Warsaw University of Technology

EASN Technical Workshop

easn
european aeronautics science network

Interest Group devoted to
"Light Aircraft Design and Optimisation"
under the umbrella of EASN

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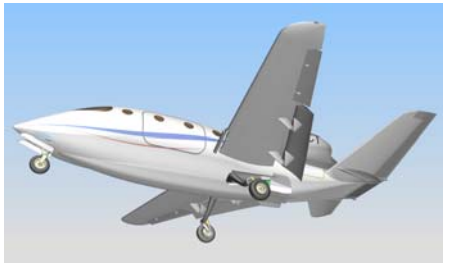


Athens, March 23, 2009

New IG: "Light Aircraft Design and Optimisation" – LADO, why we need it? (2/2)

- **Small Aircraft Transportation System (SATS) initiative; EPATS, CESAR, "out of the box" project, EPAN & PPLANE in Europe;**

- **progress in Personal Air Transport System is a long term challenge. Technology is one of the important areas & has to be progressed (together with new scenarios and regulations, public acceptance and others)**

- **Long tradition, experience in many European countries (Poland, Czech, ..)**

New IG: "Light Aircraft Design and Optimisation" – LADO, why we need it? (1/2)

•**demand for Personal Air Transport System (PATS) is growing;**

•**public air-transport available today is not efficient for mid-range distances of under 800 km;**

• **easy access to COTS elements has tremendously increased our ability to design affordable aircraft and this way to widen drastically the number of their potential owners and users**

Possible future scenario (from EPATS)

courtesy of EPATS consortium

Missions Requirement for EPATS Aircraft

courtesy of EPATS consortium

AIRCRAFT COMPARISION: Reference vs Future

2020

	PISTONS		TURBO-PROPS		JETS
					
	1eng 4seat	2eng 6seat	2eng 8pax	2eng 19pax	2eng 8pax

Range full seats	1000 km	500 km	2000 km	1000 km	2000 km
Speed (bl.) km/h	Similar	+11(+13)%	-17 (-10)%	+10(+17)%	Similar
DOC €/(pax*km)	-18%	-37%	-23 (-32)%	-12 (-15)%	-24%
SFC l/(pax*km)	-20%	-26%	-11 (-28)%	-16%	-21%

Proposed Scope of LADO interest 1/5

Aerodynamic, specific for light aircraft, including novel, sometimes up-stream research, for example

- **Forward swept wing,** offering good CG location, an easy trimming, NLF (natural laminar flow) and beginning of separation close to fuselage. All these features are difficult to obtain in traditional, back swept wing, especially of high aspect ratio;
- **Novel high lift devices,** enabling to fly with low speeds, bellow 115 km/h (according to FAR23 for MTOW < 5700 kg);
- **Novel trends in wing planform** (straight TE, and semi-elliptical LE), offering lower induced drag;

Proposed Scope of LADO interest 2/5

Aerodynamic, specific for light aircraft, including novel, sometimes up-stream research, for example:

- **New thick wing sections**, important for hosting extra fuel, but from the other side having negative influence on high critical Much number. Such modern thick wing sections, very often **mission-tailored and customized**, must have high aerodynamic efficiency, limited pitching moment, high maximum lift coefficient $C_{L,max}$, etc;
- **Novel, promising configuration** (U-tail, pushing propellers, pro-green (noise suppression) etc.

Proposed Scope of LADO interest 3/5

Light loading structure (ratio of empty weight to MTOW less than 0.5), including

- **Pressurised fuselage** (how to join the wing, sometimes built as a one piece) with fuselage in an optimal way);
- **Structure optimisation** (trade-off between metal, composite and a mix metal-composite).

Avionics, including :

- **Modern navigation systems;**
- **Flight management system with a selflearning option** (one pilot on board, sometimes inexperienced pilot);
- **Pilotless aircraft control in emergency** (fully autonomous aircraft).

