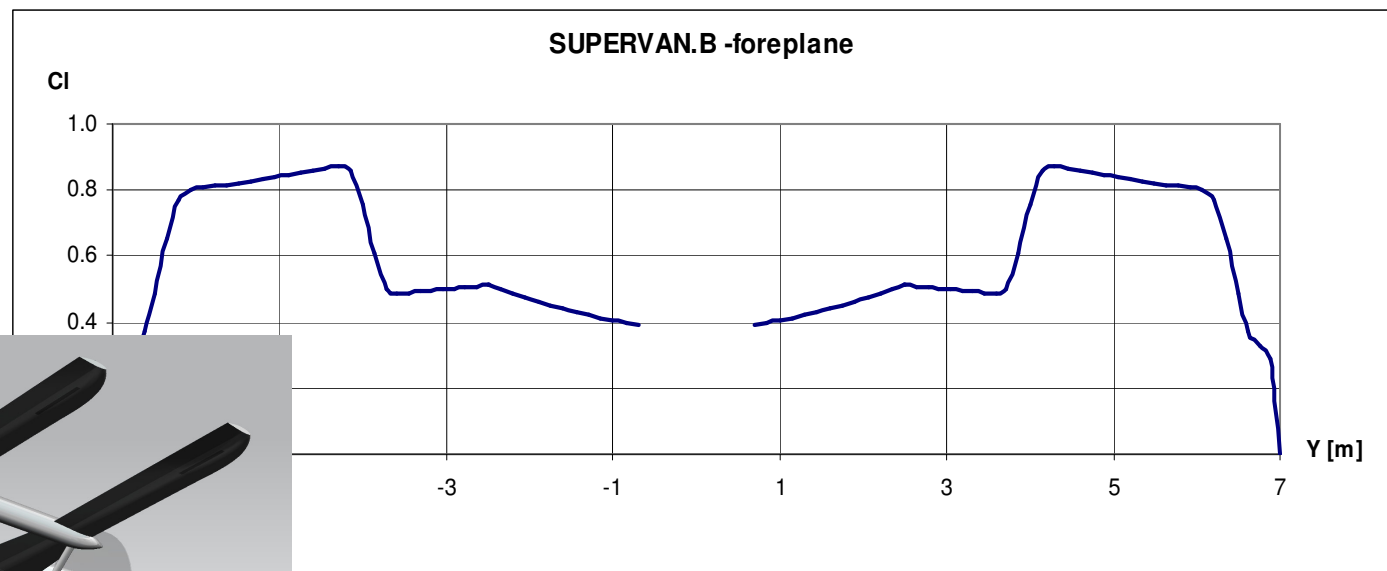
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