PROJECT

FASTWING CL

Foldable, Adaptable, Steerable, Textile Wing Structure for Delivery of Capital Loads

Funding: European (6th RTD Framework Programme)
Duration: Dec 2006 - Jun 2010
Status: Complete with results
Total project cost: €4,919,020
EU contribution: €2,899,300

Call for proposal: FP6-2005-AERO-1
CORDIS RCN : 81460

Background & policy context:
Paragliders, manoeuvrable parachute-like textile wing structures, are developed as personal parachutes for the sports and leisure market. They close the gap between manoeuvrable hang gliders or sailplanes and circular shaped parachutes. Being a controllable structure they offer the capability of steering to a pre-determined landing point. The controllability and the potential flight range resulting from the forward velocity capability and large glide ratio make such systems ideal means for the precise delivery of loads to be dropped.

Parafoil and paraglider performances that are available in the leisure market have improved during the past years and thus the technology has become more and more interesting for commercial use in emergency aircraft recovery as well as for delivering payloads. Other technologies such as the Global Positioning System (GPS) contributed to the vision of an autonomous and precise aerial payload delivery system. The European Space Agency (ESA) launched the Parafoil Technology Demonstration (PTD) project as a result of the previous Crew Transport Vehicle (CTV) studies which - beside other results - recommended the use of parafoil technology as the potential recovery system for a precise and soft land-based landing of re-entry payload systems. Furthermore, as predicted by wind tunnel tests, this high performance parafoil tested during flight tests a glide ratio of 5, being a world record for a parafoil of this size! Autoflug initiated and coordinated this project to increase the knowledge and confidence in parafoil technology as a potential land-based landing technology in Europe.

Objectives:
FASTWing CL focused on the development of a high performance parafoil for heavy loads up to 6000 kg with a high steering accuracy and soft landing capability. This approach was a clear step beyond the state-of-the-art. All functions of the developed system were tested and validated in real drop test. Such a heavy payload system was never dropped by a parafoil in Europe.

The objectives were in detail the following:

- Development and manufacturing of a high performance parafoil with a high glide ratio of >5 and a forward speed of more than 18m/s. This enables the system to be delivered with higher stand-off distances as well as wind independent flights directions.
- Development and manufacturing of an effective parachute system for low g-forces during deployment of <4g, to be optimised by deployment flight tests (parachute verification tests with a payload dummy) and verified in steerable flight tests. Low g-forces allow delivering of shock sensitive equipment and protect manned missions from injury.
- Development and/or adaptation of a deployment analysis tool for parafoil material selection and reefing layout for payloads up to 6tons. Such software is not available on the market!
- Reusable system layout for budgetary, safety and training reasons by means of short, cheap and easy refurbishment after a drop dropping, e.g. by easy change of batteries, easy handling prior to flight (automated pre-flight procedures like pre-flight functional test and target input)
- Selection of an advanced flight termination system to be tested in-flight. To drop such payloads the test range authorities requires implementation of a backup system to be initialized in case of malfunction of the system, in order to reduce hazardous situations or damage on the ground. (Note: This will require a new design complying with the requirements of the test range in order to qualify for flight testing).
- Adaptable low cost-, volume- and weight steering box for autonomous, remote controlled flight and flight to a beacon (control modes), to be verified in steerable flight tests with all control modes
- Development of advanced flight control software for all control modes, to be validated in steerable flight tests with all control modes
- Development of a portable ground station for monitoring of all control modes and measurements, to be validated in steerable flight tests. The ground station will enable remote control of the system, especially required during the

**Methodology:**

Within the duration of FASTWingCL project the following was implemented:

- An non-steered technology model for parachute verification tests allowing analysis of opening and in-flight behaviour of the parachute system (by on-board cameras and flight data acquisition system);
- A technology model capable of performing remotely controlled and autonomous flights to a pre-defined target with a payload between 3 000 kg and 6 000 kg;
- A reliable parachute system showing soft opening shocks below 4g and with a glide ratio higher than 4, mostly independent from wind influence due to a high horizontal flight velocity;
- A steering system capable of guiding the parafoil to a pre-defined target with an accuracy of better than 200m if released from a distance of 5km (to be realised with the autonomous flight tests);
- A modular light weight & low volume steering system to reach max. payload mass for different payload carriers, max weight of steering system less than 2% of payload mass;
- Low energy consuming actuation system for steering and flare in order to reach a maximum flight time with a minimum sized power supply;
- Flight control software capable to fly to pre-defined targets including wind influence and failure considering parameters (i.e. malfunction of an actuator, the failure tolerant system will be simulated but not tested during flight tests);
- Software capable of directing a number of flight systems to one single or to different targets and capable of controlling multiple cooperative systems (multiple systems will not be tested with flight tests, but simulated);
- A light weight structure payload carrier capable to carry different payloads up to 6tons like medical equipment, vehicles and food bags by standard transport aircraft like C-160 and C-130 and the new A400M;
- A landing shock below 3g to be realised by a new flare strategy and damping system in order to be able to transport fragile payloads like medical equipment;
- An autonomous emergency system able to terminate flight in order to reduce the horizontal flight distance to ensure safety of flight, if the flight system shows an unexpected potentially dangerous behaviour;
- An adaptable flight data acquisition system capable to measure location, attitude, accelerations etc. for flight analysis during and after flight of different payload carriers (for parachute verification tests and steerable flight tests);
- Design software tools for the

**Parent Programmes:**

[FP6-AEROSPACE - Aeronautics and Space - Priority Thematic Area 4 (PTA4)](https://www.aerospace-spa.eu)

**Institute type:** Public institution

**Institute name:** European Commission

**Funding type:** Public (EU)

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**EU Contribution:** €0

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**Dutch Space B.v.**
Key Results:

At the end of the project the full-scaled parachute system verification tests were planned and performed in three test campaigns. The first test campaign was carried out with a payload dummy (step by step from 3 000 kg to 6 000 kg) in order to validate the functionality of the deployment process and to identify opening loads over time of the parachute/parafoil system. In the second test campaign remote controlled flight tests were performed to verify the behaviour of the overall system during pre-defined manoeuvres. In the third campaign fully autonomous controlled flight tests were conducted. The results / analysis served as basis for validation of the design tools and flight control software developed within the project.

After the completion of the project the developed and validated software tools is now available for the development and design of e.g. aircraft emergency recovery, space vehicles and load delivery systems. The availability of intelligent GPS or remote controlled cheap delivery platforms may make future humanitarian relief actions more flexible and more efficient in short times.

Technical Implications

The innovative character of the aircraft industry and the high technological standard of equipment made in Europe have made Europe competitive. In this respect FASTWing CL continued this approach by actively developing new theories and ways to model aerodynamics of thin textile structures. This will have a positive influence on the reputation of European research effort as well as a positive spin-off for other applications demanding low weight and high efficiency lifting surfaces.

Documents:
- Final Publishable Report (Final report)

STRIA Roadmaps:
- Cooperative, connected and automated transport, Vehicle design and manufacturing

Transport mode: Air transport
Transport sectors: Passenger transport, Freight transport
Geo-spatial type: Network corridors