Proposed Scope of LADO interest 4/5

Modular, affordable design

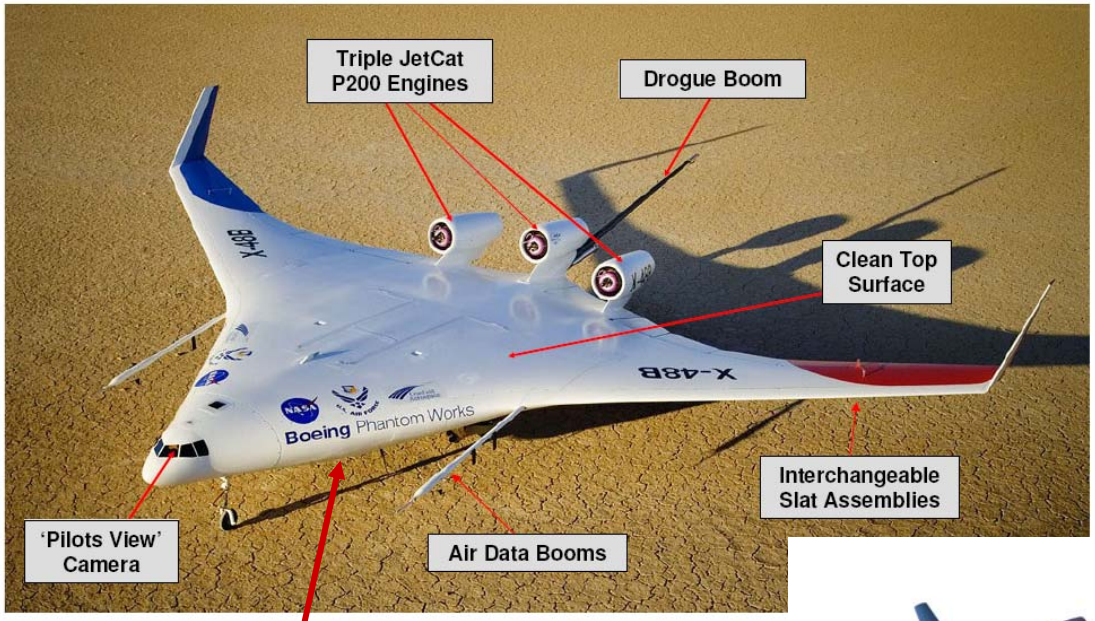
- **wide use of COTS** elements;
- **changing the wing** for the same fuselage, or **changing the fuselage** for the same wing (it enables to develop an aircraft derivate, better suited to a specific mission in a relatively low cost).

Hazardous states and recovery

- **Recovery from hazardous states** (loss of one or two engines, elevator or other lifting surface blockage, going by the pilot beyond a permissible parameter limits);
- **Parachute landing system** in emergency;
- **Redundancy.**

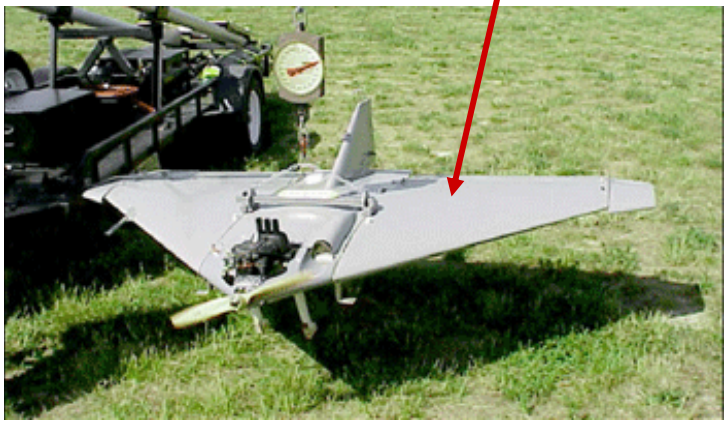
Proposed Scope of LADO interest 5/5

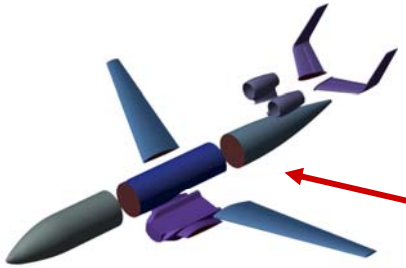
Scaled models as new research tools,
sometimes called as (Innovative Evaluation Platform)



