Bavarian e-tonomous AIR Mobility

(BeAM)

bavAIRia

Foreword

Bavarian e-tonomous AIR Mobility: BeAM

Mobility is a central factor in the competitiveness of urban areas. The further development of our transport system is therefore a major challenge. We need to improve existing means of transport and, at the same time, enable their seamless integration with new traffic systems. Airborne systems will play an important role here. What used to be a vision of the future is now taking shape. In future, environmentally-friendly "air taxis" will fly (semi-)autonomously with electric propulsion systems. It is important for Bavaria to be able to compete in the global marketplace. We have the right foundations in place for this. We have excellent research facilities and innovative companies at the cutting edge of many of the technologies on which such flying systems are based. "Air taxis" will be a focal point in which key technologies can be bundled and from which new business fields can be developed. The Bavarian Air Mobility Strategy is geared to creating optimum conditions for industry and research. We will open up test markets, conduct feasibility studies and establish a legislative framework. We are supporting the development of electric and autonomous flying in Bavaria through the "Bavarian Aeronautical Research Programme". The special publication "BeAM" is to provide further momentum!

Dr. Markus Söder

Minister-President of Bavaria

UAM Step by step to success

No area of technology is changing mobility as much as electrification and computerization. This trend has also reached aviation.

The automotive industry's activities in this sector, the air-taxi hype and the idea of urban air mobility have accelerated in a way that we are not used to in aviation.

Bavaria is a centre of this new mobility. This is due to the leading universities and large high-tech companies based here, some of which, like Siemens, Airbus and others, got in on this development at a very early stage. The numerous experienced medium and small aviation and aerospace suppliers in Bavaria, who over decades have learned to supply aviation-quality components, are an added bonus.

One thing is clear, even if more and more eVTOL prototypes have taken off in the last few months: There is still a long way to go until your average passenger will be able to fly to the city centre in an eVTOL air taxi.

In the conventional electric aircraft sector, the series production of many prototypes is getting closer or has already been achieved. The most well-known major problem is battery capacity. As in other areas of transportation, available power storage limits the success of e-mobility. But there are even more areas that are equally important for the success of electric aviation and especially eVTOL:

1. The certification of electric, eVTOL and autonomous aircraft: In different parts of the world, the aviation authorities (EASA, FAA, CAAC ...) are working on very different approaches. Europe, especially Germany and the Czech Republic has e-planes and eVTOLs that belong to the ultralight class. Increasing the take-off weight from 450 to 600 kg has helped to integrate the weight of the batteries. In the USA, the current plan is to integrate eVTOLs into the LSA class as LSA-eVTOLs. This will take some time, however, since the new version of the LSA rules has to pass through Congress.

2. Operation: In addition to the approval guidelines for the aircraft, the operating and maintenance guidelines must also be completely re written and then approved. Almost all leading manufacturers such as Airbus, Volocopter and Embraer are currently not only working on their aircraft, but also on systems for flight operations with such aircraft. A completely new air traf-

fic management system (ATM) will also have to be developed for air taxi operations, because the existing passenger aviation system cannot achieve this conceptually.

3. Infrastructure: The majority of infrastructure already exists for conventional electric planes because they can continue to use the existing runways and airports – only the charging stations need to be integrated into the existing infrastructure. This can also pose problems in individual cases: The necessary capacities require new cables to be laid as well as, if necessary, intermediate storage. But these are small problems compared to the eVTOL situation. These still pose many unanswered questions: How will this new infrastructure be implemented? Who will build it and who will pay for it? Since this traffic is to occur in densely populated cities, potential partners for the eVTOL industry may include car park operators, but perhaps also the operators of various train stations in urban areas. The latter would also have experience in providing electrical infrastructure because the building structure is only part of the problem. Plans for the new electricity infrastructure are currently being finalized in many cities and countries. Last but not least, e-mobility for cars has made new planning inevitable. If aviation is not careful, the new networks could be installed without planning the energy required for UAM and eVTOL.

4. Public acceptance is another issue concerning electric flying. After all, no new aviation technology will be successful unless it is safe and accepted by the public and politicians. This ranges from fear of the danger posed by certain battery types to acceptance of autonomous vehicles on the ground or in the air.

Taking all of this into account, it is obvious that forecasts by some manufacturers or operators who say: „We will start transporting passengers with eVTOLs in 2 years“ are very naive.

To transport passengers commercially, the aircraft will have to be approved by civil aviation authorities such as the EASA. So far, with the exception of a single glider, there has not been a single certified conventional GA aircraft with an electric motor, nor has there been a single fully certified GA aircraft with pure “fly by wire” control. Yet both components are indispensable for every eVTOL. Therefore, no eVTOL even comes close to being certified currently.

The expectation is for conventional fixed-wing aircraft to take up flight operations: first in training operations and then as an air taxi, an e-commuter, specifically from airport to airport. Many components such as batteries, electric motors as well as semi-autonomous and autonomous control systems that are used in these electric aircraft are essential for eVTOLs. Conventional e-planes are therefore an ideal test field for these technologies. The same applies to the high-voltage charging structure. After all, on the long journey to autonomous eVTOLs, it makes more sense to start by taking one step at a time than to make a big leap.

Bavaria not only has leading manufacturers in the field of eVTOL or aerospace suppliers, but also those working on e-commuters, electrically powered feeder aircraft. Rolls Royce Electric (formerly Siemens eAircraft), the leading manufacturer of aircraft electric engines, is also based here. Bavaria has an additional advantage: Bavarian car manufacturers, for example Audi, are interested in a technology crossover between ground-based and air-borne autonomous electromobility. An example of this is the test area currently being built around Ingolstadt where both autonomous driving and autonomous flying are to be tested. This area is supported by the city of Ingolstadt, the Bavarian State Government, Airbus, Audi and many other industrial partners. Another test centre for Electric Air Mobility is being built in Oberpfaffenhofen, where Lilium, AutoflightX, Quantum Systems and the Technical University of Munich, a number of companies, work and are waiting to carry out the first autonomous flights.

A co-production with:

media mind   TECHNISCHE   FlyingPages

In collaboration with:

bavAIRia
Europe's heart of aerospace and navigation

Walter Fürst
CEO
media mind GmbH & Co. KG

Willi Tacke
CEO
Flying-pages

Masthead:

Publisher:	media mind GmbH & Co. KG Hans-Bunte-Str. 5 80992 Munich/Germany Phone: +49 (0) 89 23 55 57-3 Telefax: +49 (0) 89 23 55 57-47 E-mail: mail@media-mind.info www.media-mind.info
Managing director:	Walter Fürst, Jürgen Bauernschmitt
Design + DTP:	Jürgen Bauernschmitt
Prepress:	media mind, München
Responsible editor:	Ilse Schallwegg
Printed by:	grafik+druck, München
Published annually:	1 x annually

Table of contents

bavAIRia: TUEF Bayern offers a test range for unmanned-/electric aircraft with realistic application scenarios

A global market volume of $ 75 billion for emission-free passenger transport by air taxi is expected by 2035. Added to this is the growing market of UAS (Unmanned Aircraft Systems drones) in various sizes. The majority of the business potential and thus of workplaces lies in applications and services in which operations are done **B**eyond **V**isual **L**ine **of S**ight (BVLOS).

The Bavarian State Government has committed to this growing future field and is promoting development and application. Bavarian companies and research institutes are at the forefront of technology today, but are now required to implement and extend this lead in practical applications. The new technologies increasingly need realistic application scenarios. For this we need several well-equipped test fields in Bavaria and Germany. This was also formulated by the BMVI's Unmanned Aviation Advisory Board and recommends coordination in various areas. First small funding projects with Bavarian participation have already started.

bavAIRia, the Bavarian Aerospace Cluster, has been working with its UAS Forum on the further development of this promising future technology in various test areas for over six years. The Oberpfaffhofen Research Airport is already involved in the trials and offers the best conditions for realistic tests. The start-up friendly eco-system around the Oberpfaffenhofen Campus, which has grown rapidly in recent years, now needs to be further developed quickly.

Minister of Economic Affairs Aiwanger speaking at an exhibitor's stand at the 12th UAS Forum in Oberpfaffenhofen ■

Goals of the extended Test field for the Unmanned-/Electric Flying (TUEF) in Bavaria

With the expansion to a pilot region for Urban Air Mobility (UAM/Air taxis) and testing in real application scenarios for UAS, the following goals are pursued:

- Further development of standards, regulations and approval processes
- Development of technologies and processes
- Testing and verifying inside and outside the **v**isual **l**ine **of s**ight (VLOS)
- VLOS / BVLOS operation in the EDMO control zone (CTR)
- BVLOS operation in a corridor up to 60 km
- Use as a SORA test range for standard scenarios
- testing of integrated air situation display (U-Space)
- Use as a 4G / 5G / 6G / SatCom test environment
- Use for customer presentations and training
- Testing drone defense scenarios

At the same time, the expansion of research and teaching is being promoted together with TUM / DLR at the AIR Campus Oberpfaffenhofen. Coordination takes place with a planned lighthouse projects as part of the High Tech Agenda Bavaria and with the European project Urban Air Mobility Ingoldstadt ■

Benefits of the project

With TUEF-Bayern as test area - Bavaria and Germany quickly

bavAIRia e.V.

bavAIRia, the Bavarian Aerospace Cluster is representing since 2006 over 300 members (75% are SME) in the field of Aerospace in Bavaria. It is located in Oberpfaffenhofen, near Munich, Germany. The overall objective is to foster the cooperation between industry, small and medium enterprises (SME), universities, research institutes and politics and improve the overall international competitiveness of this sector.

Special Airport Oberpfaffenhofen
Friedrichshafener Straße 1
D-82205 Gilching, Germany
T +49 8105 272927-0.
info@bavAIRia.net
www.bavAIRia.net

bavAIRia
Europe's heart of aerospace and navigation

Several bavAIRia UAS forums each year bring the Bavarian UAS community together ■

have the opportunity to try out existing product and business ideas and to test new approaches with research support from TUM / DLR. Building on the good conditions, the Oberpfaffenhofen Research Airport (OPF) with its numerous start-ups in the area of unmanned-/ electric flying, which are already located in the immediate vicinity, is ideally suited as a pilot zone. The involvement of the relevant industry and research institutes is coordinated, short routes to the air safety and licensing authorities and the national drone advisory board of the BMVI are ensured. The high level of attractiveness shows the ongoing settlements of companies in the past year. The best conditions have been created for further settlement requests. ■

Next steps

We are currently collecting and analyzing the specific requirements of existing and future

Local politicians gather information at the 12th UAS forum from users of the TUEF Bavaria test center ■

users. On this basis, the investment planning for the expansion of the capabilities is built up. The preparation of a safe airspace

Exhibition booth bavAIRia at Paris Airshow 2019 with J. Heitzmann, A. Gundel (Executive Board) P. Schwarz (Managing Director) Team C. Labitsch and E.V. Lauschner ■

(corridor) for BVLOS flights over 60 km in length is ongoing. BVLOS flights can already take place to a limited extent today. Safe integration into normal airspace will have top priority. This also requires dynamic air situation displays, including the integration of the low-flying test aircraft/ UAS with new technologies such as LTE, 5G and other modern tracking methods. Further test flights of air taxis from various manufacturers, cargo drones and other applications according to new European standard scenarios are planned. A new landing pad for air taxis for research purposes is currently being created with the support of the BMVI and a project application for redundant communication with drones in an integrated air traffic display has been submitted. bavAIRia will take over the coordination and project management in this project and invites all interested parties from Bavaria and neighboring countries to take part. The shared use of investments, jointly coordinated funding from the federal and state governments and the exchange of experience bring us closer to the goal of safe use of unmanned and electrical aircraft. ■

Contact:

Dipl.-Ing.
Erwin V. Lauschner
Special Advisor
bavAIRia

Dipl.-Ing.
Peter Schwarz
Managing Director
bavAIRia

Special Airport Oberpfaffenhofen

Friedrichshafener Straße 1
D-82205 Gilching, Germany
T +49 8105 272927-0
info@bavAIRia.net
www.bavAIRia.net

Institute of Flight System Dynamics

Disruptive Flight Systems

The paradigm shift from design assurance to performance-based safety assurance

"Flying to buy breakfast in a bathtub (Mit der Badewanne zum Bäcker)" – using this phrase, a group of tech-kids calling themselves "Real-Live Guys" have published a video where they turned an old bathtub into a really flying manned multicopter which takes them to the bakery to buy their Sunday breakfast. This clip impressively proves – if you really want, you can build your own flying device. Gone are the times where people had to look up and admire government funded multi-billion Euro aerospace projects – now it's everybody's turn again! Looking at drones that becomes even more obvious – a multitude of open source projects like PixHawk or Ardupilot and excellent books – more and more written by Asian authors – are moving design, construction and testing of exciting flying vehicles right into kids' rooms.

"Model aircraft building has been there forever" is the sentence that traditionalists would immediately use to counter at this point – however, particularly over the last 15 years the new developments allowed many to turn their hobbies into a profession, a stable basis for a prosperous and self-employed future. The revitalization of the aerospace landscape with a wealth of Start-ups around unmanned, electric and urban aerial mobility bears an enormous chance of creating new high-tech jobs. This new aerospace is coupled much tighter to other industry domains than classical aerospace. Robotics, automation, electric mobility, digitalization, navigation and communication, machine learning, artificial intelligence and additive manufacturing are key enablers for all industrial domains including aerospace.

Fig. 1: *eVTOL AutoFlightX V600* ▪

However, safe and reliable operation is the prerequisite for sustainable success of this new kind of aerospace and also the needs of uninvolved people, e.g. with respect to privacy or noise need to be considered.

Here, not only regulations and legislation come in to play but particularly the question how to meet the requirements and how to prove their compliance. Those requirements need to guarantee certain basic properties on one hand side, on the other hand, they need to be solution agnostic. Classical aerospace individually addresses the airplane itself (airworthiness), operations, operation organization and personnel. For many of the new applications these aspects get closely together and therefore may no longer be considered separately.

Looking at the airplanes from the first century of flight, they all look similar – fuselage, wing, engines and most with an empennage – a very limited set of basic components and configurations. That high level of similarity allowed to achieve a high level of safety by dedicated design requirements. The learning curve was mainly built on past accidents and incidents.

Considering the multitude of configurations for the new aerial systems, it becomes obvious that uniform component-oriented design standards will not be capable

TUM München

Fig. 2: *AUTEL Dragonfish* ▪

of successfully covering the wealth of new topologies as well as the fact that now many components have to serve different purposes and contribute to different functions simultaneously. *(Fig. 1 and Fig. 2)* For that reason a shift in paradigm is visible in the certification strategy for those types of vehicles – from design assurance to safety assurance, replacing specific component design rules by safety and performance objectives, for which compliance must be demonstrated *(Fig. 3)*.