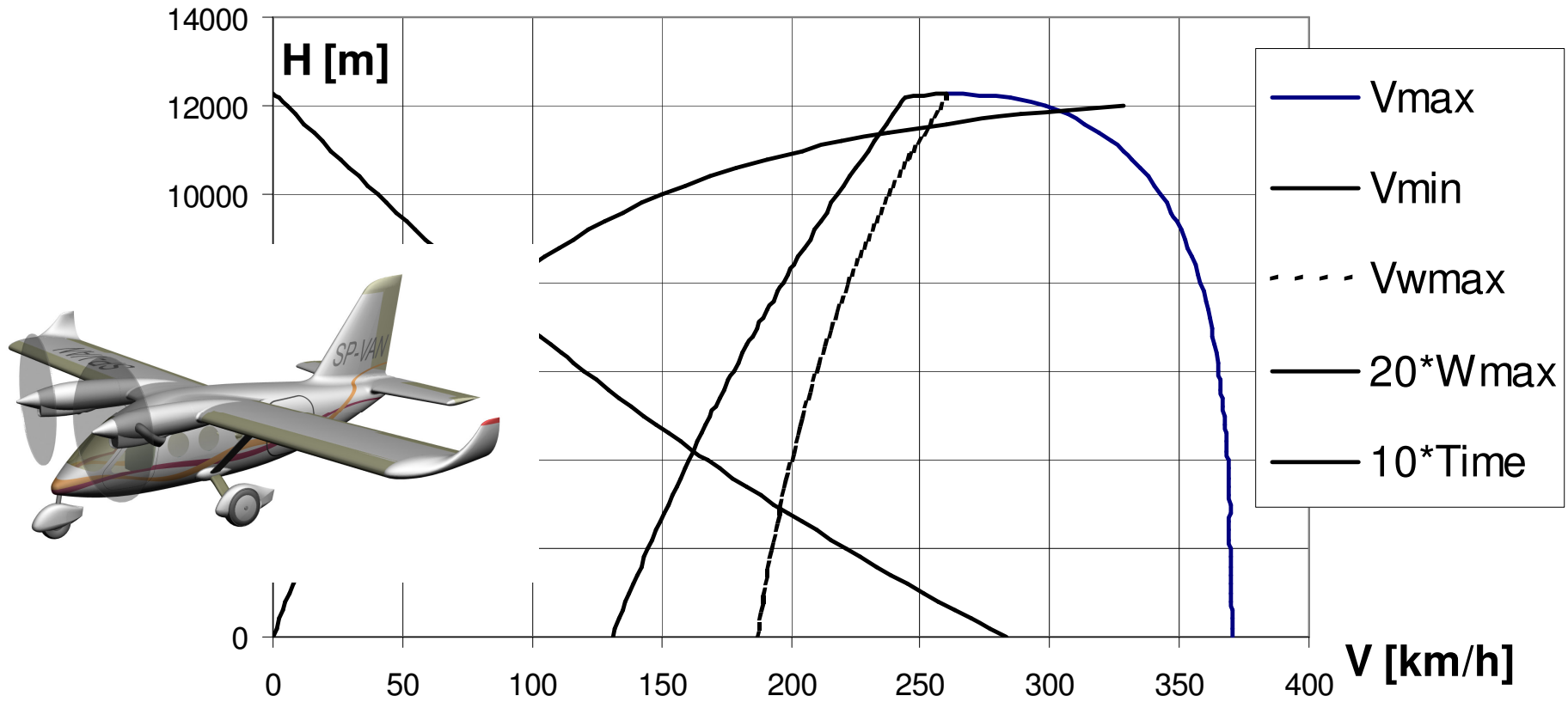
Spanwise lift distribution (trimming at rear plane)



