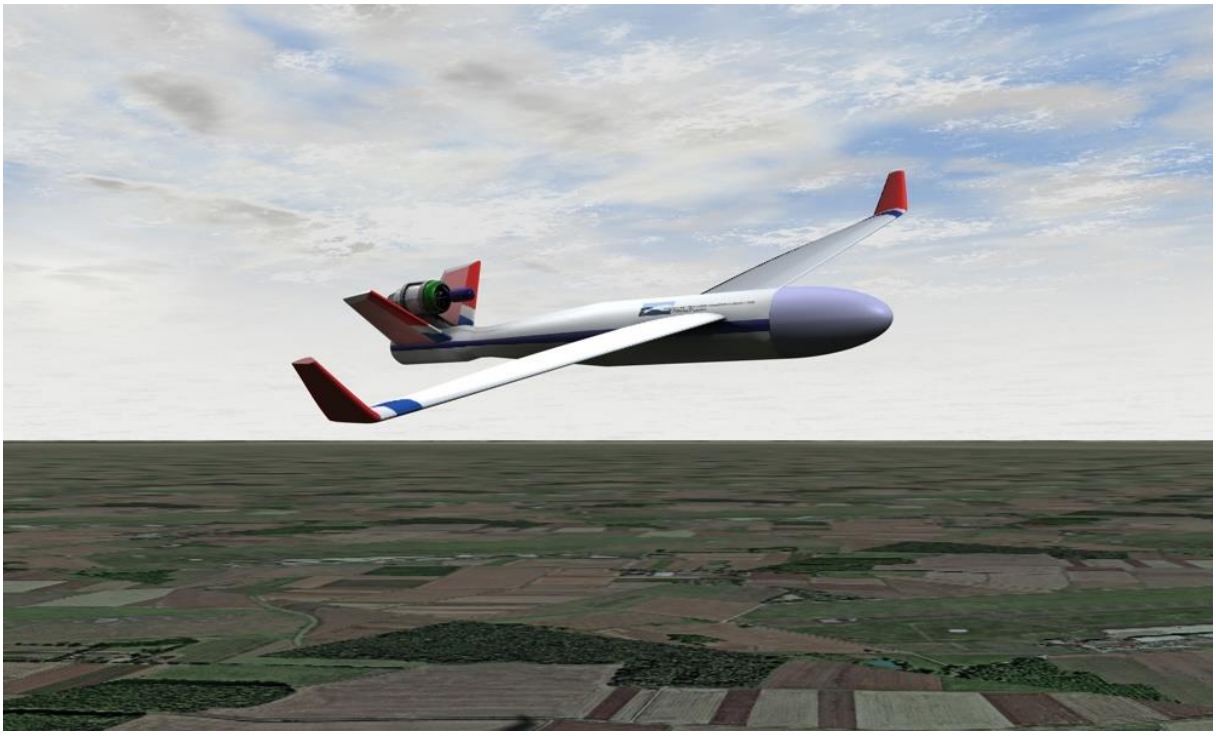
TECHNOLOGY RESOURCE TRANSFER & CONSULTING

TROUT GmbH

MAUAV

Mission Adaptable Unmanned Aerial Vehicle



TROUT GmbH - highly experienced in information technology and systems engineering.

TROUT, a well-established and typical R&D company, is developing complex and high quality technical soft- and hardware systems against medical, aerospace and automation requirements. TROUT satisfies all quality and security/safety requirements for development systems according to current standards.
Extensive technical knowledge and expert system understanding support interdisciplinary solutions in fields above.

The TROUT business model based on two columns:

- Subcontractor in projects like above for qualified support in all roles and all phases
- Development of R&D-products according to own and/or industrial partner's requirements. These products shall be sold by defined status, predominantly "prototype"

TROUT was founded in 2004 by Dipl.Phys. Martin Bussas and Dipl.Ing. Hartmut Fischer.
Martin Bussas' expertise was gained in more than 15 years of project work. Hartmut Fischer has over 30 years of experience in the above fields. Prior positions include development and project engineer, department manager and corporate manager for leading German companies.