Especially when safety objectives are of probabilistic nature, meaning if the admissible probability of an adverse event to be allowed to happen depends on the severity of the consequences of its occurrence, it is hard to predict the actual probability of occurrence. This is particularly true, if the event does not result from a component malfunction or failure (for that case, well-established safety analysis methods and standards are available in aerospace), but from an adverse combination of various parameters (external disturbances, weather parameters, tolerances, sensor uncertainties). For such cases, only very few methods are available allowing statistically significant and valid predictions of the probability of occurrence at acceptable computational cost.

At this point, the Institute of Flight System Dynamics of Technische Universität München contributes via both, development and research projects and is readily available as a project or development partner. Every time when novel systems are developed, for which little prior knowledge exists and which are not following an evolutionary learning curve but are implemented as a disruptive solution, the methods presented here provide great benefits.

Model-based design is at the core of the methodology that formalizes textual requirements to become unique and verifiable already before the actual development commences, allowing an early simulation of the desired behavior of the later product. This must not be confused with a prototype simulation – an “executable specification” of the targeted behavior is an innovation which is non-standard to date. It allows a quantitative validation oft the requirements and a data and physics driven derivation of requirements for systems, subsystems and components that before were rather based on learning curve, experience and subjective engineering judgement. *(Fig. 4)*

Textual requirements are captured in Siemens Polarion and directly linked to their fomalized counterparts (specification models, assessment models, test procedures, test cases and later prototypes) that are all implemented in the MathWorks Toolchain (Matlab, Simulink, Stateflow, etc.) This linking ensuring bi-directional traceability is provided by SIMPOL, a software developed at the TUM Institute of Flight System Dynamics. The software which can be freely downloaded from the institute homepage does not only provide bi-directional linking of the artifacts but also enforces consistency and actuality of the links.

Physical parameters contributing to the system are no longer treated as constants but as uncertainties parametrized by arbitrary probability distributions (in contrast to fixed intervals). To assess designs with respect to meeting probabilistic requirements, the probabilities for violating inequality constraints need to be determined for comparison with the admissible thresholds. The challenge is that the target probabili-

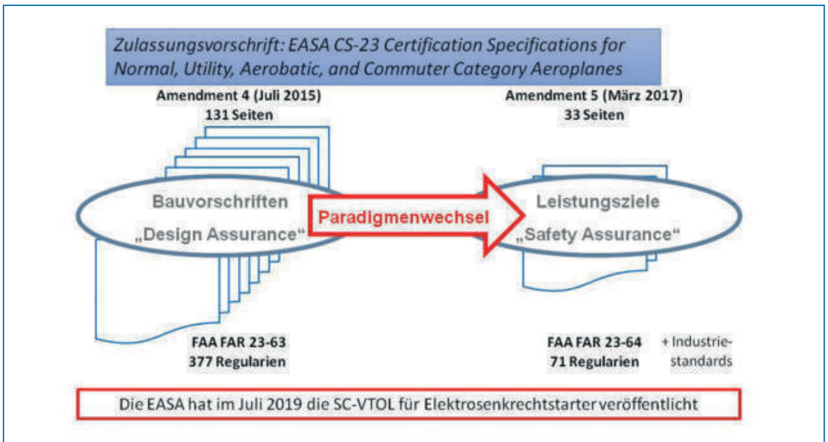


Fig. 3: *Paradigm Shift in Certification* ▪

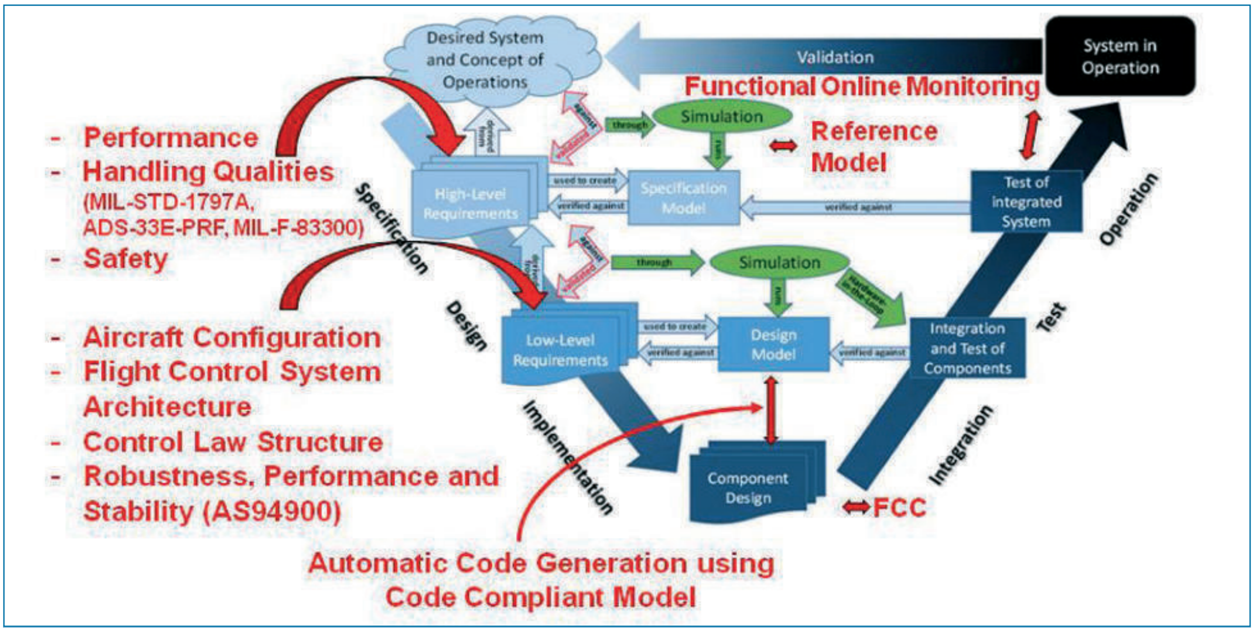


Fig. 4: *Utilization of Models in the Development Process* ▪

ties are very low whereas the uncertainty space is high dimensional and the involved system dynamics nonlinear. Due to these nonlinearities and the fact that many uncertainties are non-gaussian, expectancy and variance cannot be propagated linearly. Classical Monte Carlo methods might be suitable in principle but due to the low target probabilities and the high cost of s single function evaluation, it is infeasible to perform the number of simulations required for statistically relevant statements on a reasonable confidence level within a manageable computation time.

Therefore, new ways need to be found – the available toolset of the Institute of Flight System Dynamics consists of so-called subset simulation, propagation via unscented transform, approximation by gaussian mixture models and utilization of generalized polynomial chaos. The methods mentioned can be applied on systems with abovementioned characteristics to predict the probability at which probabilistic requirements posed as inequality constraints are violated.

The optimal control framework FALCON.m developed by the Institute of Flight System Dynamics and available for free download on the institute homepage provides another path to early discovery of weaknesses in requirements and designs – "counter optimization" or worst-case optimization tries to produce input and disturbance time histories that aim at maximizing the violation of requirements. The condition that the probability of occurrence of the related uncertainty and disturbance must exceed the violation threshold is formulated as a chance constraint. *(Fig. 5)*

Also, in the field of model-based safety analysis, the institute tool ExCuSe (exclusion of cutsets) provides and approach to guarantee the safety of state machines and other logics under uncertain inputs utilizing formal methods (property proving). For the algorithms under test, failure cases and uncertainties for the input variables and properties that negatively affect system safety ("hazards") are defined along with their admissible probability of occurrence. The tool uses property proving to identify all branches that lead to the undesired event, sorts them along their cardinality and computes the probability of occurrence. *(Fig. 6)*

Utilizing the ADS2 Hardware-in-the-Loop System by TechSAT, the functions under development are transferred from a functional to a system simulation at the earliest possible point in time, which in a virtual system integration allows to

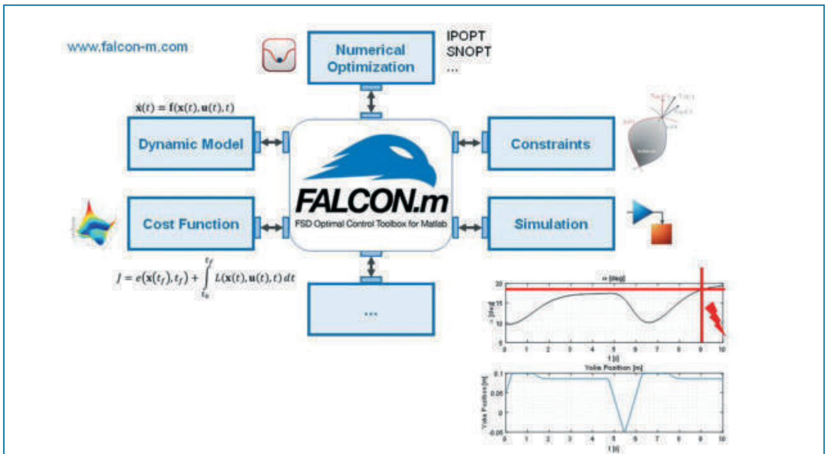


Fig. 5: Counter Optimization using falcon.m ▪

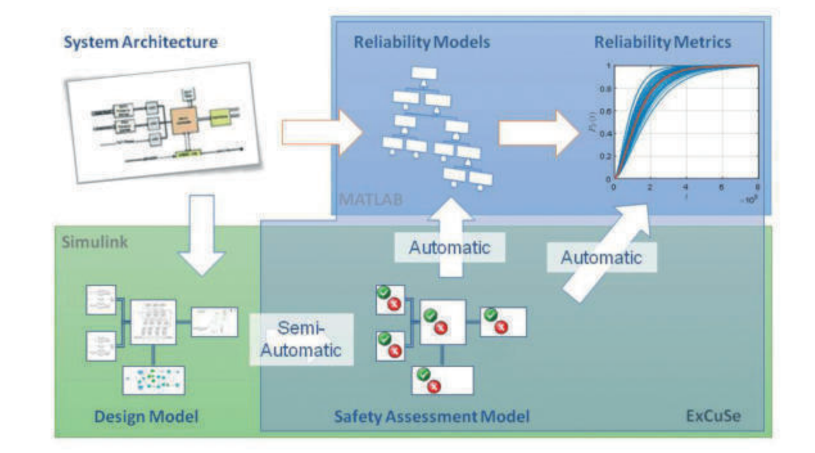


Fig. 6: Model Based Safety Analysis using ExCuSe ▪

analyze correctness and completeness of interfaces, information flows and concepts as well as the behavior under fault and failure conditions. It is a particular strength of ADS2 that the virtual components can successively be replaced by real hardware (ideally, again at the earliest possible moment). *(Fig. 7)*
The actual implementation of the functions under development is also performed following the model-based approach for later automatic code generation for the embedded target hardware. To ensure quality driven and standard and process conforming development also for smaller developer teams with high personal fluctuations, the software MRAILS was created at the TUM Institute of Flight System Dynamics. It step-by-step leads the user through the development process, automates many check and review tasks and accelerates the development process by providing a wealth of templates and design patterns. *(Fig. 8)* Day by day, the set of tools and methods presented in this article proves in a multitude of application projects that it's fit for purpose. But in particular it unleashes its potential in the development of novel systems for which no big learning curve is available – it helps to reduce development risks and by a strict "frontloading" of a development process driven by quantitative requirements helps to detect problems and avoid mistakes.
The methods discussed are only part of the spectrum provided by the TUM Institute of Flight System Dynamics. Together with our powerful network of small and medium sized partner companies, we are providing flight control solutions for the thrilling new domains of aviation – electric, unmanned and urban.
We are looking forward to also work with you – at home in Bavaria, successful in the world!

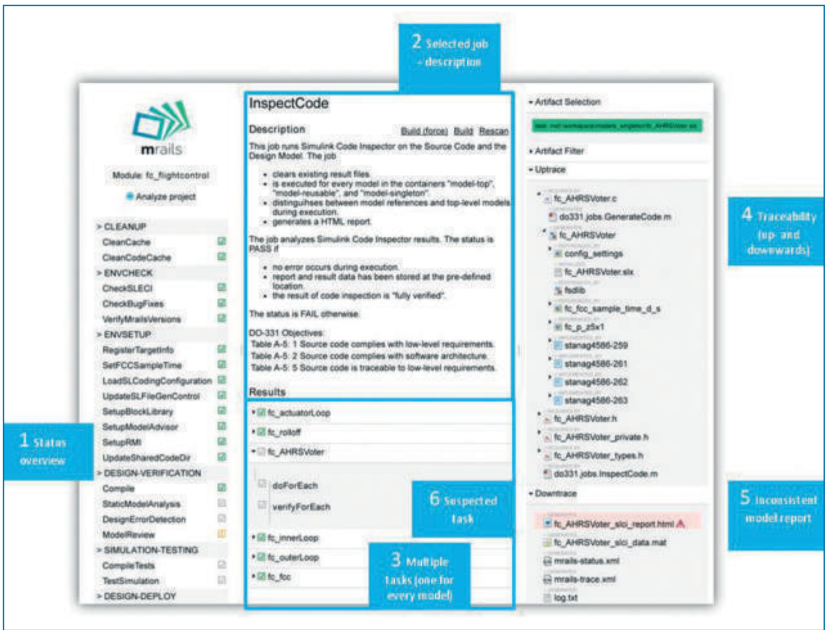


Fig. 8: HIL Simulation using TechSAT ADS2 ▪

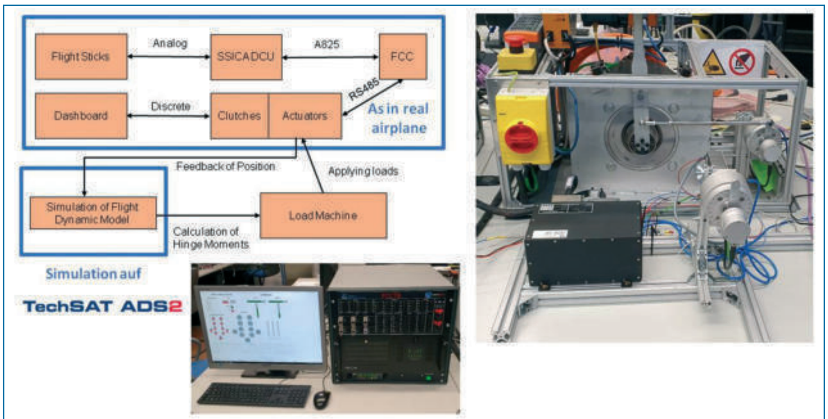


Fig. 7: Process Build Tool MRAILS ▪

Author:

Prof. Dr.-Ing. Florian Holzapfel

Lehrstuhl für Flugsystemdynamik / Institute of Flight System Dynamics Technische Universität München
Boltzmannstraße 15, 85748 Garching
Phone: +49 (89) 289-16081
Fax: +49 (89) 289-16058
e-Mail: Florian.Holzapfel@tum.de

Toward the Mobility of the Future

Ingolstadt's Urban Air Mobility initiative has taken flight

Only about one-and-a-half years into the project, it has welcomed 69 well-known domestic and international partners on board, and secured some 12 million euros in subsidies – no mean achievement. Working with partners from industry, and the small business and non-profit sectors, the city of Ingolstadt has succeeded in developing a network for 3D mobility that leads any other of its kind in Europe. The Urban Air Mobility (UAM) initiative is dedicated to supporting research and development, and providing a testing ground for trials of autonomous aircraft. The goal is to strengthen the standing of Ingolstadt and the surrounding region as a commercial hub and to secure future jobs. "We have to start now with intensive efforts to ensure fair and well-paid jobs for the future, which is why we are embracing various technology projects. With the research and development of the flying taxi concept, we can further heighten our "mobility" profile, as well as contributing to protecting existing local jobs in industry and science, and creating new ones", says Ingolstadt's mayor Christian Lösel. ■

The number of network partners rises

There is a continuous increase in the number of supporting partners for the UAM initiative. At this point, Ingolstadt has almost 70 UAM partners from the corporate, academic/scientific, and non-profit sectors. Among the best known of these are Audi, Airbus, the German Aerospace Center (DLR), and EUROCONTROL, the European air navigation agency. Also onboard are colleges, trade unions, the district administrations for Region 10 (Ingolstadt), and several state and federal ministries. Numerous new partners joined up in 2019 alone. One of those is the German rail company Deutsche Bahn. Within the UAM framework, simulations ("free rail") in cooperation with drone manufacturer Quantum Systems are exploring the use of drones, and the necessary conditions for their deployment, in the service of faster and more efficient inspections of the transport network. The newest addition to the UAM project network is the UK company Skyports. It is currently active in Singapore, among other places, where the company is developing the vertiport. Such vertical take-off and landing pads for flying taxis are in planning for Ingolstadt under the project name "INCityTakeOff". Mayor Lösel is pleased with the initiative's progress, stating "we now have all the players from industry and science on board that are necessary to research and test Urban Air Mobility. Ingolstadt can become a skills hub for drones, flying taxis, and digital, autonomous mobility". Any companies, institutions, or non-profits that would like to join the project are warmly invited to make contact via e-mail at: uam@ingolstadt.de. ■

A grand world debut

A host of media, the public, and political VIPs gathered last spring for the official presentation of the CityAirbus flying taxi at Ingolstadt's Rathausplatz square. German Minister of Transport Andreas Scheuer was among those in attendance. He said, "Germany is a pioneer in aviation. Drones and flying taxis are no longer a far-off vision, but represent a path into a new dimension of mobility. They open up entirely new opportunities, for instance ambulance transport of patients in cities and congested areas. And they are an enormous opportunity for established companies and start-ups, which are already successfully and specifically driving development. With testing under real operational conditions, Ingolstadt is seizing those opportunities – proving itself as a strong hub for

German Transport Minister Andreas Scheuer, Cabinet Minister Dorothee Bär, Mayor Christian Lösel, Wolfgang Schoder of Airbus Helicopters, and Member of Parliament Reinhard Brandl at the unveiling of the CityAirbus. Photo: City of Ingolstadt / Rössle ■

innovation". The German federal commissioner for digitization, Dorothee Bär, underlines the fundamental significance of the model project, stating "with these new forms of mobility, we are forging forward into entirely new spaces for the city, but also for rural areas. The model project proves that flying taxis are not futuristic; they have long since become reality. We seized the chance to shape a technology with enormous economic potential for a livable future". The CityAirbus is an electric aircraft with eight rotors that can take off and land vertically (VTOL). The one presented in Ingolstadt is a demonstration model. The aircraft was developed at Airbus Helicopters in Donauwörth; it is slated to make its first flights in the next few months at Manching airfield near Ingolstadt. The results of the test flights will be used in further developing the prototype. The current plan is for the CityAirbus to make its debut at the 2024 Paris Olympics, providing autonomous flights between Charles de Gaulle airport and the event venues. The manufacturer believes that transfers between airports and city centers will be one of the first applications for flying taxis. ■

The national network

The UAM initiative is a pan-European project with a total of 42 municipalities participating. In addition to Ingolstadt, German participants include the cities of Hamburg, Aachen, and Münster, as well as the North Hesse region. Meeting in Berlin in 2019, those German cities set up a national network, with the Federal Transport Ministry coordinating. Its goal is to enable a regular exchange of information between the municipalities. The city of Ingolstadt represents all 17 UAM cities in Europe vis-à-vis the European Union when it comes to financial aspects of the UAM initiative. The members of the Ingolstadt UAM initiative network meet regularly at one of the participating institutions to discuss the current state of research, ongoing projects, and challenges. Several working groups have also been set up to tackle specific subjects. One example of this is the research project ("GABi") set up by the service management department, under the chair of Prof. Dr. Jens Hogreve, of the WFI School of Management at the Catholic University of Eichstatt-Ingolstadt, with the aim of exploring civic participation and public acceptance of the UAM initiative. Among the specific issues the group is examining are what benefits UAM will bring to citizens, and what kind of expectations and fears it evokes in society. Those issues are also the jumping off point for the living lab called "Vertikal" in Ingolstadt's pedestrian zone. Working with the business incubator brigk, the lab offers a variety of UAM-related

Numerous members of the public attended the world debut of the CityAirbus in Ingolstadt. Photo: City of Ingolstadt / Rössle ▪

things directed specifically at residents and laypersons. Among those are drone workshops, the chance to fly a drone, VR headsets, exhibitions, dialogue with UAM network partners, and many other things. ▪

Flying taxis as part of the public transportation system?

The first self-contained project within the UAM initiative has been completed. A research project dubbed OBUAM, undertaken jointly by Bauhaus Luftfahrt and the technical colleges of Munich and Ingolstadt used the Upper Bavaria region as a model to explore the long-term application of Urban Air Mobility as an extension of a public transportation network. The region examined in the model comprised Ingolstadt, Munich, Augsburg, Landshut, Rosenheim, and their catchment areas. "The research showed that the number of available aircraft and the fare levels will have the greatest influence on demand for UAM", explains Kay Plötner, head of economics and transportation at Bauhaus Luftfahrt. In addition, experts assume that demand will rise with the increase of vertical take-off and landing spots, or Vertiports. By contrast, the speed of flights appears to have only a marginal influence on projected demand. Although flying taxis cannot be considered a potential replacement for traditional public transportation, they can certainly function as a complement to it. The study concludes that UAM could make up approximately one percent of modal share (the percentage of total travelers using a certain form of transportation). "Fares will have to be in the same range as traditional taxis in order to make UAM more than a niche market", says Plötner. UAM will not fundamentally change the overall mobility system, however it could complement the current transportation network with a fast and flexible service. For flying taxis, mid-range distances of between 40 and 100 kilometers are a particularly attractive target. The study was published by the state of Bavaria.. ▪

brigkAIR launches in 2020

Additional important steps in the UAM initiative will start in just a few weeks or months. brigkAIR, an offshoot of the digital business incubator, will start services at the Manching airfield in 2020. Its focus is on digitizing the aviation industry. Working with local institutions (including Airbus and the German army technical and airworthiness center), the idea is to set up a network and funding entity for start-ups in the unmanned aerial vehicle (UAV) market. "Our goal is to establish the region around the Manching test airfield as an area

Christian Leicher (CEO Rohde & Schwarz), Municipal Building Superintendent Renate Presslein-Lehle, THI (Ingolstadt technical university) President Walter Schober, and Mayor Christian Lösel at a UAM network conference. Photo: City of Ingolstadt / Michel ▪

The UK's Skyports recently built the first Vertiport (VTOL pad) in Singapore for flying taxis. Photo: Skyports ■

strong in technology and innovation in the field of 3D mobility, and to further develop the strong existing skill pool in emerging technologies. With the Urban Air Mobility initiative, the Ingolstadt region has already achieved international visibility", says Bavaria's state economics minister Hubert Aiwanger. Ultimately, technology know-how, manufacturing opportunities, and the availability of testing grounds will attract start-ups from all over the world to the area. Ingolstadt's mayor, Dr. Christian Lösel stresses that "brigkAIR is a key component of our air mobility strategy. At Manching, right at the city's door, new types of aircraft – for example, made by Airbus – can be extensively tested in a safe environment. But entrepreneurs and start-ups can also test their technologies here. That optimal testing grounds is a unique feature and a clear advantage to our region". Some 15 interested parties from all over Europe have already applied to be part of the brigkAIR complex. ■

Contact:

Hans Meier
Stadtdirektor

Stadt Ingolstadt
Direktorium

Rathausplatz 2
D-85049 Ingolstadt
Phone: +49 841 3 05-20 00
uam@ingolstadt.de
ingolstadt.de/uam

Project partners and stakeholders in the Ingolstadt Urban Air Mobility initiative (listed alphabetically)

- AES Aerospace Embedded Solutions GmbH
- Airbus
- Airbus Gesamtbetriebsrat
- Audi AG
- Audi AG Gesamtbetriebsrat
- Autoflug GmbH
- Bauhaus Luftfahrt
- bavAIRia
- Bayerisches Rotes Kreuz
- Bayerisches Staatsministerium für Wirtschaft, Landesentwicklung und Energie
- Bayerisches Staatsministerium des Inneren und für Integration
- Bayerisches Staatsministerium für Wissenschaft und Kunst
- Bayerisches Staatsministerium für Wohnen, Bauen und Verkehr
- Bayerischer Städtetag
- Bayern Innovativ GmbH
- BEE appliance GmbH
- BFFT automotive GmbH
- Brigk – Digitales Gründerzentrum Ingolstadt
- Bundesministerium für Verkehr und digitale Infrastruktur
- Bundesministerium für Digitalisierung
- Cotesa GmbH
- Deutsche Bahn AG
- Deutsches Zentrum für Luft- und Raumfahrt
- DGB Stadtverband Ingolstadt
- Droniq GmbH
- Ernst & Young GmbH
- EME Elektro-Metall
- Eurocontrol
- European Innovation Partnership on Smart Cities und Communitys
- EASA – Europäische Agentur für Flugsicherheit
- Flughafen München
- FlyNex GmbH
- Globe UAV GmbH
- Fraundorfer Aeronautics
- Fraunhofer-Gesellschaft
- Fraunhofer-Institut für Bauphysik
- Hensoldt Holding Germany GmbH
- Helicus
- Handwerkskammer München
- IHK München und Oberbayern
- IMA – Flugplatz Ingolstadt-Manching
- Indra Navia AS
- IRMA – Initiative Regionalmanagement
- IT-SCM GmbH & Co. KG
- Italdesign
- Klinikum Ingolstadt
- Katholische Universität Eichstätt-Ingolstadt
- Landkreis Eichstätt
- Landkreis Neuburg-Schrobenhausen
- Landkreis Pfaffenhofen
- Lilium GmbH
- MAI Carbon
- Media-Saturn-Holding
- MTU Aero Engines
- OKE Group GmbH
- Quantum Systems
- Roland Berger
- Rhode & Schwarz
- SBB AG
- SDT Industrial Technology
- Skyports Limited
- Stadtbus Ingolstadt GmbH
- Technische Hochschule Ingolstadt
- TECNICALIA Research & Innovation
- [ui!] Urban Software Institute GmbH
- Umlaut Consulting GmbH
- VI Forum e.V.
- Wehrtechnische Dienststelle 61
- WK IT GmbH

MOVE
WE MOVE IMAGES
IMAGES MOVE PEOPLE
PEOPLE MOVE DESTINIES
Whether a promotional video or a film for use at a trade fair – our moving images are fascinating, informative, and really catch the eye.
They ensure your company's presentation stands out, and make viewers want to learn more about your products.
Make use of one of the most effective forms of communication for your online presence or appearance at a trade fair.
We would be glad to assist and look forward to it!
MEDIA MIND MOTION
www.mediamindmotion.com
VPRO IDFA Award for Best Feature-Length Documentary
idfa 2013
Auszeichnung des Films
"Song from the forest"
beim Film-Festival Amsterdam (IDFA)
"Mindblowing cinematography."
Jakub Duszynski, Co-President of Europa Distribution
"(...) the film operates in terms of striking images."
"The Hollywood Reporter", review by Neil Young
"Delicately shot by cinematographer Siri Klug (...)"
"Indiewire", review by Eric Kohn
"The cinematography of Siri Klug is striking and gently (...)"
"Screen Daily", by Marc Adams, Chief film critic
Diese Auszeichnung erhielt unsere Kamerafrau Siri Klug.
http://songfromtheforest.com/

A higher standard

Safety and security for a new era of aviation

Urban air mobility (UAM) and hybrid/electric flight is moving from being just a vision to a tangible reality with unprecedented momentum and speed. All around the world, the aerospace and aviation industry is working tirelessly on solutions to address the big challenges of megacity mobility and reduction of carbon emissions in flight.

The industry is moving steadily to flight solutions with electric vertical take-off and landing (eVTOL) capabilities that will fulfill the promise of the new era of mobility, with new alliances being forged and new program milestone being reached on a weekly basis.

With the technological approaches more and more maturing, the attention of the industry is shifting towards a realistic market entry, where a viable product must meet the most demanding requirements regarding flight safety and, at the same time, add value to the urban mobility mix of future smart cities. ■

Urban air mobility (UAM) – mobility in the third dimension

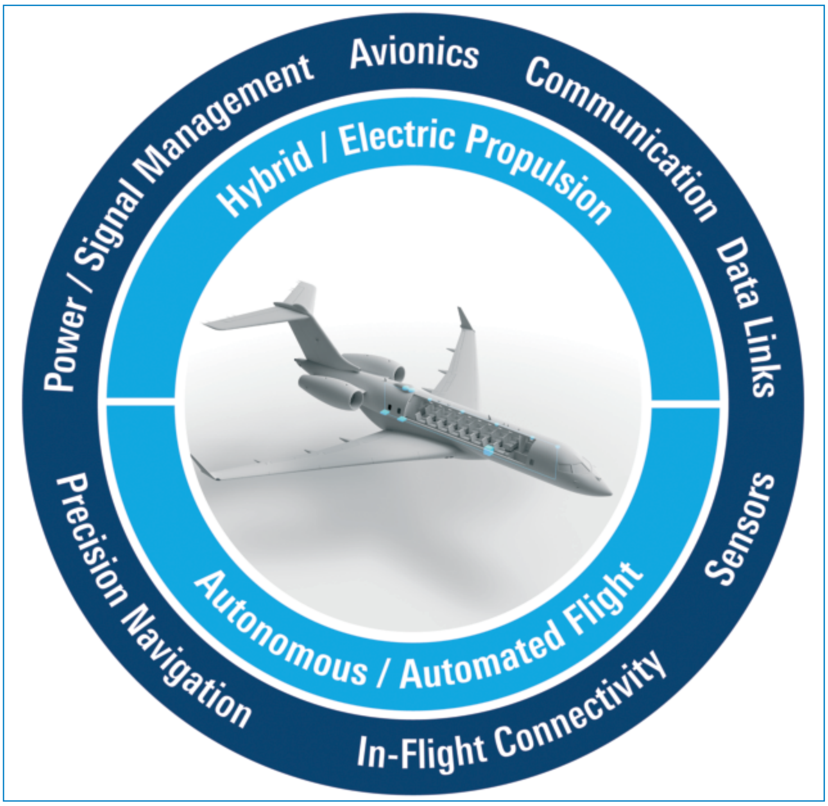
As an innovation-driven company, Rohde & Schwarz has joined the mobility initiative, providing a unique set of expertise, competencies and solutions for test and measurement, RF monitoring, secure communications and cybersecurity.