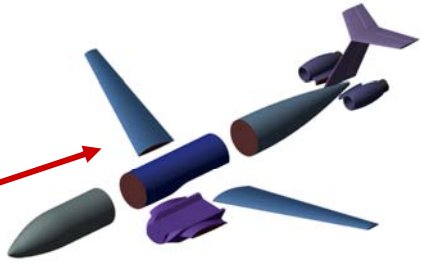
courtesy of X-48 NASA-Boeing HBW

courtesy of Stanford University





courtesy of NACRE consortium



EASN - IG: "Light Aircraft Design and Optimisation" – LADO

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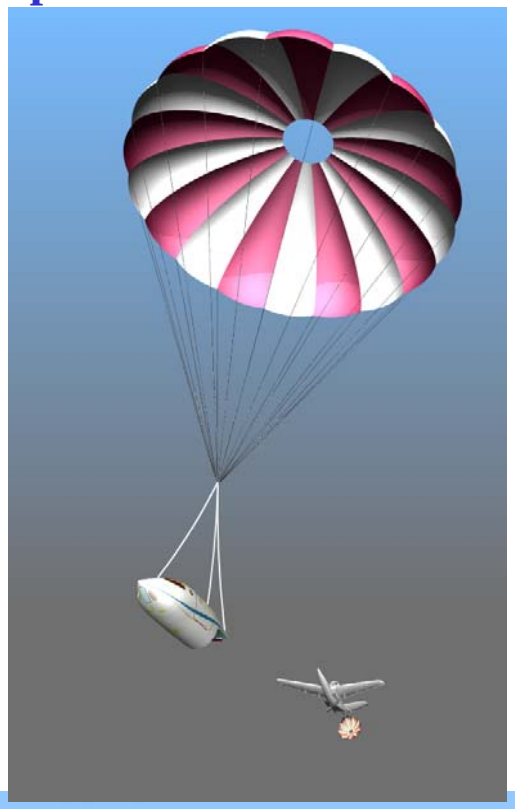

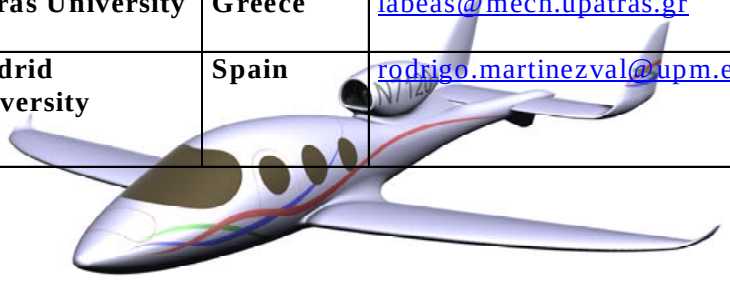

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Rationale for wider area of interest!

•Aircraft design comprising of three components: **structure, engine and systems;**

• Synergy effect resulting from collaboration in various fields of aeronautical technology

• Small EASN IGs have limited capability of success in proposal submission and acceptance

• Universities success rate 3% (average 18%)

• Greater chances for Level 2 then Level 1 proposals – probably not possible at the next call

Scepticism!

On-board systems, avionics

User friendly aircraft
Virtual co-pilot for General Aviation

Flight control systems
Pilot decision assistance
Virtual co-pilot
Single pilot technology for passenger airplanes
Autopilots with adaptive control
Flight-by-wire technology
Improving flying / handling qualities

Advance control and navigation systems
intelligent navigation systems
optical signal (visual) navigation and control systems
sense and avoid

CNS (Communication Navigation Surveillance) Systems
ATM, ATC systems
Optimal flight routes (global) due to pollution and noise
Stochastic advance methods for conflict resolution
Free flight concept support
Data fusion technique

Sensors
Laser
Fiber optics
Microwave technology
(passenger security check)
„Visual" sensors (LIDAR, FLIR)
Wireless sensors

Support technologies and certification processes

Support certification process

Testing methods with special tools for data processing

Computer sciences (distributed computing systems)

Risk assessment methods

Support technologies for other Technical Area panels

Smart structures technology

Distributed sensors

HUMS (intelligent maintenance)

Related topics (could be covered by Flight Mechanics IG)

- *Fault Tolerant System for Single Pilot Aircraft*
- *Simulation of Stability and Control Characteristics of a Aircraft for Flight Control Design*
- Relaxed Stability Analysis for Transport Aircraft
- *Reconfigurable Flight Control Systems*
- *Aircraft Handling Qualities Quantification (i.e. for Helicopters)*
- *Optimization of Aircraft Trajectories to Minimize Environmental Impact*
- Performances in Severe Weather Conditions

"Towards safer EPATS by means of STOL solution" - acronym PATIO 1/3

Utility: passenger transport between unprepared, very short runways;
rural areas, mountains, forestry, meadows,
short runways in city centres (150 m)