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In MAUAV project, a drone system shall be developed, which is easy adaptable to different missions, different requirements and newest technologies.

Project Goals

UAV/S (Unmanned/Uninhabitated Aerial Vehicle/Systems) or drones are used to an increasing degree for tasks of observation, measurements and, in addition, for various tactical tasks combined possibly with air strike ability as UCAV (Unmanned Combat Aerial Vehicle). TUAV (Tactical Unmanned Aerial Vehicle) are usually medium sized drones with a weight of up to 300 kg and operating distances of > 200 km.

Predominantly, the goal of the project MAUAV is the development of a UAV newest technology, consequently modularized and easy adaptable to different tasks/missions:

- Lightweight construction with combinable standard components (fuselage, wings, sensor- and engine units) in carbon fibre building methods (e.g. carbon fibre PREPREG)
- Standard bus systems
- Standard adapter for sensor systems with automatic sensor fuselage adaptation
- Parts of Fuselage and wing interchangeable for different tasks
- Piston or jet engine to different tasks interchangeable
- Sensor systems for by intelligent adapters (sensor ID) simply interchangeable
- Standard telemetry system of high performance, security & safety and fail-safe characteristic; parallel data storage. Easy adaptable to newest technology.
- Standard flight control system by using COTS; easy adaptable to newest technology
- Flight control system & TCAS Collision warning, usable for missions in flight levels above 100
- High quality with low price
- Simple launch starting unit or launch procedure by using cars available
- Standard evaluation and control station, simply at the tasks and sensor system in use adaptable
- Validated software system for 2D/3D-visualization of mission in 3D-Topographie environment (3DAM) usable
- Parallel data storage for later on off-line evaluation and for prevent data loss
- Etc.

System Description

In principle there is a far spectrum of UAVs, the mini drone for close ranges (predominantly realized as mini helicopter) up to the drone, similarly a manned airplane and with ranges of more largely than 1000km. In the concrete project of Mission Adaptable Unmanned Aerial Vehicle (MAUAV), the planned UAV shall be usable within the range of the TUAV (up to 500km). For this the following can be stated:

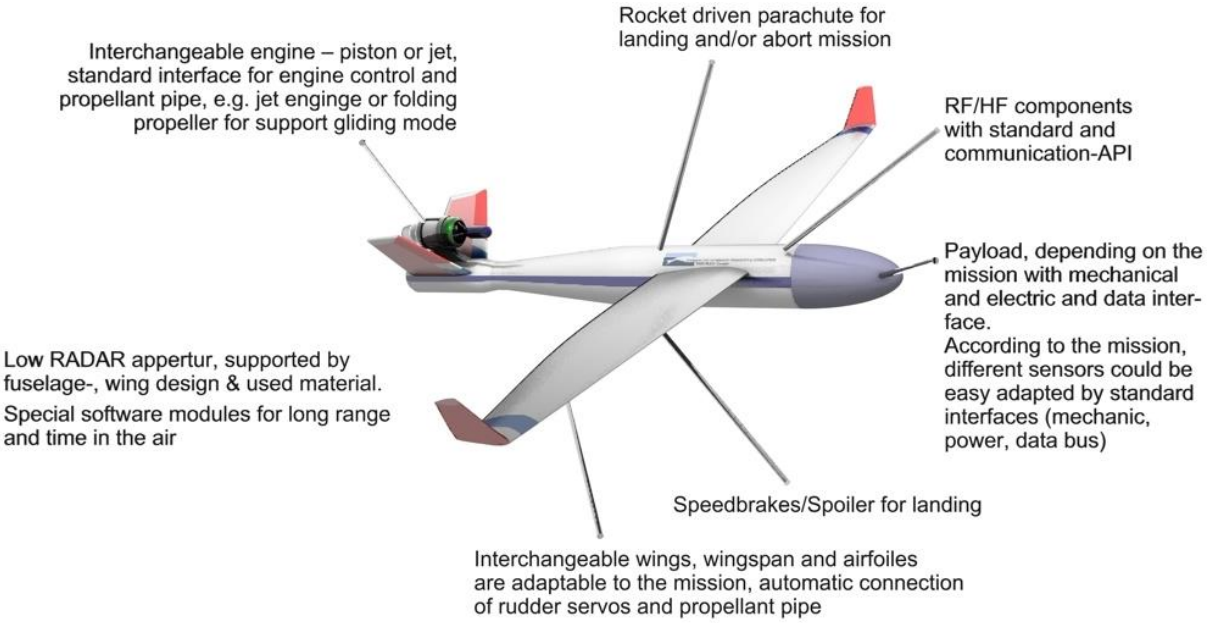
- The market is the biggest
- The spectrum of use is the biggest