Christian Leicher, CEO of Rohde & Schwarz, mentioned in his address at the UAM Ingolstadt Network Meeting in July 2019 at the Rohde & Schwarz Headquarters in Munich: “We might not be standing in the limelight all the time, but our company is providing significant contributions to create new technologies needed in this field.”

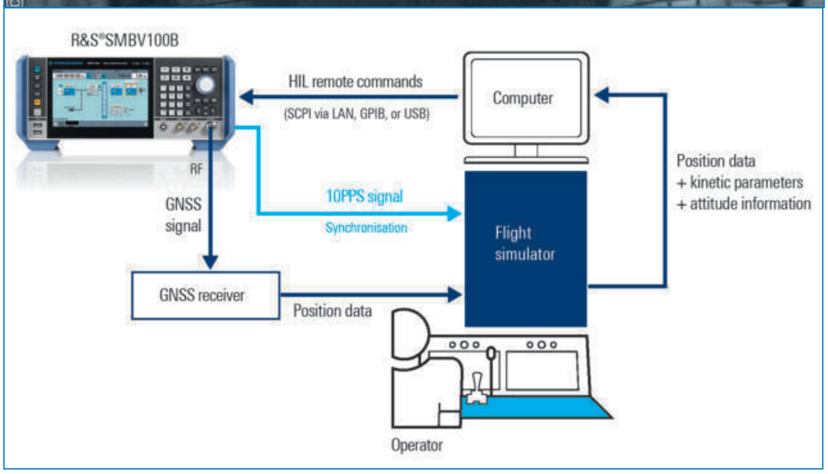
The shift in the industry is clear: from creating initial designs that focus on proving feasibility, to creating reliable, safe and cost effective solutions. These multimodal transportation services have unique challenges with great need to integrate not only electric propulsion systems, but also advanced avionic, autonomous flight control systems, reliable communication, high rated data links, smart sensors and precise navigation aids.

In addition to this, the industry is working hard to bring all these technologies together to create a fully integrated design, where another important aspect needs to be considered: the electromagnetic environment in which future eVTOLs will be operating.

For Rohde & Schwarz, as a key provider of test and measurement solutions for EMI and EMC, this is home turf. While it is still not



clear what the future applicable standards in the field of UAM will look like, Rohde & Schwarz is already contributing to the discussion with extensive knowledge, dedicated solutions and cross-industry expertise not only from the area of aerospace and defense, but also from industries like mobile wireless (e.g. LTE, 5G, etc.) and automotive.
To operate safely in a congested urban environment, eVTOL vehicles will not only rely on robust communication and data links, but will also need to seamlessly integrate various sensor devices, flight control systems and a powerful electric or hybrid propulsion system in a single design. Rohde & Schwarz provides the means to ensure resilience against electromagnetic noise, interferences and guarantee signal coexistence in these complex designs with multiple different technologies. Testing with Rohde & Schwarz instruments will help your system designs be ready for any future challenges and this high-quality integration will earn the confidence of customers and will prove to be a major differentiator in the market. ■



High-precision air navigation

High-precision air navigation with a global navigation satellite system (GNSS) will not only enable discrete movement within urban airspace, but will also have to provide resistance to the threats of spoofing, interference and coexistence. It will also serve as the basis for unified threat management (UTM), i.e. advanced air traffic management systems in urban environments that will allow real-time, fully automated monitoring and guidance of multiple vehicles.
This requires low latency instruments and the transmission of large volumes of data as well as tests for various satellite orbits, signal propagation and different electromagnetic environmental characteristics. The R&S SMW200A vector signal generator allows design engineers to easily generate signals from all important GNSS constellations (e.g. GPS, GLONASS, Galileo and BeiDou) and relevant frequency bands in order to ensure that all location based services (LBS) are functioning with the required precision. Scenarios can be generated to simulate satellite orbits, signal propagation, receiver antenna characteristics and other environmental influences. The solution portfolio for GNSS testing

helps drive a development process that meets go-to-market timelines as well as provide the means to validate system performance in real-time scenarios. ■

Robust flight connectivity

Robust and high-data-rate flight connectivity is not only crucial for vehicle-to-vehicle communication, it also provides the vital access to the urban infrastructure network. Adding to the requirements, customers want to enjoy seamless in-flight entertainment and mobile wireless services while fleet operators need to carry out fleet management and predictive maintenance monitoring.

When testing on-board communication and data link equipment, engineers can rely on the long-standing expertise of Rohde & Schwarz in this field. With instrument solutions such as the R&S CMW, a high-end wideband radio communication tester that supports the latest WLAN, LTE and even 5G standards, performance can be verified during all the phases of development, production and in-operation maintenance. The R&S CMW is capable of emulating multiple realistic network conditions under which eVTOL will operate. ■

Autonomous flight operation

In order for eVTOL vehicles to provide safe and affordable urban transportation, they need to operate with a high degree of autonomy. Taking the pilot out of the cockpit represents the biggest challenge for this new technology. Limited by strict weight restrictions and requirements regarding system costs, the number of fused sensors, power consumption as well as overall system reliability and robustness, engineers need to think in new dimensions to implement advanced detect and avoid (DAA) capabilities. Advanced radar sensors will be a key enabler for eVTOL vehicles to operate autonomously in the urban airspace and to ensure passengers have a smooth and safe ride. Addressing the need to reliably detect and avoid multiple moving objects in the lower airspace, Rohde & Schwarz provides advanced solutions for target echo generation and environment simulation. A radar echo generation setup from Rohde & Schwarz consisting of the R&S FSW signal and spectrum analyzer together with the R&S SMW200A vector signal generator can provide the most realistic test scenarios on demand and from the comfort of the engineer's lab. Radar systems need to be tested in dedicated test ranges, and this solution will significantly help reduce development costs and meet challenging time-to-market requirements.

The future of urban air mobility is just around the corner. Ensuring eVTOLs become a reality for inner city and city-to-city transportation will require multiple technologies with key enablers such as autonomy, sensing, communications, cybersecurity and fleet operations, and Rohde & Schwarz is the partner of choice to help this happen.ng time-to-market requirements. ■

Contact:

Tobias Willuhn
Marketing Program Manager Aerospace & Defense

"The key success factor in the UAM market is a seamlessly integrated system design that provides a unique, safe and affordable user experience.
A smart test strategy is a vital building block for successful designs and will prove to be a major differentiator in the future market."

Rohde & Schwarz GmbH & Co. KG
Mühldorfstrasse 15
D-81671 München
E-Mail:
Tobias.Willuhn@rohde-schwarz.com
Internet: www.rohde-schwarz.com

Rohde & Schwarz

Rohde & Schwarz is a leading supplier of solutions in the fields of test and measurement, broadcast and media, aerospace | defense | security and networks and cybersecurity. The technology group's innovative communications, information and security products help industry and government customers ensure a safer and connected world. The comprehensive portfolio includes test and measurement solutions for the wireless market, automotive applications, aerospace and defense, industrial electronics, research and education; broadcast and media for network operators, content providers and consumer electronics manufacturers; cybersecurity solutions for business and government authorities; security solutions for critical infrastructures; communications and reconnaissance equipment for armed forces.

On June 30, 2019, Rohde & Schwarz had about 12,100 employees. The independent group achieved a net revenue of EUR 2.14 billion in the 2018/2019 fiscal year (July to June). The company is headquartered in Munich, Germany, and has subsidiaries in more than 70 countries, with regional hubs in Asia and America.

Unmanned Aerial Systems in Research and for Research Applications

Technological evolution in electronics and software engineering has let to tremendous performance improvements and significant miniaturisation of electronic components. Increasingly smaller sensors, computing and communication systems still at enhanced performance levels, enable the use of smaller aircraft systems also for complex or even completely new missions and tasks. Even in the consumer segment, it is nowadays possible, to complete tasks with advanced drones, that have not thought feasible in the past.

Considering these technological advances, research is confronted with two main questions in the domain of unmanned aerial vehicles:

1. Do technological developments lead to completely new designs and applications for advanced unmanned systems?
2. Is it also favourable to utilize unmanned aerial systems in research tasks?

The research on unmanned aerial systems is integral to a multitude of research activities at Technical University Munich, among others in the domain of aircraft design. At the Institute of Aircraft Design researchers are working on the following scientific topics:

a) Design environment for unmanned aerial vehicles (UAV)
b) Advanced UAV configurations
c) UAVs as demonstrators for novel aircraft technologies ■

Design environment for unmanned aerial vehicles (UAV)

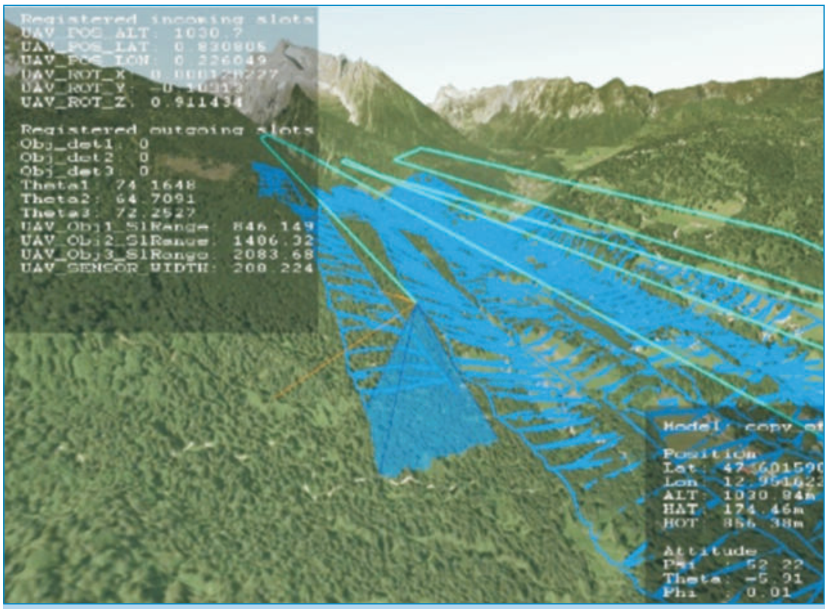


Fig. 1: *Simulation of a UAV on a search mission in mountainous terrain* ■

UAVs as well as consumer drones are used in most application cases to carry sensors or other payloads, while the majority of applications is focussed on optical sensors for pictures, videos, surveillance as well as cartography. For these applications the UAVs mainly acts as the airborne "carrier" for the payload in a way to optimize the quality of the pictures/videos. The optimum result during the task is thus depending on the optimum interplay between the "carrier" respectively aircraft and the sensor itself. Smaller sensors with less performance may be carried by smaller aircraft, which have to fly lower, but at the same time are lighter and less costly. At the same time, the covered area per time unit for such a system is much lower than for bigger aircraft that fly at elevated altitudes carrying bigger sensors with higher performance. The optimisation problem of an Unmanned Aerial System (UAS) therefore is no longer a search for the best aircraft, but rather for the best combination of aircraft and payload system. In addition, further systems like communication systems for data transmission affect the mission effectiveness of such a system.

To tackle those strong couplings between the different systems in a UAS design, the Institute of Aircraft Design is working on new approaches to optimal designs for UAVs under consideration of the sensor and payload system as well as other affected systems like the communication system and the electrical propulsion and energy systems. In order to derive optimum designs in this systems engineering task, a novel UAS design environment has been established, which allows for an integrated assessment of the UAS interacting with its (virtual) environment (terrain, buildings, weather, multiple types of targets) as part of the design process. Only through

Fig. 2: *Transition-UAV: high efficiency in cruise flight while providing vertical take-off and landing capabilities* ■

such an integrated approach, leading to a full mission simulation and mission performance evaluation, an overall optimum in the UAS design may be found. ■

Advanced UAV configurations

The increasing performance of electrical components, motors and actuators does enable complete new configurations especially in the domain of small aircraft, as they are used in unmanned aerial applications. Combining these new propulsion and control technologies in combination with novel structural design and production technologies as 3d printing or advanced composite materials

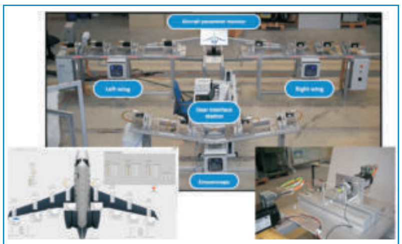


Fig. 3: *UAV Iron Bird – System testing on component and overall system architecture level* ■

allows for completely new capabilities and functionalities of the air vehicles. One example of this new and advanced class of UAVs are full electric transition UAVs, which combine the vertical take-off and landing capabilities of helicopters and multicopters with the superior cruise performance of fixed wing aircraft (the classical aircraft design). This combination allows for hybridisation well beyond the hybrid-electric propulsion system towards hybrid flight capabilities.

These new architectures are designed at the Institute of Aircraft Design utilizing the design environment for UAVs, enabling the design synthesis as well as the performance assessment of such novel configurations. Originating from the “virtual product” demonstrator concepts are being build utilizing rapid prototyping techniques established at the institute to perform early concept verification through ground and flight testing. ■

UAVs as demonstrators for novel aircraft technologies

Unmanned aerial systems do also provide unique features for the test and demonstration of novel aircraft technologies. While manned demonstrator aircraft always require a minimum size in order to carry the human on board during testing, unmanned aerial systems are providing a higher flexibility in size and also functionality. On the one hand, smaller demonstrators may be realized much cheaper and faster, while they may also be used for more radical approaches and technologies, which could increase the risk for the demonstrator vehicle in early demonstration phases.
At the same time, utilizing a UAV as a demonstrator vehicle also poses new challenges to the user. Besides well known questions regarding scalability of results from sub-scale testing to full scale applications also topics like quality and precision of results as well as reproducibility need to be addressed. TUM has assembled a wide range of expertise in the utilization of UAVs in demonstrator programmes. In the course of the EC funded H2020 research project FLEXOP (Flutter Free FLight Envelope eXpansion for ecOnomical Performance improvement) a modular flying demonstrator with 7m wing span for the inflight testing of highly flexible wing structures is currently being build up. The project targets for the demonstration of novel control concepts to fly highly efficient wing structures beyond their classical operational envelope. This could lead to further reductions in aircraft weight leading to a better vehicular efficiency. Testing beyond the flutter boundary will lead to an increased risk for the demonstrator air vehicle due to a possible structural failure of the wing. A risk which is addressed more easily with an unmanned demonstrator.

