SOAR Partners

FanWing Ltd. is the UK company responsible for design, patenting and R&D of the original technology. For the SOAR project, the company designed and constructed the wind tunnel model, and directed wind tunnel tests.

www.fanwing.com

Universitat des Saarlandes is a German university located in Saarbrücken. The Laboratory of Actuation Technology at *Saarland University* developed and implemented a fan drive system involving a brushless synchronous torque motor and various sensors. They also created a planetary gear mechanism to enable synchronous adjustment of the blade pitch angle.

www.uni-saarland.de

The von Karman Institute for Fluid Dynamics

The *von Karman Institute* is a non-profit aerospace research organization based in Belgium that specializes in applied fluid dynamics. The *von Karman Institute* conducted wind tunnel testing using the powered FanWing propulsion model, unsteady CFD simulation and validation of the results.

www.vki.ac.be

The *German Aerospace Center* (DLR) is responsible for the design and evaluation of Fan Wing configurations for new and existing markets. The Institute of Air Transport Systems is also coordinator of the SOAR project.

www.dlr.de

DLR at a glance

DLR is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation's largest project management agency.

DLR has approximately 8000 employees at 16 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Goettingen, Hamburg, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Air Transportation Systems

Arne Bachmann M.A.
Project Manager SOAR

Blohmstr. 18
21079 Hamburg

Telefon: +49 531 295-3839
Telefax: +49 531 295-2979
Email: arne.bachmann@dlr.de

www.DLR.de/ly

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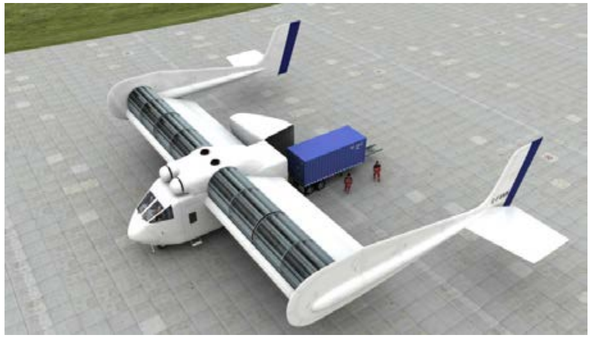
Cover photo and renderings courtesy by Adrian Mann © FanWing Ltd.

The SOAR Project

diStributed Open-rotor AiRcraft

The SOAR Project



Artist’s impression of a FanWing cargo transporter compatible with standard ISO freight containers

Overview

The *SOAR Project* investigates the aerodynamic and economic potential of the open-fan wing rotor propulsion concept, which has been under development by project partner *FanWing Ltd.*

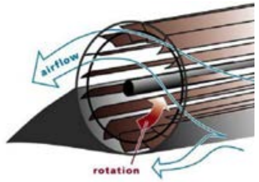
The *SOAR Project* is funded by the *European Union* through the *Seventh Framework Programme* (FP7) under the themes of "*Breakthrough and emerging technologies*" and "*Radical new concepts for air transport and funding scheme*"

SEVENTH FRAMEWORK PROGRAMME

www.soar-project.eu

How it works

A large, low-pressure vortex trapped inside the rotating fan cage "pumps" the air through the fan, generating very high lift as well as forward thrust by means of the airflow accelerated over the trailing edge. The fan's tip speed is considerably lower than in conventional aircraft propellers or helicopter rotors, offering unique opportunities for improved propulsive efficiency and reduced noise footprint.



Schematic design sketch of the open-fan wing configuration and its operation principle

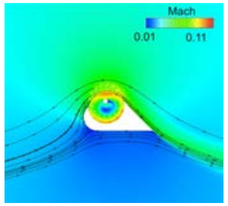
While modern jet engines make use of higher and higher bypass ratios to distribute propulsive power over as much air as possible, the new open-fan wing design effectively maximizes the distribution of thrust over the entire span of the wing by means of a cross-flow fan, resulting in a more efficient energy transmission and potentially lower noise levels. Consequently, this open-fan wing architecture represents an effective design combining many advantages of both fixed-wing aircraft and rotorcraft with *ultra short takeoff and landing* (USTOL) performance.

USTOL advantages

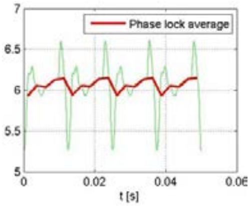
- Operation: *Takeoff field length* (TOFL) is expected to be 100m. A final approach and takeoff area can be secured on a large field without the constraint of operating from an existing airport.
- Safety: Much larger stall safety margin compared to conventional aircraft. The FanWing configuration enables safe, lowspeed approaches every time.
- Emissions: Shorter missions without airport constraint and with the technology’s basic fuel efficiency lead to fewer emissions of CO_2 and other greenhouse gases.
- Versatility: A potential game changer for a variety of applications including crop spraying, fire fighting, disaster relief, short-haul freight and civil surveillance.

Computational fluid dynamics

Advanced, unsteady Navier Stokes analysis is being used to determine time-dependent behavior and the characteristics of the vortex.



CFD analysis showing the suction effect on the leading edge and inside the rotor cavity

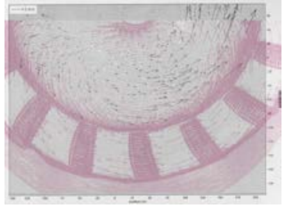


Transient analysis of blade lift coefficient

Wind tunnel testing

Powered wind tunnel tests with a brushless motor and particle tracking velocimetry were conducted to establish flow characteristics for a larger fan rotor and compared to the CFD results.

Setup of the wind tunnel model



Air flow visualization superimposed on CFD predictions

Markets

A bottom up market analysis approach was used to identify profitabilty and R&D costs for entering and creating various potential markets. The resulting markets with the most potential for success were downselected for payload and range sizing and final approach and takeoff area evaluation

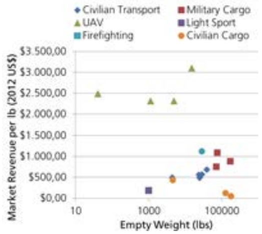


Diagram showing normalized market revenue per pound over vehicle empty mass for a relevant selection of competitor aircraft