Cruising speed: 300 km/h

Parameters: span – 15 m; wing area – 32 m2; cabin – 1.4 x 1.6 x 3.7 m

MTOW = 4000 kg

Take-off run = 100 m

Range = 1200 km

Number of passengers ~ 14

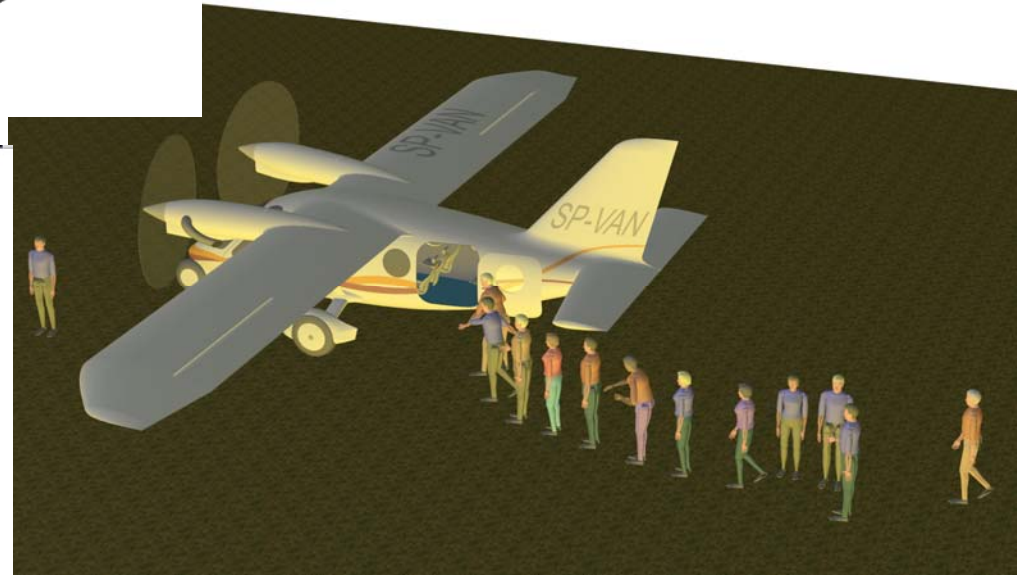
Main objective – to design and optimise an efficient aircraft of

Increased safety factor - see next slide

"Towards safer EPATS by means of STOL solution" - acronym PATIO 2/3

	General aviation, 1999	Airliners, 1999	Space shuttle 1981-2003	Predator A, 1998-2003	UAV (Israel, MALE & HALE all), 2003	Goal for PATIO
Crash number for 1 mln take-off	25,2	1	20 000	5550	20	5
Crash number for 1 mln flight hours	12,6	0,13	133	555	3	8

"Towards safer EPATS by means of STOL solution" - acronym PATIO 3/3



Is there any chance to submit a successful proposal for the next call ? (1/3)

Promising pioneering ideas in air transport

AAT.2010.6.3.3. Personal air transport systems

The aim is the research of concepts and related technologies and operations which will enable future individual air transportation. The idea of personal air transport is not new as it has been regarded as a possible solution to the ever increasing congestion in road traffic, providing at the same time greater speed and flexibility.

The viability of the concept will depend not only on the design of a vehicle capable to operate under the imposed constraints, but mainly on the operational environment both in the air and on the surface. Challenges for research are the environmental impact, automation of the vehicle and of its operation, certification, maintenance, training of the "pilot"', infrastructures, etc.

Relevant underpinning research topics could be found also in other parts of this work programme, in particular in AAT.2010.6.2.1.

Funding scheme: Collaborative Projects small or medium-scale focused research, Coordination and Support Actions aiming at coordinating research activities
Open in call: FP7-AERONAUTICS and AIR TRANSPORT (AAT)-2010-RTD-1

Is there any chance to submit a successful proposal for the next call ? (2/3)

Step Changes in AT

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
Open in call: FP7-AERONAUTICS and AIR TRANSPORT (AAT)-2010-RTD-1

Is there any chance to submit a successful proposal for the next call ? (3/3)

Breakthrough Technologies

AAT.2010.6.1.1. Lift

Investigation of new approaches to produce or to control the forces that govern flight, in particular those that lift the vehicle. It could consider topics such as other principles of physics as alternative to conventional fluid dynamics, computer controlled aircraft morphing into different aerodynamic forms for different flight phases, thrust vectoring to provide lift and control.

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Conclusion

- Solid interest of universities (and research institutes) in upstream research in aircraft system technology
- The scope of the research visible
- Light aircraft allows more flexible approach to novel ideas at low cost
- *Industry and regulating authorities must be involved*
- *Including **light aircraft into Workprogramme is expected***
- *Needed leadership and strong commitment and support from the prospective partners*
- *Working together on a proposal for the next call can consolidate LADO IG*