Fig. 4: *Unmanned demonstrator for highly flexible wing concepts (EC H2020 Project FLEXOP)* ■

Unmanned flight does enable a multitude of new potentials and novel applications in aviation as well as in every day‘s life. The Institute of Aircraft Design at TUM does address these important questions in multiple research activities as well as part of the teaching courses and student activities. ■

Author:

Prof. Dr.
Mirko Hornung
Head of Institute of Aircraft Design

Technical University Munich
Fakultät für Maschinenwesen
Lehrstuhl für Luftfahrtsysteme
Boltzmannstraße 15, 85747 Garching
Phone: +49.89.289.15980
Fax: +49.89.289.15982
mirko.hornung@tum.de
www.lls.mw.tum.de

Nexus of aerospace innovation:

AIR TECH CAMPUS OBERPFAFFENHOFEN

On the very site where Dornier made aviation history 50 years ago, with its Do 31 experimental Vertical Take-Off and Landing jet, you will now find one of Germany's most important special-purpose and research airports: Air Tech Campus Oberpfaffenhofen (ATC).

In 1936, Dornier Werke GmbH laid the foundation stone for Oberpfaffenhofen Airport – and at the same time, launched the development of the site, where tradition and vision still meet today. The focus of Air Tech Campus Oberpfaffenhofen is still on the development of innovative aviation propulsion systems. Today, companies based at the airport employ 3,400 aerospace specialists, a figure that rises to 7,500 employees when neighbouring aeronautics and astronautics companies from the DLR German Aerospace Center are included. In large part, ATC owes its leading role within the aviation and aerospace industry to the pioneering companies based at the airport. These companies – and their visionary ideas – span the entire value chain from development to production and maintenance.

Dornier's Do 31 takes off at Oberpfaffenhofen Airport

One of ATCs highest profile tenants is Lilium, which develops and tests electric vertical take-off air taxis. The airport's test field has also become a nexus for companies driving the further development of autonomous aerial vehicles.
The research airport also provides invaluable support to the DLR German Aerospace Center's largest facility in Germany (including the Galileo Competence Center and the International Space Station's (ISS) Columbus Control Centre), which is right next to ATC and serves as the base for many of the DLR's missions. So many voyages of discovery have started at ATC and the runway is now clear for the next chapter in the campus' exciting history.

Where vision meets tradition

Air Tech Campus Oberpfaffenhofen has always been synonymous with pioneering spirit – and this will continue to shape the airport's development for many years to come. This is where start-ups at the cutting edge of the aerospace industry soar alongside established international aeronautics corporations. With such unbeatable synergies, ATC offers the ideal environment for research, development and testing of innovative flying vehicles. ATC's state-of-the-art Test field for Unmanned Electric Flight (TUEF) is perfect for carrying out test flights under realistic conditions and is regarded as yet another unique selling point of the area. In order not only to secure but to build upon ATC's status as a nexus of aerospace innovation, the airport's navigation and tower technology is constantly being expanded and optimised. The airfield has now been certified by Austro Control air traffic control for unmanned flights even beyond visual line of sight (BVLOS), which means flights out of visual range can also be performed alongside more conventional flights. These expanded capabilities are made possible by the airport's new real-time flight status software and specially designed take-off and landing pad, both of which have been installed by EDMO-Flugbetrieb GmbH, the company responsible for operating the special-purpose airport. In addition to the Aerospace Cluster bavAIRia e.V. with its UAS Forum and the German Testing Center for Unmanned Flight (DEU), many other users, such as DLR and Technical University Munich, are exploiting the potential of the test field for their exciting new developments.
The number of companies in this sector is also growing rapidly. Among them, Lilium is developing an unmanned electric air taxi, which will take off vertically and has been designed for autonomous flight, providing yet another example of how tradition and vision complement each other at Air Tech Campus Oberpfaffenhofen. As well as shaping the future of innovative aviation systems, ATC is also working closely with Upper Bavaria's Aviation Office and Austro Control to develop and implement solutions concerning licensing law and air traffic control.

Multi-award-winning – Lilium's air taxi

Economic forecasts confirm the massive potential of the market for visionary flight concepts: By 2040, experts predict that the market for emission-free passenger transport, including electric air taxis, will be worth USD 850 billion. More and more companies from the astronautics industry are also set to achieve soaring success at the site. For example, the DLR Space Applications Company (GfR), a subsidiary of DLR, chose the Air Tech Campus as the site for its new building. The site is also home to the new headquarters of ADAC Air Rescue and its training centre including flight simulators.

The Trinity F9 drone delivers a quantum leap in mapping technology

The future takes flight

Public-sector support for aviation and astronautics is testament to the importance and development potential of Air Tech Campus Oberpfaffenhofen. The Bavarian government is funding research into air mobility concepts and the establishment of a test field for electric and (semi) autonomous flight.
The German Federal Ministry of Transport's unmanned aeronautics advisory board has also called for well-equipped test fields so that theoretical developments can be tested in realistic conditions.
Today, Air Tech Campus Oberpfaffenhofen is flying high thanks to its 276-hectare site and 40 hectares of approved future construction area. The same airfield where the Dornier Do 31 wrote aviation history some 50 years ago is now home to one of Germany's most important special and research airports: Air Tech Campus Oberpfaffenhofen.

EDMO-Flugbetrieb GmbH
A joint project from BEOS AG & TRIWO AG

Prof. Dr. Christian Juckenack
Site Manager / TRIWO AG
christian.juckenack@triwo.com

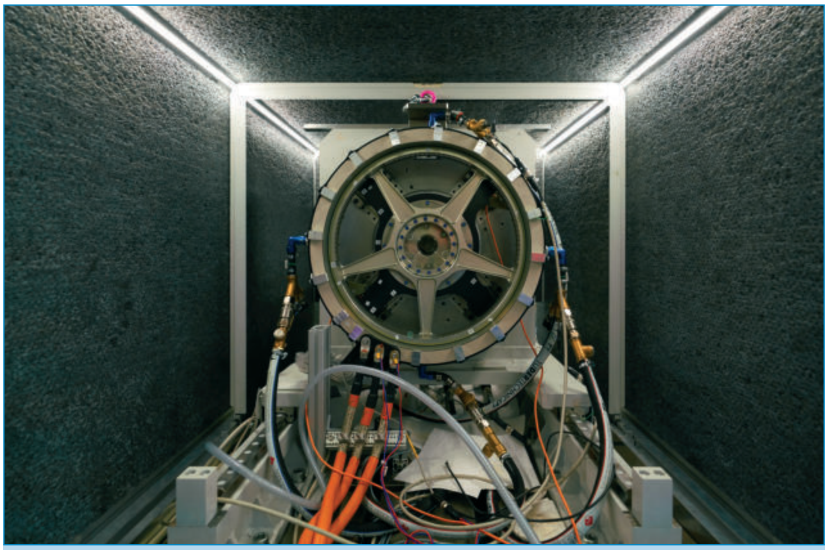
Dr. Daniel Wurstbauer
Site Manager / BEOS AG
daniel.wurstbauer@beos.net

Claude-Dornier-Straße 1
82234 Weßling

EDMO

Rolls-Royce driving aviation innovation– now in Bavaria as well

Rolls-Royce has been an aviation pioneer for over 100 years. As the industry enters what is being heralded as its third era, Rolls-Royce has gained a foothold in Bavaria for the first time with the acquisition of Siemens' eAircraft business unit.



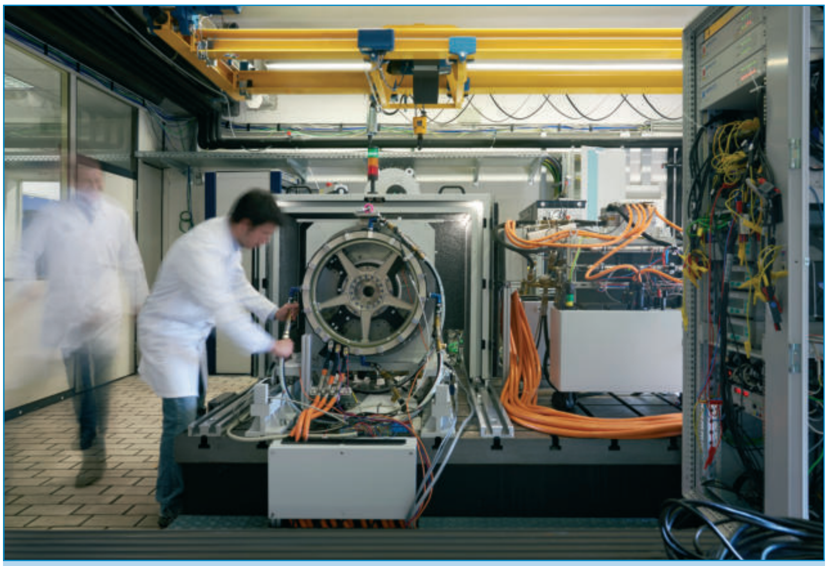
On the testbench: Rolls-Royce Electrical prototypes undergo thorough testing - like the 200 kW motor that powers the CityAirbus

The big moment arrived on 1 October 2019: 100 skilled staff at the company's Bavarian sites in Erlangen, Taufkirchen and Neuperlach in Munich were welcomed by their new boss and served cake for breakfast; the offices had already been redecorated using the new company's brand language and colours, and its name featured in cobalt blue at the campus gates. Rolls-Royce's acquisition of the Siemens startup eAircraft, which had been announced only as recently as June, had been successfully concluded.

For the staff at eAircraft, it is an exciting step: they will now be helping to shape the future of aviation as part of one of the industry's most important OEMs.

For Rolls-Royce, the acquisition of eAircraft is a critical element of its sustainability strategy. Like most other companies in the industry, Rolls-Royce fully supports the goals of Flightpath 2050 and is actively assuming responsibility to reduce the environmental impact of aviation. The industry's share of total emissions is still relatively small compared to other modes of transport, but in view of the expected rising demand for both passenger and freight transport, its emissions could increase dramatically in the next few years.

There are three elements to Rolls-Royce's sustainability plan. Firstly, the company will continue to work on improving the efficiency of gas-turbine technology in the coming years. Although new products such as the Trent XWB turbine have already reduced CO_2 emissions by 15% compared to gas-turbine generations around the turn of the century, there is still untapped potential: Rolls-Royce expects its UltraFan



Labs in Munich and Erlangen were part of the acquisition

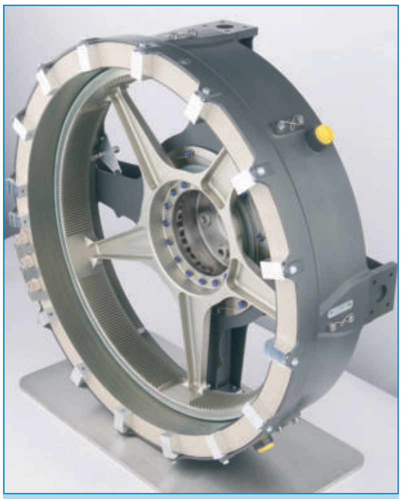
Powered by Rolls-Royce: for the CityAirbus, the team has developed motors, inverters and the energy distribution system, Copyright Airbus Helicopters – Patrick Heinz ▪

turbine to reduce CO_2 emissions by a further 10%.
Rolls-Royce believes another important step is for the oil and gas industries to further develop sustainable fuels based on biomass and organic waste or synthetic processes. In order to facilitate these developments, Rolls-Royce turbines are already designed to run partially or entirely on synthetic and biomass fuels.
Thirdly, the company aims to make significant progress with the development of expertise in the (hybrid) electrification of aviation. Electric propulsion systems in aircraft will bring about further efficiency improvements and emissions reductions and offer the potential for radically new aircraft and propulsion concepts. Rolls-Royce believes that hybrid-electric technology is set to have as dramatic an impact on aviation as the replacement of piston engines by gas turbines. "With electrification, we are at the dawn of the third era of aviation," says Rob Watson, Director of Rolls-Royce Electrical.
The transition to electric aircraft will be made up of many small steps for Rolls-Royce, ultimately amounting to revolutionary change. While most of the available expertise in five years will still be comparable with what is available today, in the next 100 years the company will change dramatically.
The plan is to electrify smaller propeller aircraft first, but at the same time research is under way to develop electric propulsion systems for larger planes such as regional aircraft. Close collaboration with partners throughout the sector is also key for Rolls-Royce: only when the industry, researchers and politicians all pull in the same direction will aviation be able to play a successful role in transforming both technology and society.
Rolls-Royce is concentrating its activities in the field of aerospace electrification in the research and development unit Rolls-Royce Electrical.
At Rolls-Royce Electrical, the eAircraft team will be working on well-known and innovative projects such as ACCEL and E-Fan X, as well as on mature technology for other industries offered by Rolls-Royce's Power Systems and Defence divisions: hybrid-electric propulsion systems for trains, network and distribution technology and gas-turbine generator sets for electrically powered ships and starter generators.
In addition to its new sites in Bavaria, Rolls-Royce Electrical also has

Hybrid-electric: APUS i-5 shall demonstrate the benefits of distributed propulsion ▪

Rolls-Royce now employs around 100 experts from various disciplines in Bavaria ■

offices and workshops in Brandenburg, England, Norway, the US, Singapore and, as another result of the acquisition of eAircraft, Budapest as well.
Germany is set to play a key role in Rolls-Royce's efforts to make electric flight a reality.
As well as integrating eAircraft's activities, the company is also working on a project in Brandenburg together with the Brandenburg University of Technology Cottbus-Senftenberg (BTU): in Dahlewitz a hybrid-electric system is being developed that will initially be tested in an innovative aircraft concept developed by APUS. The lightweight APUS i-5 (4,000 kg) has four distributed 150 kW electric drive units and demonstrates one of the most important advantages of hybrid-electric systems: this highly efficient aircraft design is made possible by the spatial separation of power and thrust generation. The hybrid-electric propulsion system using the proven Rolls-Royce M250 turbine will serve as a test platform for research on board the i-5 for a period of three years. Further flying applications of this efficient system are also conceivable in the future: as a propulsion system for hybrid-electric eVTOL concepts, for example.
In the eVTOL market segment, the new teams in Erlangen and Munich have just achieved an important success: CityAirbus, an Airbus demonstrator for urban air mobility, took off again in December 2019 with a propulsion system developed by eAircraft. The eight motors went beyond what was required of them: to permit extremely quiet flying,