- A product family with different sizes could be easy developed
- Dimension of the drone corresponds best to the project philosophy of easy adaptable, easy to use and consistently modularized UAV

Disadvantages of present UAVs:

- Predominantly developed for one case of application and for special requirements developed.
- Not modular.
- Expensively.
- Not simply adaptable to new technologies.
- Dates of starting developments and thus of the assigned techniques are approx. 10y. ago.

The figure below shows the components of the airborne MAUAV system.



The communication system includes the following features:

- Via satellite or conventional system with standard communication API on two channels:
  - Channel for mission control with narrow-band transmission protocol.
  - Data channel for user data such as video data with broad band transmission protocol.
- Mission control: system status, energy status, fuel consumption & flow, speed, altitude, etc.
- 2D/3D visualisation on ground station with flexible camera, topography, obstacles, weather information's, etc.
- Intelligent mission planning: weather conditions, vertical air flow, UAV configuration, kind of mission, fuel, used sensor, etc.

High-experienced companies are selected for install a R&D project to develop the functional prototype of mission adaptable UAV/S system, according to TUAV requirements:

- Company 1 (developer and manufacturer of carbon fiber airplanes (at time gliders which are drive by gasoline-, diesel-, electric- engine or turbine):
  - Requirements.
  - Development of the aircraft and its testing.
  - Conceptual tests with basis of man-controlled airplanes.
  - Development of new and economical production methods.
  - Development of a modular construction UAV of newest technology.
  - System integration/tests.
  - Etc.
- Company 2 (developer of vehicles and systems in fields of defence)
  - Requirements.
  - Concept.
  - Test.
  - Integration.
  - Know-how-transfer of carbon fiber technology.
  - Structure of new system products/product family: Drones and additional systems/system components.
  - Launch system & System components.
  - System integration/tests.
  - Etc.
- TROUT GmbH
  - Concept.
  - Requirements.
  - Project management.
  - Quality management.
  - Development software UAV.
  - Evaluation station.
  - Development hardware UAV.
  - System integration/tests.
  - Etc.
- DLR
  - Aerodynamic model
  - Verification of aerodynamic data
  - Optimization of aerodynamic model
  - Simulated flight tests
  - Etc.