Spanwise lift distribution (trimming at foreplane)



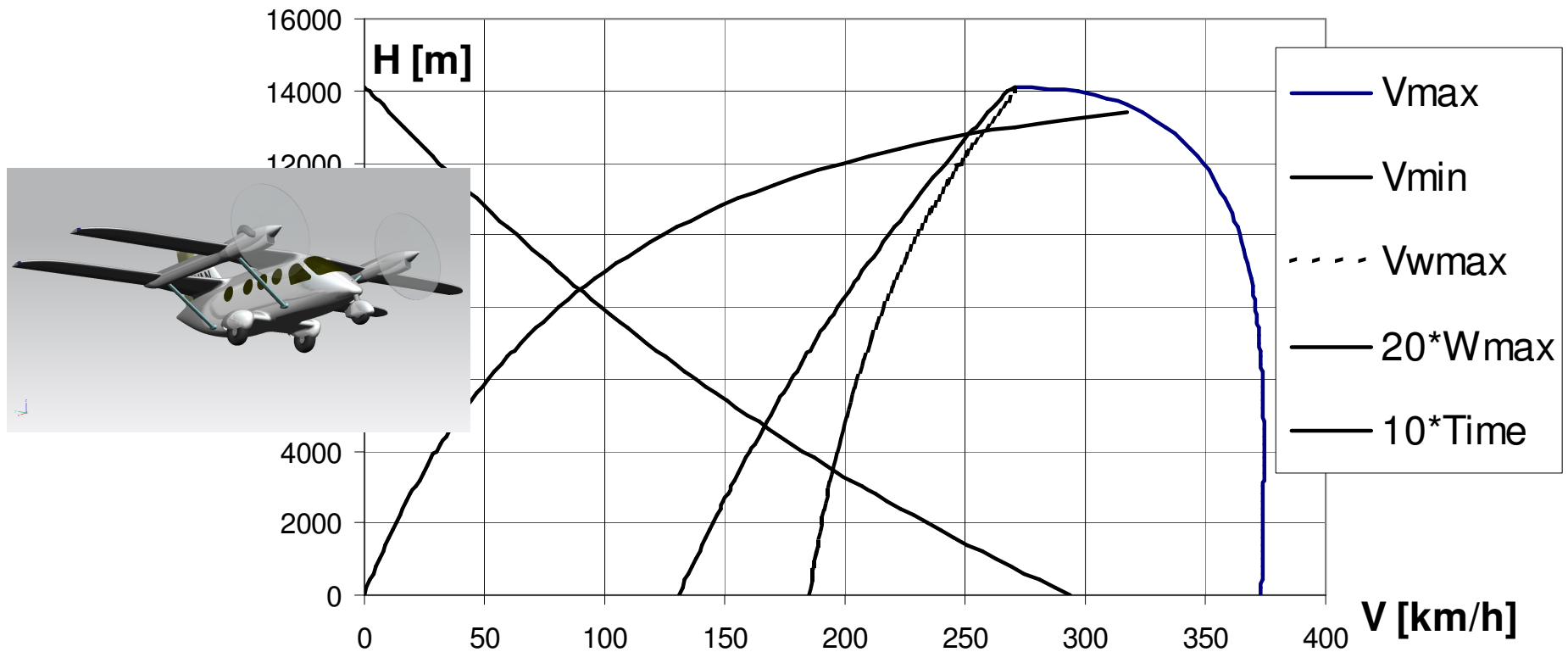
Baseline AEROVAN - performances



Tandem AEROVAN – performances (trimming at rear plane)



SUPERVAN.A



Research Topic for 3-rd Call FP-7:

AAT.2010.6.2-1. Novel air transport vehicles



„ Investigation of novel aircraft configurations which **could be better adapted to provide the services** that future air transportation concepts demand, including combined transport modes vehicles (hybrid vehicles). Consideration should be given to **overcoming the weaknesses of current configurations**, taking a mission oriented perspective where the vehicle is **to be fully integrated in the total transport system**. Vehicle size and mission could range from **very small door to door personal transport to very large platforms** of transportation, including those suitable for new forms of networking traffic flows, air-to-air and air-to-ground, at subsonic, supersonic or hypersonic (suborbital flight) speeds addressing the environmental concerns regarding energy consumption and noise and setting clearer differentiations between vehicles to transport passengers or goods.

Funding scheme: Collaborative Projects small or medium-scale focused research, Coordination and Support Actions aiming at coordinating research activities”.

Consortium



Universities

- | | |
|--|----------------|
| 1. PW (Warsaw University of Technology) | Poland |
| 2. BUT (Brno University of Technology) | Czech Republic |
| 3. CUA(Cranfield University Aerospace Engineering) | United Kingdom |

Industry

- | | |
|--------------------------------|---------|
| 4. Hoffmann | Germany |
| 5. Grob | Germany |
| 6. Piaggio Aero Industries SpA | Italy |

Research Institutes

- | | |
|---|----------------|
| 7. ARA, Aircraft Research Association Ltd. | United Kingdom |
| 8. IoA (Institute of Aviation) | Poland |
| 9. VZLU (Vyzkumny a Zkusebni Letecky Ustav) | Czech Republic |

Structure of the project



- WP1. Operational scenarios, requirements
- WP2. Concepts of configurations
- WP3. Aerodynamics
- WP4. High lift devices
- WP5. Concepts of Propulsion
- WP6. Trimming, stability and control
- WP7. Community noise analysis
- WP8. Dissemination and exploitation
- WP9. Management

Possible impact of AEROVAN



- AEROVAN will help to develop closer links between Aeronautical Entities from Eastern and Western Europe
- AEROVAN will explore the technical potential of a door-to-door VSTOL passenger transport aircraft Concept for future exploitation by industry
- AEROVAN will develop a lot of new unconventional passenger aircraft features in many domains (aerodynamics, controls, stability, power units, low noise operation etc.) which will also be applicable to other configurations and on short to medium terms