The 200 kW electric motor that propels the CityAirbus has an outstanding torque-to-weight ratio ■

they were designed for a low engine speed range; at the same time, however, they had to enable the four-seater CityAirbus to take off, and the system is, of course, also subject to strict weight limits. The development team responded to the challenge and, after only 10 months, came up with the prototype of an electric propulsion system with an impressive torque of 30 Nm per kilogram. The motor has since been thoroughly tested together with the inverters developed by eAircraft and the power distribution system in laboratories and on the ground. In 2020 it will be undergoing flight tests scheduled to take place at Manching.
The foundations are thus being laid for the development of further propulsion systems designed specifically for the requirements of eVTOLs. Rolls-Royce will be working on those in Bavaria.
In addition to eVTOLs, other flight segments are also relevant for the former eAircraft teams: the 260 kW electric motor developed in Erlangen that powered the Extra 330LE for its impressive world record flights continues to be further improved. It will be used, for example, in the hybrid-electric 4-seater Smartflyer SFX-1 as well as in the purely electric 11-seater Alice developed by the startup Eviation.
Turning to the commuter market, Rolls-Royce in Bavaria is also developing components for a hybrid-electric drive train around the 500 kW mark.
Rob Watson is confident: "Our new colleagues in Bavaria complement our portfolio ideally with their expertise and new technology."
Rolls-Royce has been an aviation pioneer for over 100 years. Following the acquisition of eAircraft, this pioneering work will also be going ahead in Bavaria – paving the way for the "third era" of aviation. ■

Author: Julia Hetz

Contact:

Olaf Otto
Head of Projects and Programs für Rolls-Royce Electrical

Rolls-Royce Deutschland
81739 München
Germany
Phone.: +491735954364
eMail: olaf.otto@rolls-royce.com
www.rolls-royce.com/electrification

AutoFlightX – Urban Aerial Mobility

Many of the infrastructure and mobility issues we currently face, especially in major cities and metropolitan areas around the world, can be addressed by adding the third dimension, in the form of „urban aerial mobility", to the existing transport systems. That is why AutoFlightX works hard on an all-electric air taxi, which can take off and land vertically, but moves as efficiently in cruise flight as a conventional aircraft. With such an emission-free and quiet eVTOL (electric Vertical Take-Off and Landing) vehicle urban air mobility and the relief of our roads will become possible – and all this already in the 2020s, and not just decades later.

When Tian Yu founded AutoFlightX GmbH in early 2018, he chose Gilching/Oberpfaffenhofen as the ideal location for his latest venture. The entrepreneur was aware of the ideal conditions in the Greater Munich area: The combination of experts, know-how, the network of partner companies and research institutes, the regulatory boundary conditions, and the well-renown „German engineering skills" are unique around the world. The proximity to the research airport Oberpfaffenhofen with its highly-developed infrastructure for testing highly automated systems also played a role in the choice of location.

The prototype of the V600 from AutoFlightX presented to the public at the AERO air show in April 2019 in Friedrichshafen. ■

First, AutoFlightX has built a complete simulation environment and a development simulator – which was already flown by Bavarian Prime Minister Markus Söder – for their first manned eVTOL prototype. This prototype, the V600, was presented to the public in April 2019 at the AERO air show in Friedrichshafen. The V600 serves primarily as a technology demonstrator and a platform for technical development and for testing of subsystems – always according to aviation standards. As always in aviation, safety is paramount here, too. This can be seen from the fact that also in the V600 plenty of considerations on redundancy and fail-safety have been done.

Detail of the prototype of the V600 from AutoFlightX at the AERO air show in April 2019. ■

We are currently working hard on further technical developments – stay tuned for what will happen in 2020! ■

Author:

Dr.-Ing. Matthias Bittner

Chief Operating Officer, Prokurist

AutoFlightX GmbH
Friedrichshafener Str. 1
82205 Gilching
Phone: 08105 7989755
Fax: 08105 7989775
info@autoflightx.com
www.autoflightx.com

AutoFlightX GmbH

Research and engineering education on eVTOLs at the Institute of Helicopter Technology

The Institute of Helicopter Technology was founded by Eurocopter (today: Airbus Helicopters) in 2010 to set a special focus on helicopters in engineering education and research. In recent years, the number of developments of electrically powered aircraft capable of performing vertical take-off and landing (eVTOLs) has dramatically increased. In contrast to helicopters, which are powered by internal combustion engines and have an elaborate rotor control system, providing unique maneuverability, eVTOLs are powered by electric motors and use much more simple propellers to generate lift.

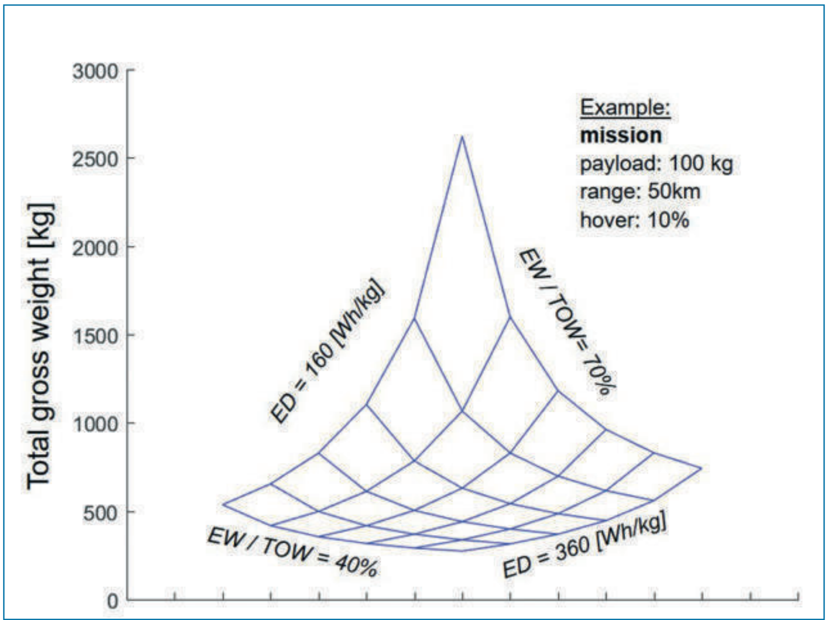


Fig. 1: *"Carpet plot" for eVTOL* ■

Sizing and design of eVTOLs

Basically, the design of eVTOLs does not differ from the helicopter design: based on requirements for payload and range, we determine rotor area and drive power to match the required flight performance. Although numerous designs for eVTOLs are existing and new projects are added every day, a publically available database with technical data of these aircraft does not exist. Today, energy densities of batteries and power-to-weight ratios of electrical drives are well known. However, since the empty mass of an aircraft has a dramatic impact on its performance, extensive studies are carried out at the chair to develop and improve models that take into account uncertainties of design parameters. This approach allows to better compare individual configurations and identify design drivers and potential optimization. ■

Propeller aerodynamics

Although they look similar to those on conventional aircraft, the propellers of multi-rotor configurations are operated in a fundamentally different flow state and therefore experience significantly different loads. In addition, the thrust characteristic is controlled by changing the propeller rotational speed. The resulting transient thrust behavior has an important impact on the vehicle's control characteristic.

At the Chair of Helicopter Technology, numerical methods are used to simulate this transient characteristic and validated by experiments. Using largely automated CFD modeling (CFD for Computational Fluid Dynamics), a drone propeller can be optimized in shape and other rotor parameters. Various model approaches are applied and then compared to avoid systematic errors in simulation *(Fig. 2)*. ■

eVTOLs in teaching

The teaching of the basics of helicopter flight includes models for propellers as they are used in eVTOLs. Besides classical aerospace engineering skills, teaching includes key knowledge about flight safety and certification or basic approaches in systems engineering. Only when these

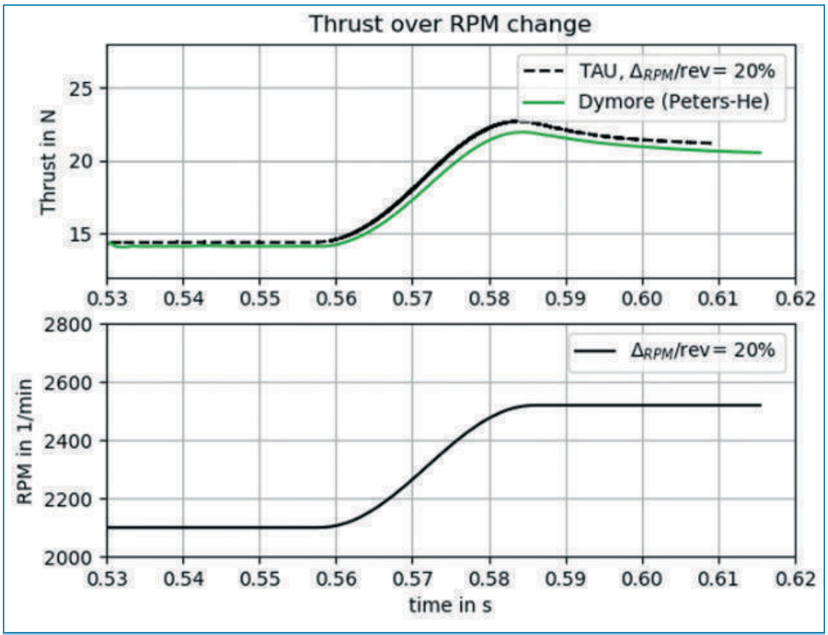


Fig. 2: *CFD vs. Dynamic Inflow simulation of accelerated propeller flow* ▪

theoretical topics are applied to eVTOLs, our students begin to acquire a broader understanding of the economic and social aspects of this new form of mobility. For this purpose, the project seminar „Urban Air Mobility“ was developed, in which a group of bachelor students (under the guidance of experts from the chair) goes through the entire process of product creation from the design of the aircraft to economic and legal aspects of the operation of air taxis over cities. Managers and experts from the UAM industry are finally invited to the closing event, which on the one hand serves as an additional incentive for the project team and on the other shows the companies how closely engineering training and practice can be interlinked. ▪

Research topic „Electromagnetic Actuators in Flight Control“:

In helicopters above 1000kg take-off mass, primary flight controls use hydraulic actuators to amplify the pilot‘s forces. These technologies are well-known since decades and have matured accordingly. Despite obvious benefits of technological maturity, significant efforts are necessary for hydraulic systems: reservoirs, pumps, valves, lines, filters and numerous other components are required to establish a complete hydraulic system. Much easier and cheaper to implement are electromechanical actuators („EMA“) – but for the price of inferior failure characteristics. As a consequence, EMAs haven‘t been introduced in primary flight control systems of rotary wing aircraft; This is where a LuFo research project comes in that examines the usability of EMAs in drones.

In the TEMA-UAV project, an innovative, electromechanical actuator for unmanned aircraft is developed in a holistic develop-

Fig. 3: *eVTOL designed by a team of bachelor students* ▪

Fig. 4: *TEMA-UAV application platform: ALAADy autogyro, source: DLR (CC-BY 3.0)* ▪

ment process, taking into account aviation-specific regulations and requirements. In the joint project with the German Aerospace Center (DLR) and the company Maccon, the central tasks of the Chair of Helicopter Technology are the actuator's systems engineering – synchronized to that - all development steps for the safety and reliability analyses as required for the certification process necessary in aviation.

With an autogyro as application platform for the planned actuator prototype, the TEMA-UAV project has access to a proven test platform. This configuration is already being researched as part of another DLR project *(ALAADy, see fig. 4)*. ▪

Author:

Prof. Dr.-Ing. Manfred Hajek

Technische Universität München
Lehrstuhl für Hubschrauber-technologie

Boltzmannstr. 15
D-85748 Garching
Germany
Phone: +49(0)89-289-16300
e-mail: hajek@tum.de
web: www.ht.mw.tum.de

Design Boxwing ▪

The asto Park Oberpfaffenhofen – Campus of Technology

Digitally connected, electrically and autonomously flying... this is how many people imagine the aerospace industry of the future. With Autoflight X, Quantum-systems and Lilium, Oberpfaffenhoffen is already the location for e-tonomous AIR Mobility and the hotspot for researching and testing future-proof solutions.
The research and establishment of air taxis is already a reality around the asto Park, the internationally known aviation location and cradle of the German aerospace industry. This is where the urban mobility of the future is being tested. The asto Park is at the forefront of digital, electrical and autonomous mobility.
At the Mobility Conference of the Metropolitan Region of Munich, the special prize "Innovation" was awarded to the asto park-based company Lilium. Lilium is currently in the process of conquering the third dimension of locomotion with its air taxi. Prof. Florian Holzapfel from the TUM reports that flying cars, recently were still part of the realm of science fiction, while today the first ones are already in the air. The market is exploding, says Holzapfel, and there is an incredible spirit of optimism. „It's such a cool time as it has not been for a long time," enthuses the professor. At the presentation of their autonomous aircraft in front of the Bavarian State Chancellery, Quantum-Systems and Lilium were able to signal that Bavaria should become the leading location for the development and construction of air taxis. Improving mobility, as air transport is clean, cheap, flexible and quiet, and the creation of additional jobs are key issues in this context. In a first step, a test field for autonomous flying will be set up in Oberpfaffenhofen, where companies based in the asto park will be able to test their electronic aircraft. The long-term vision is, that taxis could be used as a supplement to public transport.
While the Aero-Taxis are still in the development phase, drones like those from Quantum-Systems are already flying around the world. Drones are already providing valuable services in the areas of parcel services, medicine deliveries to remote areas and pest control on plantations in Malaysia.
The asto Park and the research airport in the southwest of Munich are again officially the hotspot of aerospace, according to the Federal Ministry of Transport. Oberpfaffenhofen is one of the twelve nationally important airports. Innovative technologies in aerospace, satellite navigation, IT, mechanical engineering, robotics and automotive are developed and produced around the asto Park. Furthermore 8,000 sustainable jobs have been created. Here in the asto Park, young companies as well as established technology companies, which want to use the dynamics of the location and bundle their activities, are addressed.
In the immediate vicinity of the international aviation group RUAG, the satellite manufacturer OHB and the DLR with its Galileo control and robotics centre, more than 80 technology companies have settled in the asto park. The internationally operating companies in the asto Park are the ESA BIC Incubator, the aircraft manufacturer Dornier-Seawings, Telespazio, OHB as well as companies such as the Diehl Group, Dassault Systèmes, Microchip, SII, Mynaric, Valeo, Vectoflow, pro-beam and Coherent. ■

astopark
BUSINESS INNOVATION CENTER

Contact:

Dipl.-Ing.
Ekkehart Fabian
Geschäftsführer

Dr. Bernd
Schulte-Middelich
Geschäftsführer

ASTO Aerospace & Technology Park GmbH
Friedrichshafener Straße 5
D-82205 Gilching
Phone.: +49 89 38 66 55 – 0
Fax: +49 89 38 66 55 – 22
eMail: info@astopark.de

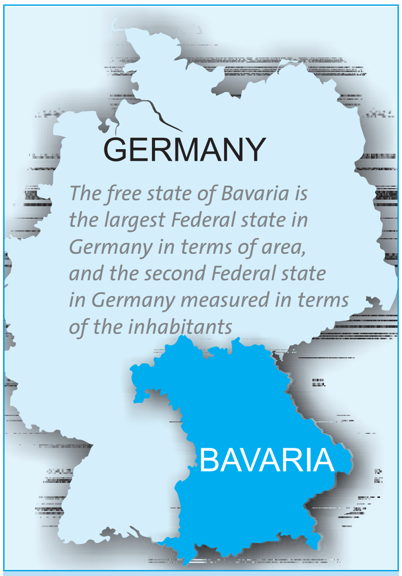
Bavaria- Partner of the World and Business Location with Future

The Free State of Bavaria ranks among the most economically strongest regions of Europe. Thanks to an offensive economic policy and a first class infrastructure, Bavaria is and remains a location with future. A productive network of "global players" and a wide class of efficient small and medium-sized enterprises exists to ensure growth and employment for almost all sectors.