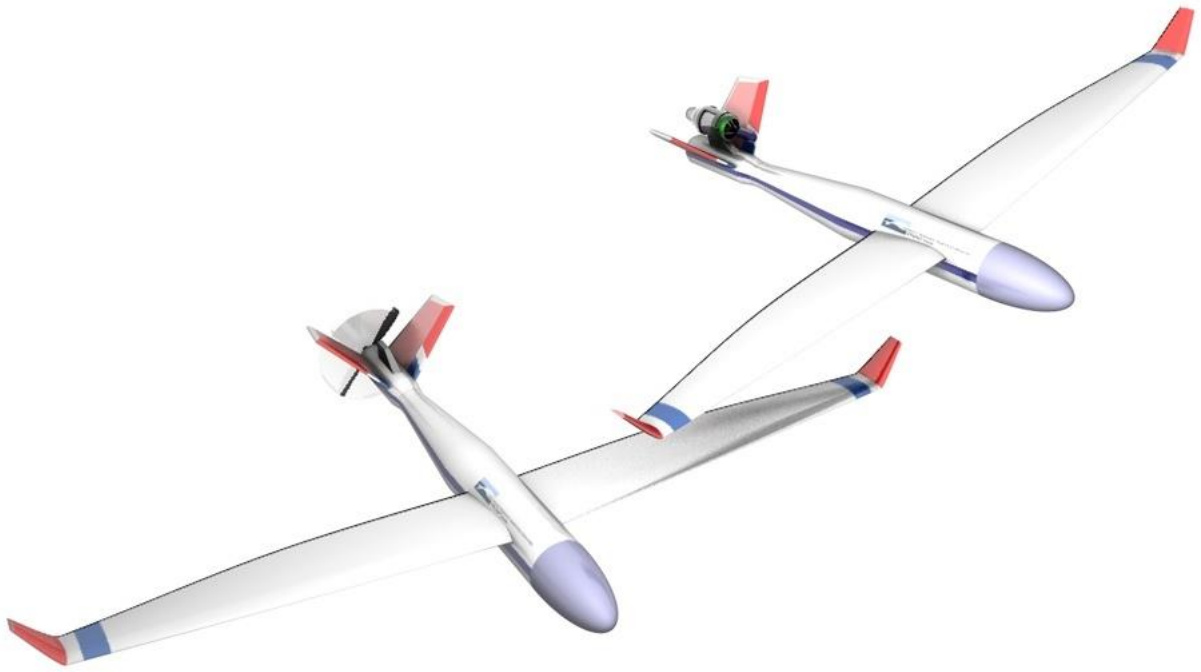
Additional project partners: Universities, etc.

System features (overview):

- Consistently modularised.
- Easy to adapt to different missions – surveillance or combat.
- Easy to update to new technologies.
- Consistent usage of existing and proved technology.
- Consistent usage of COTS (commercial off-the-shelf) parts.
- Usage of proved and high quality components.
- High quality system for low costs.
- Low RADAR profile.
- Easy series production, based on PREPEG (Carbon fibre).
- System prices against comparable systems about a tenth.
- Payload against comparable systems about factor 2 at minimum.
- Cruising range at minimum 500km.
- System costs approx. 1/10 against comparable systems
- Simulation and training included.
- Increase of payload by at min. 100%.
- Increase of mission time by at min. 100%.
- Weight of body at min. -30%.
- Optimization of cruising range by intelligent flight profiles (using of vertical air flow, yet stream, saw tooth profile, etc.)

The following table describes the characteristics of the MAUAV system and below a design study of the airborne part is shown.

MAUAV	Piston engine	Jet engine (230 N)
Wing	5-7 m	3-5 m
	Wingspan and airfoil for best gliding at low altitude	Wingspan and airfoil for best performance at high altitudes
	„Saw Tooth“- flightprofile for max. range	
Glide ratio	> 50	> 35
Lenght of fuselage	3m	
Payload	> 20 kg	
Propellant weight	35kg	
Netweight	30kg	
Total weight	80-90kg	
Cruise speed	100-200 km/h	300-500 km/h
Altitude of operation	500-2000 m	1000-10000m
Consumption	max. 6-8 l/h Petrol	max. 30 l/h Kerosene
Operation range	- > 500km	
Mission time	3h-10h	1h-3h
Landing	By parachute	On skid



Estimation to get functional prototype status:

Costs	approx. 3.8MEUR
Period	22-24 month

Fields of Application

Cross-sectional carrier system, easily adaptable to different missions (e.g. surveillance or combat), requirements, new components and newest technologies

Status

Concept

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