The Free State of Bavaria covering more than 70,000 km^2 is the largest Federal state in Germany in terms of area and with a population of 13 million people is the second largest Federal state after North Rhine-Westphalia in terms of inhabitants. Apart from the indisputable advantage as a living and leisure location, Bavaria enjoys an excellent reputation worldwide primarily as a high-tech and service location. Compared with other countries in Europe, nearly all national economic data has reached peak values. ■

Successful race to catch up

In an unprecedented race to catch up, Bavaria has developed from being an Agrarian state with an above average level of unemployment and a below average economic value-added at the end of the Second World War into a first rank economic power. A low rate of unemployment compared with all other federal states, a far higher proportion of self-employed persons and a high level of immigration primarily during the last ten years verify this fact. The rapid upswing in Bavaria has been accompanied by an above average employment dynamic. As a result, the number of employees subject to social insurance contribution regulations has increased by almost one quarter and is thus considerably greater than in all other federal states. ■



Germany and Bavaria ■

Offensive economic policy

In the context of an offensive economic policy, the Bavarian state government is pursuing four strategic primary objectives:

- Cost relief of the economy in global competition
- Release of free enterprise dynamics for the benefit of more growth and employment
- Support of the economy in the structural change in the line of „new products, new enterprises, new markets“
- Through further development and expansion of the infrastructure

based on the motto „Save – reform – invest“, the state and administration in Bavaria are being made fit for the future. ■

New Element „Cluster policies“

This is the next logical stage in the offensive of Bavarian innovative policies geared towards the „High-Tech-Offensive“ and the „Future of Bavaria“ offensive. Through the application of cluster policies, the existing state measures for the promotion of innovation are being expanded by organising the networking of economy and science.

These clusters can basically be subdivided into:

Nuremberg ■

■ *High-Tech clusters*
e.g. biotechnology, aviation and aerospace, medical engineering, environmental technology
■ *Production oriented clusters*
e.g. automotive, energy, engineering, logistics, sensors
■ *Cross-sectional technologies*
e.g. nanotechnology, new materials, mechatronics

The cluster policy should create momentum to intensify the dynamics between companies and research establishments and optimise possibilities for cooperation ■

Prepared for the future

The structure of the Bavarian economy is robust and future-oriented. A productive network comprising „global players“ and a wide class of efficient small and medium-sized enterprises in the industrial,

European Patent Office ■

Munich Airport ■

Munich Exhibition Centre ■

handcraft and service sectors ensures economic strength. The industrial sector is dominated by the industries of automotive and mechanical engineering, biotechnology and medical engineering as well as energy and transport technology. In the service sector, Bavaria holds leading positions in Germany as an insurance, banking and stock exchange centre. The infra-

Wieskirche ■

structure is first rate in the key sectors of transport, energy and telecommunications. The large number of foreign companies that have been set up in South Germany within the last few years and decades, bears testimony to Bavaria‘s high degree of attractiveness as an international innovation location for high-quality research and development activities and productions.
And last but not least, Bavaria has a variety of attractive „soft“ locational factors: world class culture, intact environmental conditions, high recreational value, a cosmopolitan outlook, interior security as well as social and political stability. ■

Source:
Bavarian Ministry of State for Economy, Infrastructure, Transport and Technology

Development of promising air transport systems

The development of the modern world is impossible without functionally, stable and dynamic adapting to external conditions of transport systems. Over decades, the transport infrastructure of states via road, rail, marine and air nearly has reached its capacitive limits, estimated by the value of functional availability.
Functional availability of vehicle accessibility often show, that in relation to the cumulative time, the time to prepare a cargo exceeds the time to move directly from one point to another and that it's actually an indicator for operational mobility of trans-tailor means.
Processing statistical data allowed us to identify areas of significant aviation transport systems *(Fig. 1)*, including promising: hybrid vehicles apparatuses (VTOL – Vertical Takeoff and Landing).
The main advantages of transport systems, based on hybrid aircrafts, are:

- lack of need for airports and aerodromes
- high functional indicators, e.g. mobility, adaptability and accessibility
- economically low operating costs
- high flexibility and efficiency

In favor of creating and applicating transport systems with VTOL, the main argument is the
ability to implement technologies, that theoretically reduce adverse effects of environmental impacts.

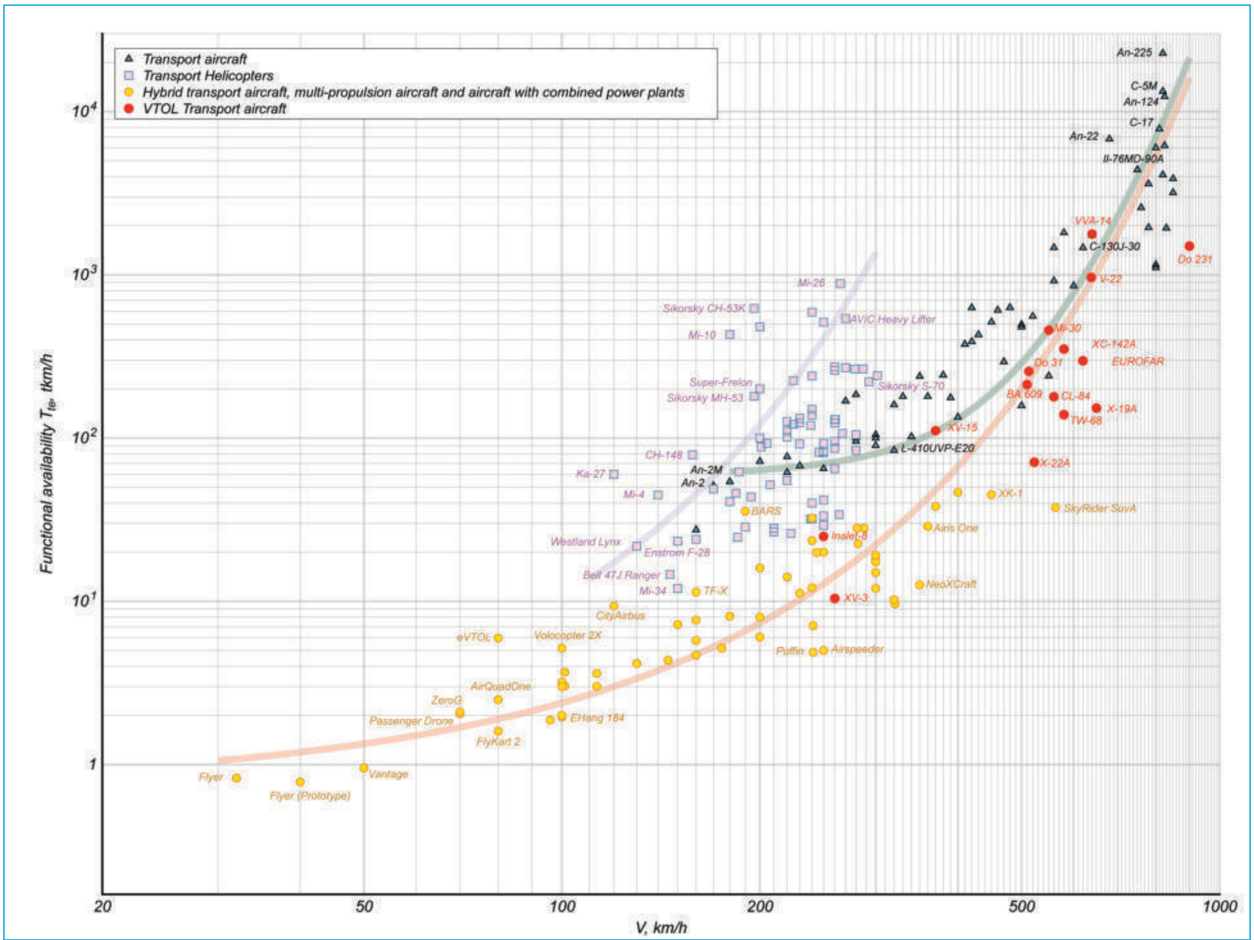


Fig. 1: *Areas of existence of transport aircrafts* ▪

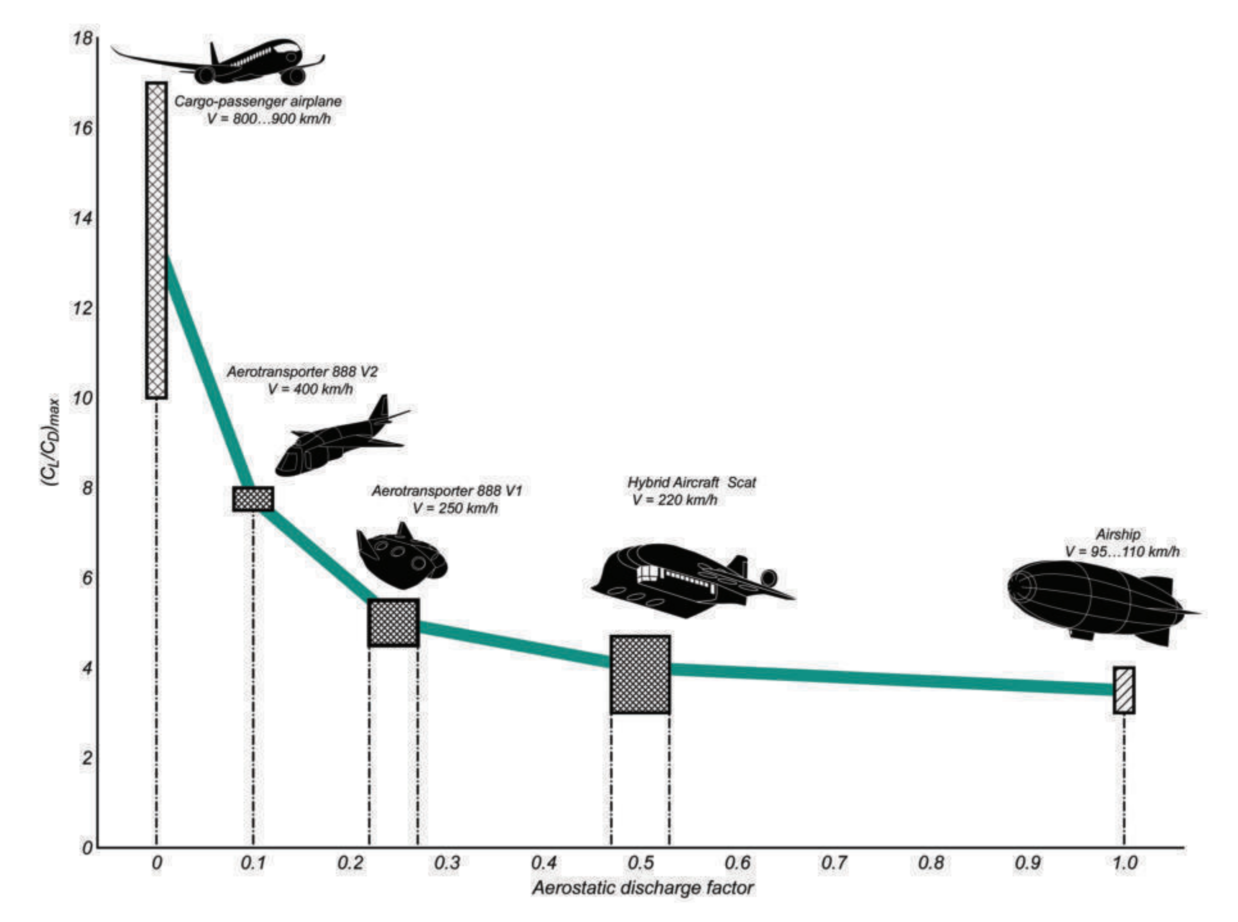


Fig. 2: *Dependence of achievable maximum aerodynamic quality (C_L/C_D)$_{max}$ transtailors from aerostatic discharging level* ▪

Significant efforts are being made by many experts to create VTOL models. From stuffy reactive to fully electric power plants, including aerostatic discharging, various options are considered.

SDT – Industrial Technologies research results show, that VTOL with an aerostatic discharge factor of more than 0.3 have perpractical implementation prospects due to the impossibility of obtaining acceptable aerodynamic characters *(Fig. 2)*.

Experience in development and operation of airships (aerostatic discharge factor 1.0) confirms the conclusion about the low competitiveness of inflatable and pressurized transport aircraft in comparison to existing.

An example of a transport aircraft VTOL with aerostatic discharging is the project Aerotransporter 888 v.1 *(Fig. 3)*. Aerostatically discharged to 0.22 and with its weight reducting design and its combined power plant with internal utilization of thermal energy,

Aerotransporter 888 v.1 provides high flight-technical and transport characteristics. The appropriate use of such a VTOL is light-tonnage cargo transportation up to 1.5 tons. According to SDT-Industrial Technologies, daily up to 400.000 tons of food and drinks run through Germany's distribution network. For support up to 1.600.000 trucks with a nominal load of current stores stocks, there's used a hoisting capacity from 0.5 to 1.5 tons.

Furthermore, the average distance from the distribution warehouse to the store's warehouse is over 77 miles, so that it lasts 2 to 3 hours of

Fig. 3: *VTOL Aerotransporter 888 v.1* ▪

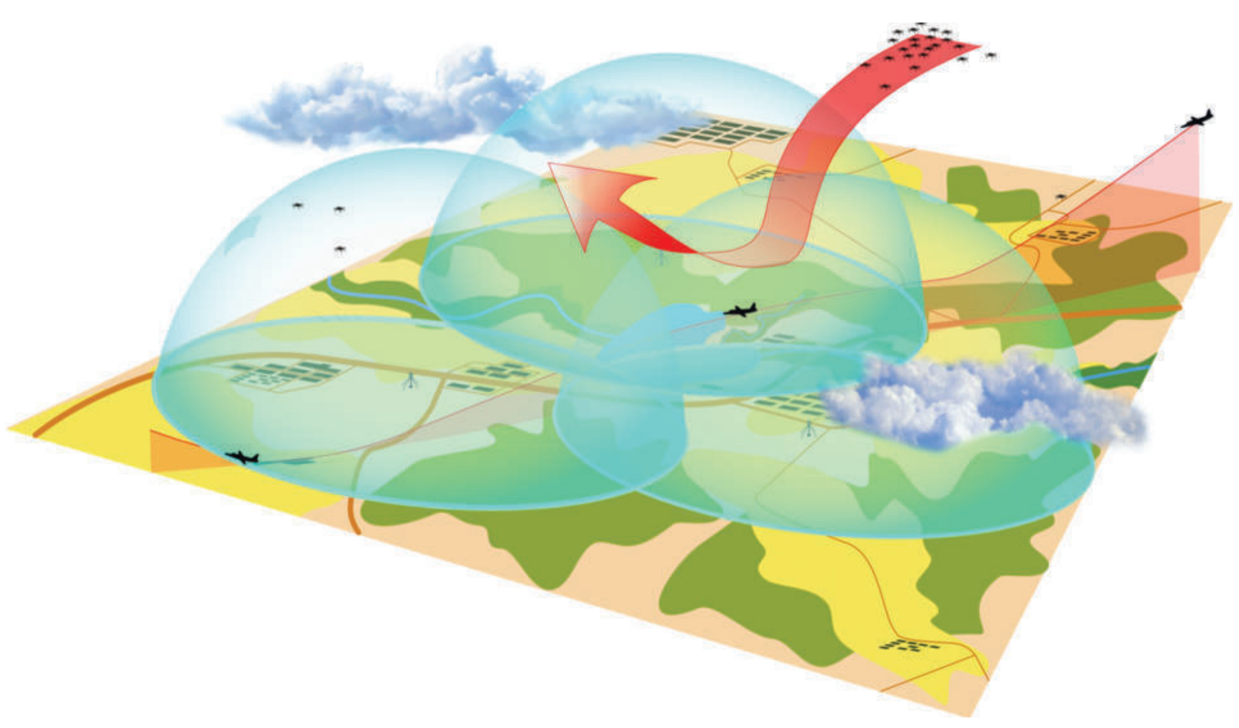


Fig. 4: *Illustration of the modern airspace environment in the surface layer of the atmosphere and its control by means of air and air traffic controll* ▪

transportation time by trucks, which load the road network accordingly.

In the future, transport aircraft VTOL of the type Aerotransporter 888 v.1 can – partially up to 50% – replace a car-cargo transportation and increase the speed of cargo circulation.

Use of a power plant with internal heat energy recovery for VTOL Aerotransporter 888 v.1 reduces the fuel requirement up to 70 kg of hydrocarbon fuel (kerosene), which is 10 to 12% of the fuel supply on board. The development of air transport systems inevitably entails the development of appropriate existing infrastructure: air traffic control and air traffic management, ground handling and flight support devices.

The industry and the market offer and expect a wide range of fixed and mobile means of security for flight operations, e.g. tankers, charging stations, automatic control systems, etc. Moreover, it's obvious, that the available automatic means of monitoring the air situation and air traffic control are restricted and unsuitable for conditions of high saturation of airspace traffic, especially in approach and departure zones *(Fig. 4)*.

Heterogeneous aviation in the areas of airfields, cities and other important airspace areas at the same time: manned and unmanned aerial vehicles, aircraft models as well as their ordered and disordered squadrons *(Fig. 4)* have a high probability.

In this regard, the current situation of airspace control in the atmospheric layers up to altitudes of 2.485 to 3.107 miles is relevant today and the problem of air traffic control will increase.

Given this, SDT – Industrial Technologies included airspace control and air movement control

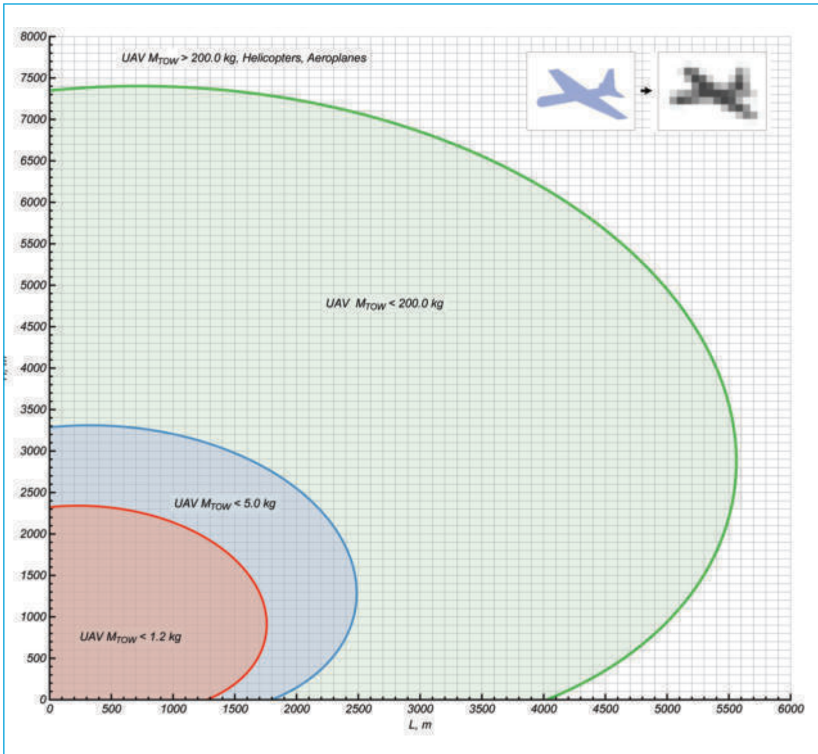


Fig. 5: *Detection boundaries of various air objects FAA and EASA* ▪

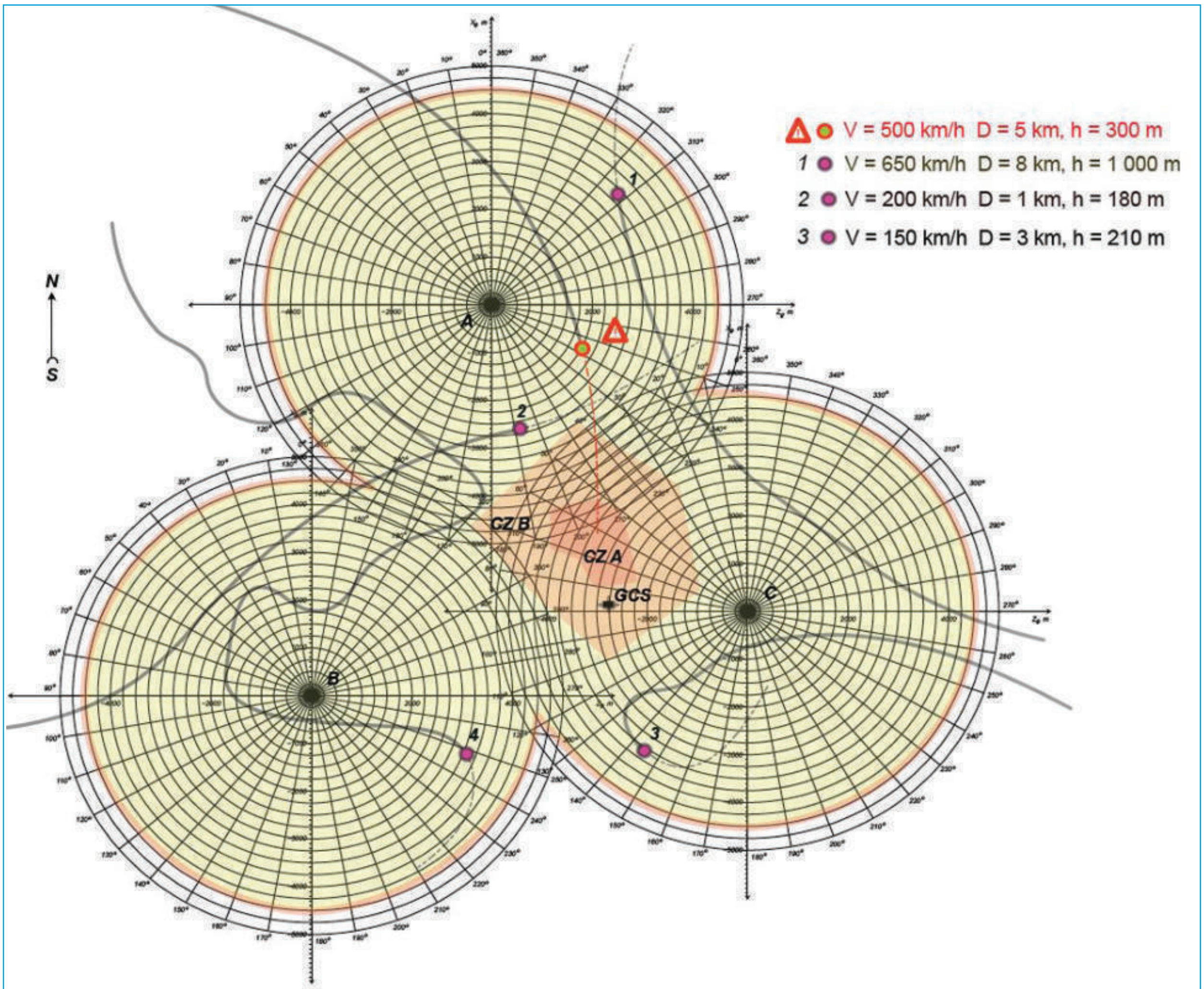


Fig. 6: *Configuration option of air defense system and air traffic control when covering an important object or space* ▪

system (AC&AMC system) in the transport system based on VTOL Aerotransporter 888 v.1.

Features of the developed AC&AMC system are:

- the possibility of fixing and tracking a huge number of air objects
- fully automatic operation mode
- the possibility of increasing the coverage area and the automatic formation of the overall digital appearance of the operational environment
- high accuracy in determining the current coordinates and motion parameters of all fixed airborne objects, including birds *(Fig. 5)*.

The combination of devices in a single system enables large spaces for airspace control, including cities and objects of important government agencies *(Fig. 6)*. The controlled space in the map on the surface of the earth *(Fig. 6)* is divided into zones: A (CTZ - covered territory zone), B (AZ - adjacent zone) and actually airspace control zone. To cover all zones, there are monitoring stations at 3 points (A, B, C) that transmit their information to the ground control station (GCS). In this example, the coverage area is more than 155 square miles, the speed of air objects is up to 373 mph and the maximum density of airspace is up to 800 air objects per square mile. Such functional indicators offer a high reliability of fix air objects in a controlled airspace. The creation of promising air transport systems requires the development of large amounts of components and devices. Many of them are original and not analogous among those produced by industrial operation. A large amount of research work, carried out by STD – Industrial Technologies, and their results enabled us to formulate tactical and technical requirements and to begin to develop an air transport system based on VTOL. ▪

Kontakt:
Dr. Boris Linschitz/Generaldirektor
Mobile: +49 172 66 33 404
boris.linschitz@sdt-industrial.com
Autoren:
Dr. Boris Linschitz
Dr. Vladimir Rostopchin
Dr. Arkadij Linschitz
SDT Industrial Technology
Alte Landstraße 23
D-85521 Ottobrunn, Germany
Tel : +49 (0) 89 209 816 22
www.sdt-industrial.com

Augsburg Innovation Park with the Technology Centre Augsburg

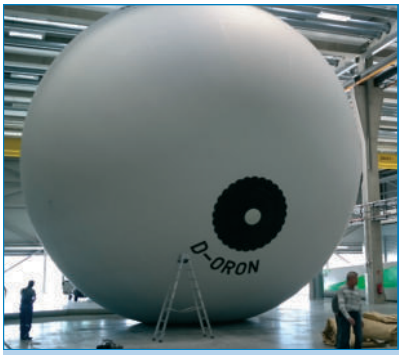
Location factor innovation competence

The new challenge in the aerospace industry is faster and more economical production, automation, greater flexibility and above all increased resource efficiency in the use of energy and materials throughout the entire production and use cycle of the aircraft.

Simulated aerial image, Innovation Park, Photo: © KCAP Architects & Planners ■

To meet these challenges, Augsburg has founded one of the largest economic development projects.

The Augsburg Innovation Park with the Technology Centre Augsburg is an economic development measure of the city of Augsburg and the Region of Augsburg, supported by the Free State of Bavaria, the Economic Chambers as well as further institutions.



Technical Centre Hall in the Technology Centre Augsburg, Photo: © Wolfgang Hehl ■

The goal is to support innovation and technology transfer for businesses in the field of aerospace, lightweight construction, fibre composites, mechatronics and automation, digitization, industry Technology companies can settle in the 70-hectare Innovation Park or work closely together with research institutions as a project group in the 12,000-m² Technology Centre Augsburg in order to improve production processes and products. 40 users such as start-ups, regional businesses and global players are already on site.

In the modern event area, over 15,000 specialists have exchanged information and experience on technological topics in the past 2 years. 13 technology-oriented research institutions from the above-mentioned technology fields are active in the Park and provide important contributions to moving the aerospace industry forward – such as the DLR German Aerospace Centre, the AMU Application Centre for Material and Environmental Research, the Fraunhofer Research Institute for Casting, Composite and Processing Technology IGCV and the ITA Institute of Textile Technology Augsburg as well as the central offices of the Bavarian and federal cluster institutions in the fields of carbon fibre, the environment, mechatronics, digitization and aerospace.

The innovation competence is also supported by excellent specialists provided by the university, technical colleges and further educational institutions.

Welcome to the Augsburg Aerospace Area! ■

Contact:

Augsburg Innovationspark GmbH

Wolfgang Hehl, Managing Director
Am Technologiezentrum 5
D-86159 Augsburg
Phone: +49(0)821 80 90 30 60
Email:
info@augsburg-innovationspark.com
www.augsburg-innovationspark.com